Self-Assessment With the Communication Profile for the Hearing Impaired: Pre- and Post-Cochlear Implantation

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Use of the Communication Profile for the Hearing Impaired (CPHI) was examined with adult recipients of a multichannel cochlear implant. Experiment 1 compared normative data from a multi-center study of hearing aid candidates and users (Erdman & Demorest, 1998a, 1998b) with preoperative implant candidates at Washington University School of Medicine. The greatest difference in scale score means was for the Communication Performance and the Personal Adjustment scales and is explained largely by audiologic variables and their consequences for these 2 populations. Experiment 2a compared the average scale scores for recipients of the Nucleus 22 or 24 Cochlear Implant System (SPEAK speech coding strategy) preoperatively with those at 3-months post-initial stimulation. The most dramatic improvements in scale score means was for the Communication Performance and the Personal Adjustment scales. Experiment 2b compared scale difference scores of these recipients with their ability on sound-alone speech recognition measures at 3-months post-initial stimulation. Difference scores increased as a function of improved speech recognition for the majority of scales.

Current evaluation of benefit following cochlear implantation is typically based on recorded speech recognition measures. Sole use of these measures precludes analyses of changes in functional communication performance, communication style, fluency of communication, and "quality-of-life," as described by adult cochlear implant recipients. Equal attention should be given to these psychosocial issues because adjustment difficulties are more prevalent among cochlear im-

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plant candidates than the general population. In addition, these factors contribute substantively to the overall benefit derived from cochlear implantation (Zhao, Stephens, Sim, & Meredith, 1997).

Self-assessment questionnaires address disability, handicap, expectations, practical maintenance issues, and performance resulting from implantation. Zwolan, Kileny, and Telian (1996) found that a questionnaire was the *only* measure to indicate functional benefit and satisfaction from implantation in 11 adults with prelinguistic onset of deafness. Self-assessment questionnaires can also assess psychosocial benefits resulting from a perception of lessened handicap and/or improved communication. Additionally, the patient's perception of change is becoming increasingly accepted as a valid measure of improvement. Wexler, Miller, Berliner, and Crary (1982) pointed out that the ultimate judge of the value of a technological advance is the patient. With the advent of managed care, *patients* are more often thought of as *clients* or *consumers*. Self-assessment questionnaires provide a way to quantify a client's perception of functional benefit and quality-of-life changes.

Several articles describe the use of customized and/or open-ended questionnaires to assess disability, handicap, expectations, functional issues, and/or quality-of-life changes resulting from cochlear implantation (e.g., Cunningham & Stoeckert, 1992; East & Cooper, 1986; Horn et al., 1991; Kelsall, Shallop, & Burnelli, 1995; Kou, Shipp, & Nedzelski, 1994; Maillet, Tyler, & Jordan, 1995; Tyler, 1994; Tyler & Kelsay, 1990; Zhao et al., 1997; Zwolan et al., 1996). Other studies have used questionnaires for which normative data and statistical information were available. These studies utilized the Performance Inventory for Profound and Severe Loss (PIPSL; Owens & Raggio, 1988), and the Communication Profile for the Hearing Impaired (CPHI; Demorest & Erdman, 1987).

The CPHI has been used with adult cochlear implant recipients in studies conducted at the University of Iowa (Knutson & Lansing, 1990; Lansing & Davis, 1990; Lansing & Seyfried, 1990), and Washington University School of Medicine (WUSM; Erdman et al., 1990). The CPHI is a 145-item inventory utilizing 22 scales and three importance ratings to assess areas of Communication Performance, Communication Environment, Communication Strategies, and Personal Adjustment. It was developed at Walter Reed Army Medical Center (WRAMC), where normative data were obtained on an active-duty military population of young males (Demorest & Erdman, 1987; Erdman & Demorest, 1990). Average scale scores range from 1.0 to 5.0, with lower scores representing greater difficulty in that area. Some scales are reversed for scoring. A sample Communication Profile is seen in Figure 1.

Lansing and her colleagues conducted three studies with adults with postlinguistic profound hearing impairment who completed the CPHI. In the first study, Knutson and Lansing (1990) correlated CPHI responses of 27 cochlear implant candidates with general measures of psychosocial maladjustment. They found

COMMUNICATION PROFILE

RECORD NUMBER: 244
NAME:

ID: pre-op eval
TEST DATE: 05/24/96

COMMUNICATION PERFORMANCE

	IMPORTANCE	SCALE SCORE	SCORE 1....2....3....4....5
SOCIAL	3.2	1.3	* / /
WORK	4.5	1.5	* / /
HOME	3.0	1.3	* / /
CONDITIONS:			
AVERAGE		1.6	* / /
ADVERSE		1.1	* / /
PROBLEM AWARENESS		5.0	/ / *

COMMUNICATION ENVIRONMENT

		1....2....3....4....5
COMMUNICATION NEED	3.2	/ / *
PHYSICAL CHARACTERISTICS	3.6	/ /*
ATTITUDES OF OTHERS	4.0	/ */
BEHAVIORS OF OTHERS	4.4	/ *

COMMUNICATION STRATEGIES

		1....2....3....4....5
MALADAPTIVE BEHAVIOR	3.4	/* /
VERBAL STRATEGIES	4.3	/ / *
NONVERBAL STRATEGIES	5.0	/ / *

PERSONAL ADJUSTMENT

		1....2....3....4....5
SELF-ACCEPTANCE	2.8	/ * /
ACCEPTANCE OF LOSS	4.2	/ */
ANGER	3.5	/ */
DISPLACEMENT OF RESPONSIBILITY	2.6	/ * /
EXAGGERATION OF RESPONSIBILITY	2.5	/ * /
DISCOURAGEMENT	1.2	* / /
STRESS	1.8	*/ /
WITHDRAWAL	1.3	* / /
DENIAL	4.6	/ / *

Figure 1. Sample Communication Profile for a cochlear implant candidate. Asterisks are the graphic representation of the scale score. Slashes indicate plus and minus 1 *SD* for the Walter Reed Army Medical Center (WRAMC) norms.

