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The Effect of Hearing Aids and Frequency Modulation Technology on Results from the Communication Profile for the Hearing Impaired

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Abstract

Hearing impairment has been associated with decline in psychosocial function. Previous investigations have reported that the utilization of hearing aids can ameliorate these reductions in psychosocial function. To date, few investigations have examined the effects of frequency modulation technology on hearing handicap, adjustment to hearing loss, and communicative strategies. The purpose of this investigation was to examine these effects and to compare them to the benefits obtained when using hearing aids alone. Subjects ranged in age from 34 to 81 years and had mean pure-tone thresholds consistent with a bilateral moderate to severe sloping sensorineural hearing loss. All subjects wore hearing aids only and hearing aids plus FM system in a randomized fashion. The Communication Profile for the Hearing Impaired (CPHI) was administered prior to fitting the study devices and once a month for three months in each of the two conditions. A statistically significant difference between device conditions was obtained for the Importance of Communication in Work Situations subscale. Additionally, statistically significant differences over time were noted in several CPHI subscales. Despite statistical significance, none of these results were clinically significant. The implications of these results will be discussed.

Key Words: CPHI, frequency modulation (FM) system, hearing aids, self-assessment

Abbreviations: APHAB = Abbreviated Profile of Hearing Aid Benefit; BTE = behind-the-ear; CPHI = Communication Profile for the Hearing Impaired; FM = frequency modulation; ICF = International Classification of Function; MIL = Most Intelligible Listening level; PTA = average of the pure-tone air-conduction thresholds at 500, 1000, and 2000 Hz; QOL = quality of life; SAV = select-a-vent; SNHL = sensorineural hearing loss; SNR = signal-to-noise ratio; WRS = word recognition score

Sumario

Los trastornos auditivos han sido asociados con una disminución en el funcionamiento psico-social. Investigaciones previas han reportado que la utilización de auxiliares auditivos puede atenuar esta reducción en la función psico-social. A la fecha, pocas investigaciones han examinado los efectos de la tecnología de modulación de la frecuencia (FM) sobre el impedimento auditivo, el ajuste a la pérdida auditiva, y las estrategias de comunicación. El

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propósito de esta investigación fue examinar estos efectos y compararlos con los beneficios obtenidos cuando se usan solamente los auxiliares auditivos. Las edades de los sujetos variaron entre 34 y 81 años y sus umbrales tonales puros promedio fueron consistentes con una hipoacusia sensorineural moderada a severa, con pendiente progresiva. Todos los sujetos usaron auxiliares auditivos y auxiliares auditivos más sistemas de FM, en una distribución aleatoria. Se aplicó el Perfil de Comunicación para el Hipoacúsico (CPHI) antes de adaptar los dispositivos del estudio, y una vez al mes durante tres meses, en cada una de las dos condiciones. Se obtuvo una diferencia estadísticamente significativa entre las diferentes condiciones del dispositivo por medio de la sub-escala de Importancia de la Comunicación en Situaciones Laborales. Además, en el tiempo se observaron diferencias estadísticamente significativas en varias sub-escalas del CPHI. A pesar de la significación estadística, ninguno de estos resultados fue clínicamente significativo. Se discutirán las implicaciones de estos resultados.

Palabras Clave: CPHI, sistema de modulación de la frecuencia (FM), auxiliar auditivo, auto-evaluación

Abreviaturas: APHAB = Perfil Abreviado del Beneficio de un Auxiliar Auditivo; BTE = retroauricular; CPHI = Perfil de Comunicación para el Hipoacúsico; FM = modulación de la frecuencia; ICF = Clasificación Internacional de la Función; MIL = Nivel de audición más inteligible; PTA = promedio tonal puro para la conducción aérea a 500, 1000 y 2000 Hz; QOL = calidad de vida; SAV = seleccione una ventilación; SNHL = hipoacusia sensorineural; SNR = relación señal-ruido; WRS = puntaje de reconocimiento de palabras

Over 29 million individuals in the United States exhibit some degree of hearing impairment (National Institutes of Deafness and Communication Disorders [NIDCD], 1996). Clearly, hearing loss is one of the most common chronic conditions reported by the elderly. In fact, hearing loss has been reported to affect almost half of the population over the age of 65 years (Cruikshanks et al, 1998). With increases in life expectancy, the aging of the population, and increases in environmental noise, these numbers are likely to continue to rise.