that use of ineffective communication strategies and poor adjustment to hearing loss were associated with higher likelihood of psychosocial difficulties. To aid in data interpretation, they also compared their scores on selected scales of the CPHI with the WRAMC norms (Demorest & Erdman, 1987). Scores appeared to be similar except for the Communication Performance at Home and the Withdrawal scales. In a second study, Lansing and Davis (1990) followed seven Ineraid (compressed analog speech coding strategy [CA]) or Nucleus 22 (FOF1F2 speech coding strategy) recipients to 18 months post-implantation. Each received an intensive 40-hour training program over a 10-day period, at either 1 or 9 months after initial stimulation. The program focused on analytical and synthetic auditory/audiovisual training. Although the authors did not specify the CPHI test time interval, they found differences between pre- and postoperative scores to generally be greater for the Personal Adjustment scales despite considerable variability among the participants. The authors therefore advised cautious interpretation of the data's clinical relevance. In the third study, Lansing and Seyfried (1990) analyzed 30 selected items from Personal Adjustment scales of the CPHI administered at 1-, 9-, and 18-months post-initial stimulation to 21 Ineraid (CA) or Nucleus (FOF1F2) recipients who had participated in one of the training paradigms described above. These selected items comprised Factor 1 as described by Demorest and Erdman (1987; feelings and emotions toward hearing loss) and were divided into (a) hearing-related feelings and attitudes and (b) general-communication feelings and attitudes. There was no difference in the time course of change for the two categories. However, as a group, the recipients reported a significant improvement in attitudes and feelings toward hearing loss after only 1 month of cochlear implant use. Four participants showed a significant change at 1 month post stimulation while eight demonstrated a more gradual change, exhibiting significant score changes beginning at 9 or 18 months. Of the nine participants who reported no significant change, many exhibited the highest scale scores preoperatively and/or reported little speech recognition ability post implantation.

A study performed at WUSM (Erdman et al., 1990) compared WRAMC norms (Erdman & Demorest, 1990) to the CPHI responses of 26 adult cochlear implant candidates (5 pre/perilinguistically deafened; 21 postlinguistically deafened). A two-tailed t test (Sokal & Rohlf, 1981, chap. 9) was used to determine significant differences. The configurations of the profiles for these two groups are shown in Figure 2. Mean scale scores for implant candidates were significantly lower ($p \leq .002$) for most Communication Performance scales (Social, Work, Home, Average Conditions, and Adverse Conditions) and Importance ratings (Work and Home). The younger WRAMC group, a larger percentage of whom were employed, reported greater communication need. Cochlear implant candidates reported their communication environments to be less challenging than the WRAMC population. Communication Strategies scale score means were similar for the two groups. Implant candidates reported greater psychosocial difficulties on six of eight Personal Adjustment scales, with the Displacement of Responsibility, Discouragement, and Withdrawal scale means being significantly different between the two populations.

Although the CPHI has a section tapping both functional benefit and psychosocial adjustment, most studies to date have focused on just one of these areas. Another limiting factor in some studies has been the small sample size. Additionally, although the implant recipients in the studies described above received substantial benefit from earlier processors and speech processing strategies, they used devices and strategies that provided significantly less open-set speech recognition than speech coding strategies used in this study (i.e., Nucleus

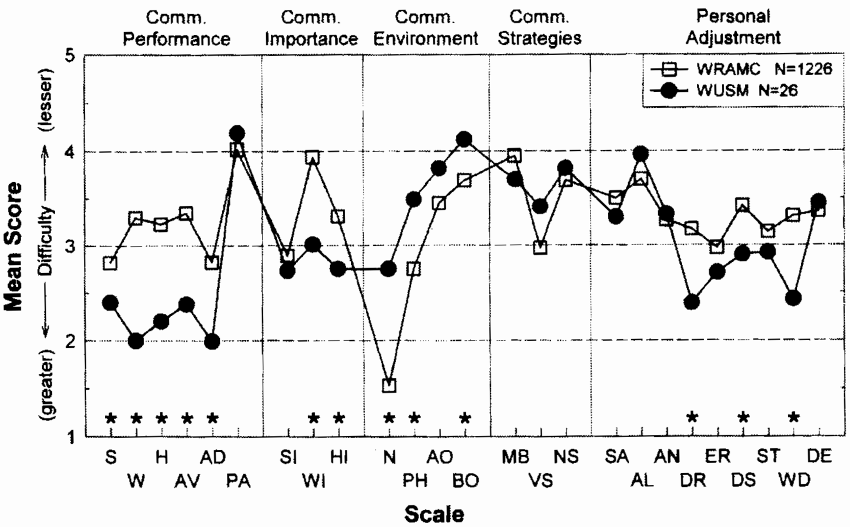

Figure 2. Mean Communication Profile for the Hearing Impaired (CPHI) profile. Information for Walter Reed Army Medical Center (WRAMC) taken from *CPHI Manual: A Guide to Clinical Use* by S.A. Erdman and M.E. Demorest, 1990, Simpsonville, MD: CPHI Services and information for Washington University School of Medicine (WUSM) taken from *Factors Affecting Adjustment to Hearing Loss* by S.A. Erdman et al., 1990, November, presented at the convention of the American Speech-Language-Hearing Association, Seattle, WA. $*p \leq .002$, two-tailed t test. CPHI scale abbreviations: Communication Performance, S = Social, W = Work, H = Home, AV = Average Conditions, AD = Adverse Conditions, PA = Problem Awareness; Communication Environment, N = Need, PH = Physical Characteristics, AO = Attitudes of Others, BO = Behaviors of Others; Communication Strategies, MB = Maladaptive Behaviors, VS = Verbal Strategies, NS = Nonverbal Strategies; Personal Adjustment, SA = Self-Acceptance, AL = Acceptance of Loss, AN = Anger, DR = Displacement of Responsibility, ER = Exaggeration of Responsibility, DS = Discouragement, ST = Stress, WD = Withdrawal, DE = Denial.

SPEAK [Skinner et al., 1994]; Ineraid CIS [Wilson et al., 1991]; Ineraid CIS [Dorman & Loizou, 1998]). In this study, two experiments were conducted to address these limitations. Experiment 1 explored responses of cochlear implant candidates compared to established norms for hearing aid candidates and users, and Experiments 2a and 2b explored changes in implant users' scores at 3 months post stimulation.

EXPERIMENT 1: COMPARISON OF MULTI-CENTER NORMS WITH COCHLEAR IMPLANT CANDIDATES' SCORES

The purpose of Experiment 1 was to update the Erdman et al. (1990) study by comparing the norms from the University of Maryland, Baltimore County (UMBC) multi-center study for hearing aid candidates and users with a larger cochlear implant candidate group. It was important to determine if trends noted with the small implant population ($N = 26$) would be observed when a larger sample was examined.

Method

Participants. Erdman and Demorest (1998a, 1998b) reported on a study involving five audiologic clinics representing diverse geographic regions and clinical settings headquartered at the UMBC. The resulting database of responses from over 1,000 persons with hearing impairment was established to permit a norm-referenced interpretation of the CPHI for those with mild to moderately-severe hearing losses. The participants ranged in age from 16 to 97 years ($M = 64.5$), with slightly more males than females (55.8% vs. 44.2%). A variety of ethnicities were represented, although the majority were Caucasian (82.6%). The greatest percentage of participants was unemployed or retired (62.5%) and married (56.2%). The majority had moderate sensorineural hearing loss with good word recognition ability and were hearing aid users.

The comparison CPHI database was from 60 cochlear implant candidates postlinguistically deafened and subsequently implanted at WUSM. Tables 1 and 2 present the demographic and audiologic data for the groups in the UMBC and WUSM studies. The WUSM participants ranged in age from 26 to 86 years ($M = 58.0$) with an almost equal number of males and females. Over 90% of the participants were Caucasian, 61.7% were unemployed or retired, and 63.3% were married. The majority of WUSM participants had profound sensorineural hearing loss with no word recognition ability even with appropriate amplification. In addition to the obvious audiologic differences, the WUSM implant population was smaller, younger, less culturally diverse, and less educated than those in the UMBC study.

Procedure. The cochlear implant candidates were instructed on how to complete the CPHI and asked to finish it at home. The CPHI consists of four sections, each of which has several scales. As shown in Figure 1, the Communication Performance section includes five scales of communication effectiveness in a variety of situations (Social, Work, Home, Average Conditions, and Adverse Conditions) and one evaluating the client's awareness of communication difficulties

Table 1

Demographic Characteristics of Subjects of University of Maryland, Baltimore County (UMBC) and Washington University School of Medicine (WUSM) Groups for Experiment 1

	UMBC (*N*=1,008) multi-center		WUSM (*N*=60)	
	N	%	*N*	%
Gender:				
Male	560	55.8	28	46.7
Female	444	44.2	32	53.3
Age group:				
≤25	19	1.9	0	0
25+ to 35	45	4.5	5	8.3
35+ to 45	70	7.0	12	20.0
45+ to 55	108	10.8	10	16.7
55+ to 65	166	16.6	11	18.3
65+ to 75	318	31.9	13	21.7
75+ to 85	242	24.3	8	13.3
85+	29	2.9	1	1.7
Race/ethnicity:				
White (not Hispanic)	800	82.6	55	91.7
Black (not Hispanic)	101	10.4	5	8.3
Hispanic	25	2.6	0	0
Asian/Pacific Islander	31	3.2	0	0
Native American/Alaskan	5	0.5	0	0
Multiple ethnicities	7	0.7	0	0
Education:				
≤8 years	45	4.9	4	6.6
8+ to 12 years	267	28.8	37	61.7
12+ to 16 years	288	31.1	12	20.0
16+ years	327	35.3	7	11.7
Employment status:				
Full-time	269	27.7	23	38.3
Part-time	95	9.8	0	0
Retired	459	47.3	19	31.7
Not employed	148	15.2	18	30.0
Marital status:				
Married	551	56.2	38	63.3
Single	166	16.9	8	13.3
Divorced/separated	97	9.9	4	6.7
Widowed	167	17.0	10	16.7

Note. Due to some missing data, not all percentages add up to 100.

(Problem Awareness). Problem Awareness scale questions are constructed such that even those with normal hearing agree with many of the questions. Therefore, scores less than 3.0 indicate the subject is either unaware of their problem or not prepared to admit it. Because the majority of respondents in both the WUSM and UMBC multi-center studies were not employed, these participants were instructed to answer the "work" questions to reflect experiences at "a place of business." The Communication Importance section assesses this topic in Social, Work, and Home environments but is not plotted on the Communication Profile (see Figure 1). The Communication Environment section includes both physical μand personal aspects with scales titled Communication Need, Physical Characteristics, Attitudes of Others, and Behaviors of Others. The Communication Need and Physical Characteristics scales probe communication demands in a spe-

Table 2

Mean, Median, and Standard Deviation *(SD)* of Audiological Variables for Two Subject Groups in Experiment 1

Variable	*N*	*M*	*Mdn*	*SD*	CNT[a]	DNT[b]
		UMBC multi-center group (N = 1,008)				
Better SRT[c]	985	30.2	30.0	18.2		
Worse SRT[c]	938	38.9	35.0	20.3		
Better PTA[d]	999	39.6	38.8	17.3		
Worse PTA[d]	999	52.3	47.5	23.2		
Better slope[e]	999	15.7	15.0	20.1		
Worse slope[e]	999	26.6	27.5	20.2		
Normal range[f]	1006	2.1	2.0	1.2		
PTA_{ANR}[g]	988	46.8	48.0	17.69		
		WUSM group (N = 60)				
Better SRT[c]	8	90.9	92.5	11.0	37	14
Worse SRT[c]	4	96.3	100.0	11.8	51	4
Better PTA[d]	59	109.2	108.0	11.9		
Worse PTA[d]	59	116.7	120.0	9.3		
Better slope[e]	NA[h]					
Worse slope[e]	NA[h]					
Normal range[f]	59	1.0	1.0			
PTA_{ANR}[g]	NA[h]					

Note. Due to some missing data, not all percentages add up to 100. UMBC = University of Maryland, Baltimore County; WUSM = Washington University School of Medicine.
[a]Could not test; hearing loss beyond output limits of audiometer. [b]Did not test. [c]Speech reception threshold. [d]Pure tone average threshold at .5, 1, 2, and 4 kHz; non-responses were set at 125 dB HL. [e]Pure tone average threshold at 2 and 4 kHz minus threshold at 500 Hz. [f]Frequency range through which hearing is normal (≤25 dB HL): 1 = Not normal through 500 Hz; 2 = Normal through 500 Hz; 3 = Normal through 1 kHz; 4 = Normal through 2 kHz. [g]Pure tone average threshold at frequencies above the normal range. [h]Not applicable.

cific context, whereas the Attitudes of Others and the Behaviors of Others scales are more psychological in nature (Erdman & Demorest, 1998a). The Communication Strategies section includes scales for measuring both ineffective and effective communication strategies. The Maladaptive Behaviors scale assesses strategies such as pretending to understand or ignoring the speaker as a way to request repetition. The Verbal Strategies and Nonverbal Strategies scales assess willingness to be proactive in the communication process, whether by asking others for clarification or moving away from the noise for example. The Personal Adjustment section includes eight scales assessing acceptance and adjustment to hearing loss (Self-Acceptance, Acceptance of Loss, Anger, Displacement of Responsibility, Exaggeration of Responsibility, Discouragement, Stress, and Withdrawal). The ninth scale, titled Denial, examines reactions to typical communication problems. Like the Problem Awareness scale, items on the Denial scale are constructed such that even those with normal hearing agree with many of the questions. Again, scores less than 3.0 indicate the subject is disagreeing more than agreeing with the questions and may therefore be painting an unrealistically positive picture of their adjustment status.