It is well accepted that the major consequence of sensorineural hearing loss (SNHL) is communicative difficulty, particularly in noisy and/or reverberant listening situations (Helfer and Wilber, 1990; Crandell, 1991; Helfer and Huntley, 1991). Due to these communicative difficulties, reduced psychosocial function in this population has often been reported. In particular, declines in social interaction, intimate relations, self-concept, psychological status, and cognition have been noted (Harless and McConnell, 1982; Weinstein and Ventry, 1982; Magily, 1985; Mulrow, Aguilar, Endicott, Velez, et al, 1990; Mulrow, Aguilar, Endicott, Tuley, et al, 1990; Hetu et al, 1993; Sherer and Frisnia, 1998).

Fortunately, previous investigations suggest that individuals utilizing amplification report less depressive feelings, richer social relationships, and higher quality of life (QOL) measures than those who do not (Mulrow et al, 1992; Kochkin and Rogin, 2000).

Numerous investigations have demonstrated that frequency modulation (FM) systems can improve the speech-perception ability of individuals with SNHL in these adverse listening environments (see Crandell et al, 1995, for a review of these investigations). Specifically, past investigations have demonstrated that FM technology can improve the signal-to-noise ratio (SNR) for listeners with hearing loss by as much as 20 dB over unaided listening (Hawkins, 1984; Fabry, 1994; Pittman et al, 1999; Crandell and Smaldino, 2000, 2001) and 12 to 18 dB over hearing aid alone listening conditions (Hawkins, 1984; Lewis et al, 2004). With these signal-to-noise improvements in speech perception, it is reasonable to assume that FM technology would also have an impact on psychosocial function.

To date, relatively few studies have examined the psychosocial benefits of hearing aids used in conjunction with FM technology in the adult population. Jerger et al (1996)