Data analysis. A two-tailed t test was used to determine significant differences in mean scale scores between the UMBC and WUSM groups. For clinical ease, a response change of one scale unit may be considered significant, but the value is smaller for many scales (Demorest & Erdman, 1988).

Results

Despite the increased sample size for both groups compared with the 1990 study, the configuration of the profile across scales was maintained for each group with few exceptions, as were the trends described above for the Erdman et al. (1990) study. Significant mean differences ($p \leq .002$) between the WUSM and UMBC groups were found for 18 of 25 scales (see Figure 3). In addition, six mean scale scores were significantly different for this study that were not significant in the 1990 study. Most of the differences in scale score means for the WUSM and UMBC groups can be explained by the differing audiologic variables and their consequences.

Communication performance. The rank order of means for the WUSM group differed from the population in the UMBC multi-center study for the Communication Performance scales: Work < Social < Home compared with Social < Work < Home, respectively. That is, the cochlear implant candidates at WUSM found communication to be easiest at home and most difficult at work. Those in the UMBC study also found communication to be easiest at home but cited social situations as most difficult. Both groups had more difficulty in adverse conditions. Cochlear implant candidates indicated greater awareness of their problem. All Communication Performance scale score means (including Problem Awareness) were significantly different for the two studies ($p \leq .002$).

Communication importance. The rank order for the importance of these three scales was the same for both populations (Social < Home < Work) with social situations most important and work situations least important. However, all Communication Importance scale means were significantly different for the two populations, with the implant candidates indicating greater importance for all three situations than those in the UMBC study.

Communication environment. The shape of the profile for the two studies was identical for the Communication Environment section (Communication

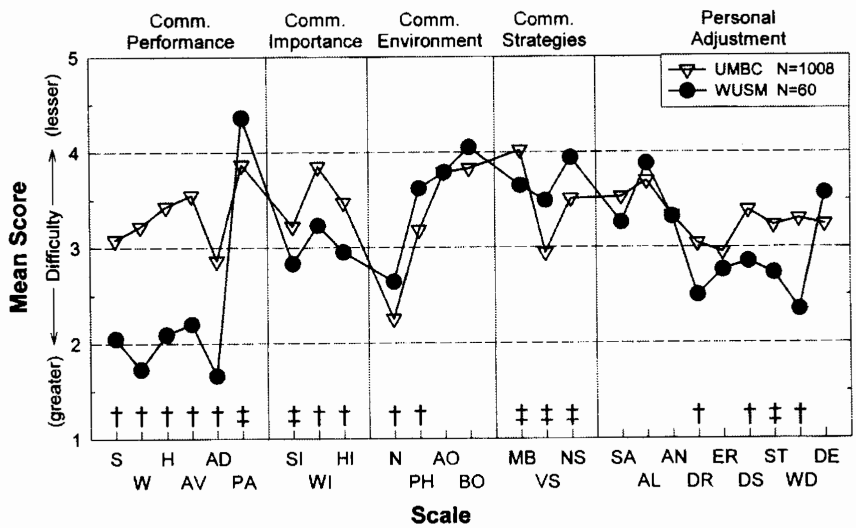

Figure 3. Mean Communication Profile for the Hearing Impaired (CPHI) profile. Information for University of Maryland, Baltimore County (UMBC) taken from "Adjustment to Hearing Impairment I: Description of a Heterogeneous Clinical Population" by S.A. Erdman and M.E. Demorest, 1998a, *Journal of Speech-Language-Hearing Research, 41,* 107-122 and information for Washington University School of Medicine (WUSM) taken from the current study, Experiment 1. †$p \leq .002$, two-tailed t test, for Walter Reed Army Medical Center (1990) and WUSM (1990). ‡Additional significant scales over *Factors Affecting Adjustment to Hearing Loss* by S.A. Erdman et al., 1990, November, presented at the convention of the American Speech-Language-Hearing Association, Seattle, WA. CPHI scale abbreviations: Communication Performance, S = Social, W = Work, H = Home, AV = Average Conditions, AD = Adverse Conditions, PA = Problem Awareness; Communication Environment, N = Need, PH = Physical Characteristics, AO = Attitudes of Others, BO = Behaviors of Others; Communication Strategies, MB = Maladaptive Behaviors, VS = Verbal Strategies, NS = Nonverbal Strategies; Personal Adjustment, SA = Self-Acceptance, AL = Acceptance of Loss, AN = Anger, DR = Displacement of Responsibility, ER = Exaggeration of Responsibility, DS = Discouragement, ST = Stress, WD = Withdrawal, DE = Denial.

Need < Physical Characteristics < Attitudes of Others < Behaviors of Others). Cochlear implant candidates had significantly less communication need and found their physical environments less challenging than those in the UMBC multi-center group. However, they judged the attitudes and behaviors of others in a similar fashion as the UMBC multi-center respondents. In contrast, the Behaviors of Others mean scale score was significantly different between the two groups in the Erdman et al. study (1990).

Communication strategies. Cochlear implant candidates reported significantly more frequent use of maladaptive behaviors and of verbal and nonverbal strategies than those in the UMBC group. This result confirms the findings of Erdman and Demorest (1998b) that those with greater hearing loss tend to use more communication strategies. The rank ordering of means showed that, like those with lesser degrees of loss, cochlear implant candidates employed more nonverbal than verbal strategies.

Personal adjustment. The shapes of the profiles for the WUSM and UMBC respondents were most dissimilar for the Personal Adjustment scales. However, the trends noted in the Erdman et al. (1990) study were generally maintained with the larger sample size of the present study. No significant differences for mean scale scores were noted for the Self-Acceptance, Acceptance of Loss, Anger, Exaggeration of Responsibility, and Denial scales. Cochlear implant candidates reported significantly more displacement of responsibility, discouragement, stress, and withdrawal than the respondents in the UMBC study.

Discussion

The larger sample size for this comparison study of WUSM and UMBC revealed significantly different scale score means for an additional seven scales relative to the smaller sample size in the WUSM-WRAMC comparison study (Erdman et al., 1990). The Behaviors of Others scale was the only scale that was significantly different in the original study but not for the present study. No explanation other than increased sample size is offered. The configurations of the profiles remained nearly identical to the earlier study.

For the present study, although mean scores on most of the scales were significantly different between the WUSM and the UMBC groups, the configuration of the profiles was remarkably similar. This was especially true for the Communication Importance and Communication Environment sections in which rank ordering of the scale score means was identical. Erdman and Demorest (1998a) similarly found that, despite the greater heterogeneity in the UMBC study, the communication environments were similar to those of the WRAMC group (Erdman & Demorest, 1990). For the present experiment, the shape of the two profiles for the Communication Performance, Communication Strategies, and Personal Adjustment sections are similar, although they do not follow as closely as for the Communication Importance and Environment sections. Many of the statistically significant differences are not surprising given the widely differing audiologic variables for the two groups of respondents.

The more communicatively challenged cochlear implant candidates may have found conversing at work or a "place of business" sufficiently more difficult, explaining why they ranked work situations more challenging than social situations when the reverse was seen for the hearing aid candidates and users in the UMBC group. As an equal percentage of respondents in each study were no longer working, it is plausible that the implant candidates' reduced ability to communicate may, in part, have dictated need and thus explain why they reported lower need for communication. The finding of less challenging physical environments may be due to the implant candidates' limited ability to hear background noise or an avoidance of difficult listening environments. In addition, some candidates were not wearing hearing aids when evaluated and therefore could not have accurately answered questions pertaining to the background noise in a given situation and its effect on their communication abilities. Certainly, the greater communication and psychosocial difficulties seen in many of these implant candidates can readily explain the differences seen on the Discouragement, Stress, and Withdrawal scales. Knutson and Lansing (1990) noted that the Withdrawal scale score means were dissimilar between their cochlear implant candidates and the WRAMC norms. As degree of hearing loss increases, more difficulties can be expected in the adjustment to that loss (Erdman & Demorest, 1998b; Knutson & Lansing, 1990). The differences in the scores on the Displacement of Responsibility scales between the WUSM and UMBC groups are perhaps related to an expectation of the implant candidates that communication problems should be more obvious to others, given their significant degree of hearing loss. It may also be indicative of greater passivity in the face of more challenging or, in the case of especially poor speechreaders, nearly impossible communication situations.

The profiles for other published studies utilizing the CPHI are plotted in Figure 4 (Demorest & Erdman, 1987 [WRAMC]; Erdman & Demorest, 1998a [UMBC]; Garstecki & Erler, 1996 [NU]; Hyde, Malizia, Riko, & Storms, 1992 [TORONTO]). The configurations of the profiles are nearly identical. Although there are obvious mean differences between the WUSM group and these studies, the overall shapes of the profiles are strikingly similar. There are only a few noteworthy differences in profile configuration. For the published studies, the Work scale score mean is ranked in difficulty between the Social and Home means, whereas it is ranked lowest for the implant candidates. The Communication Strategies section also revealed a different configuration for the two groups. While both indicated more frequent use of nonverbal strategies, the implant candidates also reported greater use of ineffective communication strategies as measured by the Maladaptive Behaviors scale. In addition, the difference in mean scale scores between Maladaptive Behaviors and Verbal Strategies is much less for the cochlear implant candidates than for the other studies. In the Personal Adjustment section, the largest differences in profile shape occur for Displacement of Responsibility and Exaggeration of Responsibility, with implant candidates reporting greater displacement than exaggeration. Lastly, implant candidates also digress from the other studies for the Withdrawal scale, the lowest mean score of all Personal Adjustment scales.

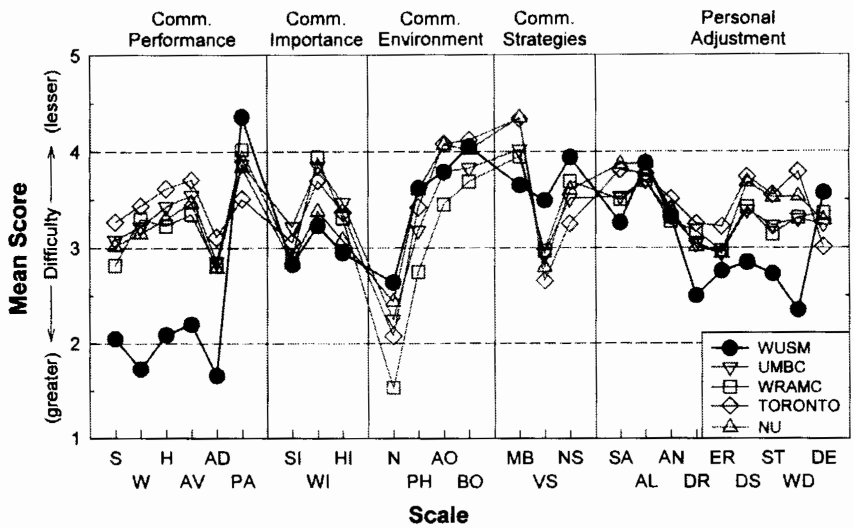

Figure 4. Mean Communication Profile for the Hearing Impaired (CPHI) profile for the present study, Washington University School of Medicine (WUSM); University of Maryland, Baltimore County (UMBC) information from "Adjustment to Hearing Impairment I: Description of a Heterogeneous Clinical Population" by S.A. Erdman and M.E. Demorest, 1998a, *Journal of Speech-Language-Hearing Research, 41,* 107-122; Walter Reed Army Medical Center (WRAMC) information from *CPHI Manual: A Guide to Clinical Use,* by S.A. Erdman and M.E. Demorest, 1990, Simpsonville, MD: CPHI Services; TORONTO information from *Evaluation of a Self-Assessment Inventory for the Hearing Impaired* (Project Report No. 6606-4122-45), by M.L. Hyde, K. Malizia, K. Riko, and D. Storms, 1992, Toronto, Ontario, Canada: Mount Sinai Hospital/The Toronto Hospital, Otologic Function Unit; and NU (Northwestern University) information from "Older Adult Performance on the Communication Profile for the Hearing Impaired" by D.C. Garstecki and S.F. Erler, 1996, *Journal of Speech and Hearing Research, 39,* 28-42. CPHI scale abbreviations: Communication Performance, S = Social, W = Work, H = Home, AV = Average Conditions, AD = Adverse Conditions, PA = Problem Awareness; Communication Environment, N = Need, PH = Physical Characteristics, AO = Attitudes of Others, BO = Behaviors of Others; Communication Strategies, MB = Maladaptive Behaviors, VS = Verbal Strategies, NS = Nonverbal Strategies; Personal Adjustment, SA = Self-Acceptance, AL= Acceptance of Loss, AN = Anger, DR = Displacement of Responsibility, ER = Exaggeration of Responsibility, DS = Discouragement, ST = Stress, WD = Withdrawal, DE = Denial.

EXPERIMENT 2: USE OF THE CPHI TO ASSESS BENEFIT FROM A COCHLEAR IMPLANT

The goal of Experiment 2 was to determine if the CPHI could be used as a valid self-assessment tool of benefit from a cochlear implant. Comparison of the average scale scores for recipients of the Nucleus 22 or 24 Cochlear Implant Sys-

Table 3

Sound-Alone Speech Perception Measures for 19 Adult Cochlear Implant Recipients: Experiment 2a

			Sound-alone tracking rate[a]	
Recipient number	**NU-6[b] word score (%)**	**NU-6[b] phoneme score (%)**	**Words per minute**	**% of ceiling rate**
		***Above average* performers ($N = 6$)**		
1	74	91	96.4	75
2	64	83	82.4	77
3	64[c]	77[c]	73.5	65
4	60[c]	78[c]	78.5	70
5	58	84	108.9	90
6	52	70	81.8	69
		***Average* performers ($N = 8$)**		
7	50	74	63.6	62
8	46	72	64.2	CNT[d]
9	46	69	42.0	43
10	44	69	52.0	52
11	30	61	45.7	40
12	30	53	48.7	51
13	26[c]	53[c]	65.2	61
14	26	53	64.6	59
		***Below average* performers ($N = 5$)**		
15	22[c]	46[c]	49.0	41
16	20	48	43.6	39
17	4	20	CNT	CNT
18	0	14	DNT[e]	DNT
19	DNT	DNT	CNT	CNT

[a]Speech Tracking (from "A Method for Training and Evaluating the Reception of Ongoing Speech," by C.L. De Filippo and B.L. Scott, 1978, *Journal of the Acoustical Society of America, 63*, 1186-1192). [b]NU-6 Word Lists (from *An Expanded Test of Auditory Discrimination Utilizing CNC Monosyllabic Words: Northwestern University Auditory Test No. 6* [Technical Report No. SAM-TR-66-55], by T.W. Tillman and R. Carhart, 1966, Brooks Air Force Base, TX: USAF School of Aerospace Medicine). [c]CNC Word Lists (from "Revised CNC Lists for Auditory Tests," by G. Peterson and I. Lehiste, 1962, *Journal of Speech and Hearing Disorders, 27*, 62-70). [d]Could not test. [e]Did not test.

tem (SPEAK speech coding strategy) preoperatively and at 3-months post-initial stimulation were made in Experiment 2a. Comparison of the scale difference scores for these recipients with their ability to understand on sound-alone speech recognition measures at 3-months post-initial stimulation were made in Experiment 2b.

Method

Participants. Nineteen adult cochlear implant recipients of the Nucleus 22 or 24 Cochlear Implant System with the SPEAK speech coding strategy had completed the CPHI at their 3-month post-initial stimulation evaluation. Two were prelinguistically deaf, and 17 were postlinguistically deafened.

Procedure. The procedure for administration of the CPHI was described in Experiment 1. Eighteen of the participants responded to recorded NU-6 50-word lists (Tillman & Carhart, 1966) or CNC word lists (Peterson & Lehiste, 1962) presented at 70 dB SPL (scored for phonemes and words correct); 16 of the 19 participants responded to sound-alone speech tracking (De Filippo & Scott, 1978) conducted live voice at an average of 60 dB A (measured at the recipient's headset microphone). Participants not evaluated with one or both of these measures had little or no open-set speech recognition.

Data analysis. When considering the overall pattern of scores on these measures, these 19 recipients fell into a natural grouping of performance with only a slight overlap at some category boundaries. These performance categories were labeled *above average, average,* and *below average* (see Table 3). Monosyllabic word scores ranged from 52-74% for the *above average* group, from 26-50% for the *average* group, and from 0-22% for the *below average* group (one *below average* subject was not tested on this measure). Phoneme scores ranged from 70-91% for the *above average* group, from 53-74% for the *average* group, and from 14-46% for the *below average* group. Speech tracking rates ranged from 73.5-108.9 words per minute (wpm) for the *above average* group, from 42-65.2 wpm for the *average* group, and from 43.6-49 wpm for the *below average* group (three *below average* participants were not tested on this measure). Percentage of speech tracking ceiling rates ranged from 65-90 for the *above average* group, from 40-62 for the *average* group, and from 39-41 for the *below average* group.

The CPHI mean scale scores were compared preoperatively and at 3-months post-initial stimulation. Small sample size did not permit formal statistical analysis. The number of recipients in each performance group for whom there was a statistically significant change in CPHI score from the preoperative to the 3-months post-initial stimulation evaluation was calculated.

Results

Experiment 2a. The pre- and postoperative profiles of mean scores for each scale of the CPHI are seen in Figure 5. The Communication Performance in Social Situations scale had the greatest percentage of implant recipients with significantly improved scores at 3-months post-initial stimulation (79%). More than half of the recipients (53%) showed significant improvement on the Work, Home, Average Conditions, and Withdrawal scales. Nearly half of the recipients (47%) showed a significant improvement on the Adverse Conditions and the Stress scale. The Work scale score mean continued to be lower than the mean for the Social and Home scales. Little change was seen for effective communication strategies as described on the Verbal Strategies and Nonverbal Strategies scales. However, nearly half of the implant recipients reported significantly fewer ineffective or maladaptive strategies and behaviors.

Experiment 2b. CPHI difference scores between pre- and 3-months post-initial stimulation mean scale scores for each of the three groups are seen in Table 4. Difference scores increased as a function of improved speech perception per-

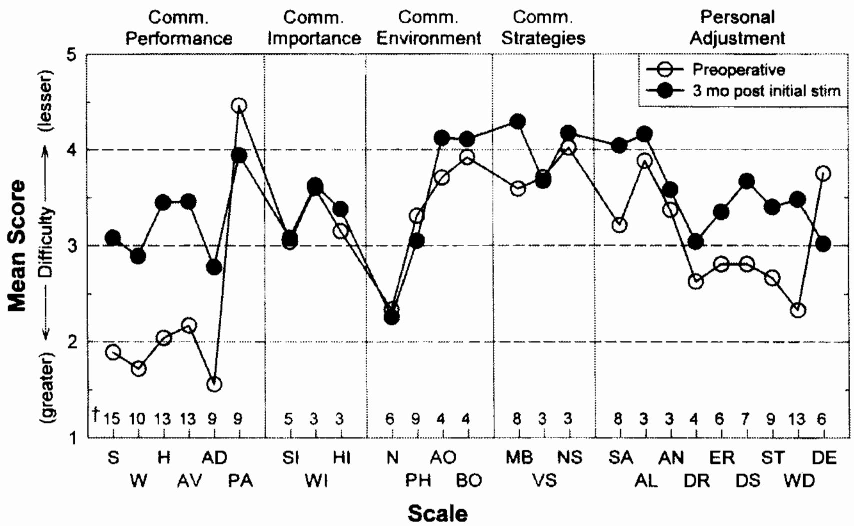

Figure 5. Mean Communication Profile for the Hearing Impaired (CPHI) profile for 19 adult cochlear implant recipients preoperatively and at 3-months post-initial stimulation, Experiment 2a. The number of recipients who had a significantly higher score at 3-months post-initial stimulation is along the horizontal axis. CPHI scale abbreviations: Communication Performance, S = Social, W = Work, H = Home, AV = Average Conditions, AD = Adverse Conditions, PA = Problem Awareness; Communication Environment, N = Need, PH = Physical Characteristics, AO = Attitudes of Others, BO = Behaviors of Others; Communication Strategies, MB = Maladaptive Behaviors, VS = Verbal Strategies, NS = Nonverbal Strategies; Personal Adjustment, SA = Self-Acceptance, AL= Acceptance of Loss, AN = Anger, DR = Displacement of Responsibility, ER = Exaggeration of Responsibility, DS = Discouragement, ST = Stress, WD = Withdrawal, DE = Denial.

formance for 15 of 22 scales including: Social, Work, Home, Average Conditions, Adverse Conditions, Problem Awareness, Work Importance, Attitudes of Others, Maladaptive Behaviors, Nonverbal Strategies, Self-Acceptance, Displacement of Responsibility, Exaggeration of Responsibility, Withdrawal, and Denial. Unlike Lansing and Davis' (1990) results, the Communication Performance scale difference scores were greater than the Personal Adjustment scale difference scores.

Table 4

Mean Communication Profile for the Hearing Impaired (CPHI) Difference Scores (3-Months Post-Initial Stimulation Mean Minus the Preoperative Mean) for Each of Three Performance Groups of 19 Adult Cochlear Implant Recipients: Experiment 2b

Scale	*Above average*	*Average*	*Below average*
Communication performance			
Social[a]	1.53	1.30	0.60
Work[a]	1.45	1.27	0.69
Home[a]	1.75	1.46	0.90
Average conditions[a]	1.62	1.35	0.77
Adverse conditions[a]	1.52	1.34	0.65
Problem awareness[a]	-0.77	-0.61	-0.07
Communication importance			
Social	0.06	0.00	0.07
Work[a]	0.29	0.10	-0.40
Home	0.25	0.33	0.04
Communication environment			
Communication need	-0.53	0.06	0.23
Physical characteristics	-0.18	-0.37	-0.16
Attitudes of others[a]	0.55	0.43	0.22
Behaviors of others[a]	0.22	0.22	0.12
Communication strategies			
Maladaptive behaviors[a]	1.09	0.65	0.32
Verbal strategies	-0.02	0.22	-0.45
Nonverbal strategies[a]	0.37	0.28	-0.35
Personal adjustment			
Self-acceptance[a]	0.98	0.80	0.70
Acceptance of loss	0.18	0.33	0.29
Anger	0.22	0.46	-0.20
Displacement of responsibility[a]	0.63	0.43	0.12
Exaggeration of responsibility[a]	0.95	0.54	0.04
Discouragement	0.95	0.79	0.87
Stress	0.94	0.58	0.70
Withdrawal[a]	1.55	0.98	0.94
Denial[a]	-0.98	-0.66	-0.55

[a]Difference scores increase as a function of improved speech perception performance.

However, the test interval for Lansing and Davis' study was not reported by the authors.

The number of recipients in each performance group for whom there was a statistically significant change in CPHI score from the preoperative to the 3-months post-initial stimulation evaluation is shown in Figure 6. The majority of recipients in the *above average* and *average* performance groups showed significant changes on the Withdrawal scale and on at least three of five Communication Performance scales. The majority of the *below average* performers showed a significant change on the Social scale. Although significant improvements were seen for some, the majority of *below average* participants did not show significant improvement on any other scales.

Response patterns. Responses on the Communication Performance and Per-

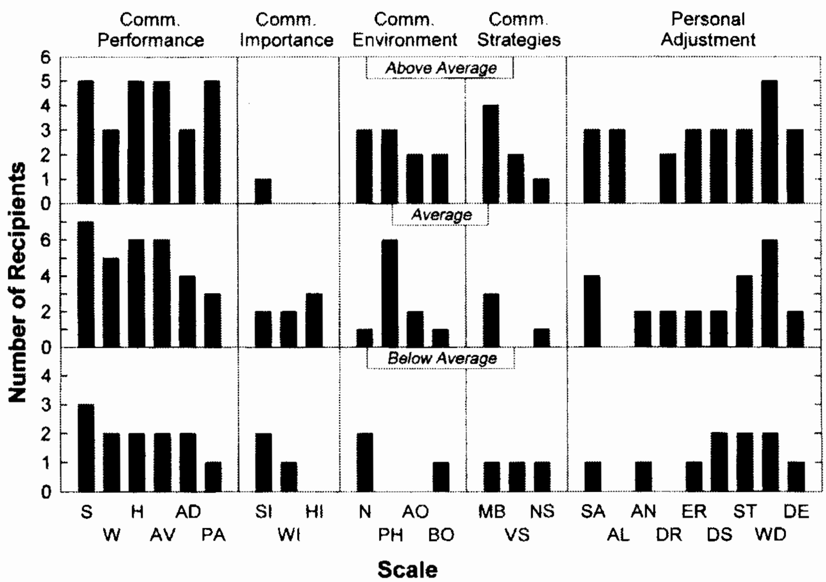

Figure 6. Number of 19 adult cochlear implant recipients for each performance group showing a clinically significant change preoperatively to 3-months post-initial stimulation, Experiment 2b. Communication Profile for the Hearing Impaired (CPHI) scale abbreviations: Communication Performance, S = Social, W = Work, H = Home, AV = Average Conditions, AD = Adverse Conditions, PA = Problem Awareness; Communication Environment, N = Need, PH = Physical Characteristics, AO = Attitudes of Others, BO = Behaviors of Others; Communication Strategies, MB = Maladaptive Behaviors, VS = Verbal Strategies, NS = Nonverbal Strategies; Personal Adjustment, SA = Self-Acceptance, AL= Acceptance of Loss, AN = Anger, DR = Displacement of Responsibility, ER = Exaggeration of Responsibility, DS = Discouragement, ST = Stress, WD = Withdrawal, DE = Denial.

sonal Adjustment scales were used to analyze patterns of change for the group of Nucleus 22 or 24 implant recipients who used the SPEAK strategy. The Communication Importance, Communication Environment, and Communication Strategies sections were excluded from this analysis because less than one third of the recipients demonstrated significant postoperative improvements for most of these scales. Five patterns of change for responses to the Communication Performance and Personal Adjustment sections were observed (see Table 5). *Below average* performers tended to exhibit Pattern 1, with three of the five recipients showing no significant improvement on any scale. These three recipients had no open-set speech recognition ability; two were prelinguistically deaf. *Average* performers were represented across all patterns, with the majority of recipients demonstrating Pattern 4 or 5. *Above average* performers tended to exhibit Pattern 4 or 5, with half exhibiting Pattern 5.

Discussion

For Experiment 2, more than half of the recipients showed significant improvements at 3-months post-initial stimulation on all five Communication Performance scales. The greatest number of recipients reported a significant improvement on the Social scale; social situations were also judged to be the most important. The Work scale mean score remained lower than the Social and Home

Table 5

Response Patterns on the Communication Performance and Personal Adjustment Scales for 19 Adult Cochlear Implant Recipients

Pattern #	Pattern description	Performance: *Above average*	Performance: *Average*	Performance: *Below average*
1	No significant improvement on any scale.	0	1	3
2	Positive direction of change on at least 3 of 5 Communication Performance scales only.	0	1	0
3	Positive direction of change on at least 4 of 8 Personal Adjustment scales only.	1	1	0
4	Significant improvement on at least 3 of 5 Communication Performance scales; positive direction of change on at least 4 of 8 Personal Adjustment scales.	2	3	1
5	Significant improvement on at least 3 of 5 Communication Performance scales; significant improvement on at least 4 of 8 Personal Adjustment scales.	3	2	1

scale means postoperatively, indicating that this situation presented the most difficulty for the cochlear implant recipients. The Work scale had only 10 of 19 respondents showing a significant improvement, whereas the Social and Home scales had 15 of 19 and 13 of 19 respondents respectively, showing a significant improvement. The Personal Adjustment scales of Stress and Withdrawal had the greatest number of recipients reporting significant improvement. It seems reasonable to expect that initial improvements would be more readily seen for the Communication Performance scales than for Personal Adjustment scales because adjustment difficulties are often the end result of a slow progression of disturbances arising from the initial impairment (Erber, 1996). The two participants with prelinguistic deafness showed no significant improvement on any scales at 3-months post-initial stimulation. In the study by Lansing and Seyfried (1990), many of the participants showing no significant improvement on the CPHI also had little speech recognition ability with their cochlear implant. Given the long-term deafness of these two participants, benefits may emerge more slowly. Difference scores grew as a function of improved communication performance for most of the CPHI scales. Although this might seem logical for the Communication Performance scales, most of the Personal Adjustment scales also demonstrated the same trend. Five response patterns of change were noted when examining the Communication Performance and Personal Adjustment sections.

GENERAL DISCUSSION

The results of Experiments 1 and 2 showed that adults with mild to moderately-severe hearing loss, and those with severe and profound hearing loss who are cochlear implant candidates, provide significantly different profiles of responses on the CPHI. Due to the increased communication difficulties and resulting psychosocial sequelae experienced by those with severe and profound hearing impairment, these results were not unexpected. Differences were seen for most of the CPHI scales, with the largest differences noted for the Communication Performance scales (Social, Work, Home, Average Conditions, and Adverse Conditions) and the Personal Adjustment scale (Withdrawal).

Despite these mean differences, some specific trends noted by Erdman and Demorest (1998a) for the hearing aid candidates and users were applicable to the performance of the cochlear implant group: (a) communication performance was best at home; (b) communicating at work and in social situations were of greatest and least importance, respectively; (c) attitudes and behaviors of others did not pose the same challenges as the need for communication and the characteristics of the listening environment; (d) those with greater hearing loss tended to use communication strategies more frequently and have poorer scores on the Personal Adjustment scales; (e) nonverbal strategies were used more often than verbal ones; and (f) cochlear implant candidates were aware of their communication difficulties and recognized the resulting psychosocial consequences.

For the group of 19 cochlear implant recipients using the SPEAK speech coding strategy, all five Communication Performance scale scores and the Withdrawal scale score mean improved at 3-months post-initial stimulation, consistent with clinical experience and anecdotal reports from cochlear implant recipients worldwide. For the majority of scales, the preoperative to 3-months post-initial stimulation difference score increased as a function of the amount of improvement in speech recognition ability. For *below average* performers there were fewer scales with significant improvements, and those with pre- or perilinguistic deafness showed no improvements at all. These results are in contrast to Zwolan et al. (1996) who found that a customized questionnaire was the only measure to show improvement for 11 implant recipients who were prelinguistically deafened. Lansing and Seyfried (1990), however, found that implant recipients with minimal open-set speech recognition ability demonstrated little or no change on the CPHI at 18-months post-initial stimulation. Comparative analysis of response patterns and rate of improvement on the Communication Performance and Personal Adjustment sections at 3-months post-initial stimulation may be the first indications of differing time course changes for improvements in understanding versus improvements in psychosocial adjustment. These differing time course changes may help us learn more about how individuals vary in their adaptation to significant hearing impairment.

Some precautions should be followed when using the CPHI with cochlear implant candidates and recipients. Because some candidates may be unable to wear or tolerate amplification, several questions on the CPHI may need clarification to be answered appropriately. For example, Question #26 reads, "In difficult listening situations, I position myself so I can hear as well as possible." The candidate may need to be instructed that the intent of the question is to determine his or her behavior when communication difficulty is experienced, not whether he or she can "hear" in that situation. Several Communication Performance questions ask about understanding on the telephone, television, and in large-area situations such as places of worship and schools. Because many cochlear implant candidates use TTYs, closed- and open-captioning, and real-time captioning, they may answer these questions by considering their performance with these visual assistive devices. The intent of the questions is to determine functioning in the auditory channel. Particular care should be taken when administering the CPHI to those who are retired. It should be explained that the "work" questions are attempting to assess their performance in situations outside the home with unfamiliar speakers, such as at the grocery store or bank.

The CPHI is a psychometrically rigorous self-assessment measure that can be used as an evaluation tool for demonstrating the improved fluency of communication and resulting psychosocial benefits after cochlear implantation. The results of this study support the CPHI's validity as a tool for assessing coping and adjustment to hearing impairment for cochlear implant candidates and recipients.

Further research should focus on the use of the CPHI to monitor long-term progress of implant recipients, as timing of post-rehabilitation assessments can significantly influence the degree of benefit seen (Malinoff & Weinstein, 1989; Seyfried, 1990, as cited by Lansing & Seyfried, 1990). A larger sample of cochlear implant recipients would allow exploration for trends of increased difference scores with improvement in sound-alone speech recognition. It would then be possible to determine whether the patterns noted in this study are confirmed or if new patterns emerge. This could lead to a clearer understanding of the variables determining how individuals adapt to significant hearing impairment. In this study, the CPHI did not show improvement for the two recipients who were prelinguistically deaf. Data from a larger sample would provide clarification into whether this measure could be used to assess benefit from cochlear implantation. The administration of the CPHI to "significant others" (e.g., a spouse, relative, close friend) and a comparison of responses with those of the implant candidate or recipient might provide an alternative way of assessing long-term benefit.

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