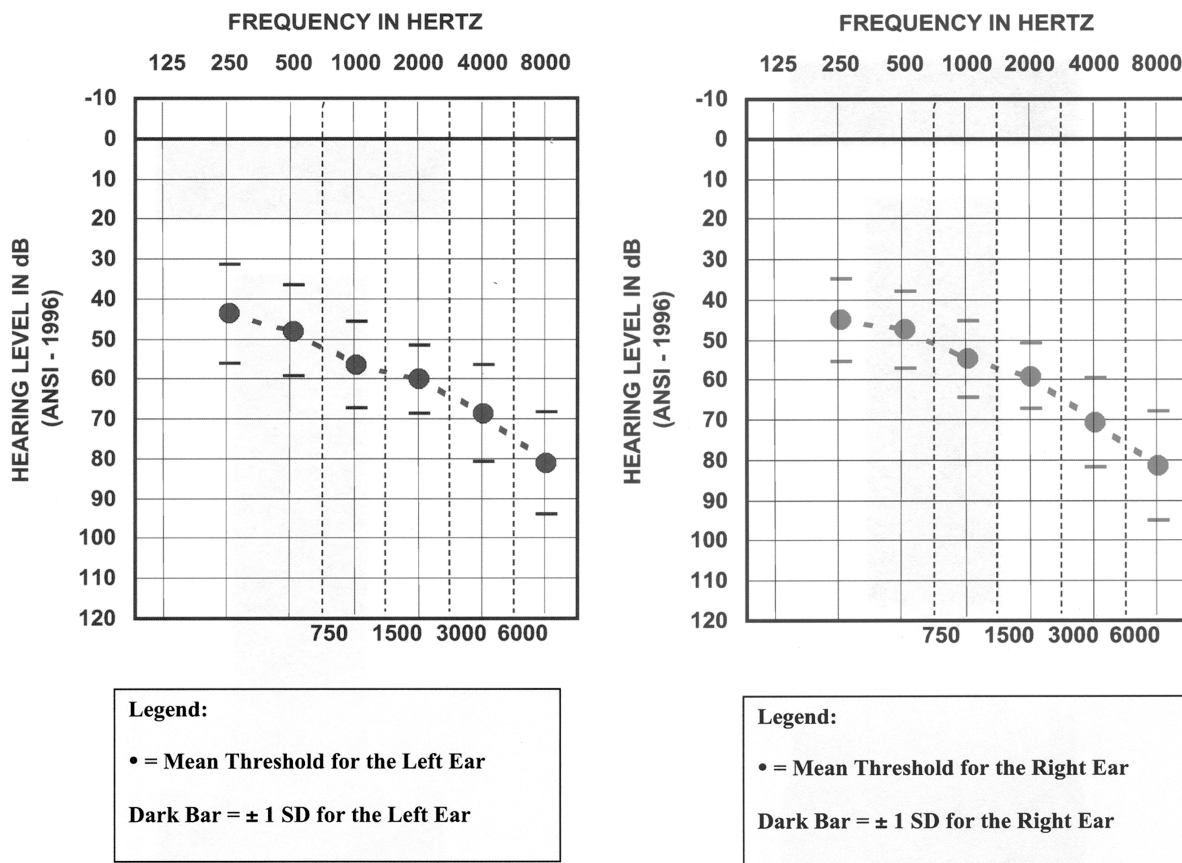


Figure 1. Mean air-conduction thresholds (± 1 SD) for the left (*left*) and right (*right*) ears.

evaluated the effect of an FM system and a hearing aid on the quality of life of older adults. In this investigation, 180 subjects were evaluated in four different conditions: (1) hearing aid alone, (2) FM system alone, (3) hearing aid plus FM system, and (4) no amplification. Subjects participated in each treatment condition for six weeks. At the end of each six-week period, various outcome measures were assessed. These measures included a test of hearing handicap (Hearing Handicap Inventory for the Elderly [HHIE]; Ventry and Weinstein, 1982), speech understanding in noise, emotional status, social anxiety, life satisfaction, affect, and use of amplification. Results revealed that both speech understanding and hearing handicap were improved with the use of amplification. Speech understanding in noise was significantly better in the two FM conditions. There were no significant differences noted in hearing handicap between the three amplification conditions. Despite the perceptual advantages offered by the use of the FM system, subjects preferred to use a conventional hearing aid

to using an FM system in their everyday listening environments. The authors suggested that the subject's preference for the use of the conventional hearing aid over the FM system was due to the difficulties associated with its use. These difficulties included (1) a large transmitter, (2) a large receiver, and (3) use of wires on the FM transmitter and the FM receiver. Recently, Phonak Corporation developed a new personal FM system receiver, the Phonak Microlink, which does not utilize wires or a body-worn box and is much smaller than its predecessors. This relatively new device is more cosmetically appealing and as such is growing in popularity in the FM market. It is possible that, with this new technology, subjects may be more accepting of FM utilization. With these thoughts in mind, the purpose of the present investigation was to examine the effects of utilizing hearing aids in conjunction with this new FM technology on hearing handicap, adjustment to hearing loss, and communication strategies, and to compare the effects of using hearing aids plus FM technology to using hearing aids

alone. Specifically, subjects were evaluated via the Communication Profile for the Hearing Impaired (CPHI; Erdman and Demorest, 1990) one time prior to starting the study and three times (one time per month) in the two experimental conditions: (1) binaural hearing aids alone and (2) binaural hearing aids plus FM system.

METHODS

Subjects

Subjects were recruited from the audiology clinic at the Washington University School of Medicine in St. Louis, Missouri. All subjects were reimbursed for mileage and parking and were offered either \$50 at the end of the study or a significant discount (30%) to purchase the hearing devices and FM system. Twenty-three subjects were evaluated, of which 13 (57%) were male and 10 (43%) were female. These subjects ranged in age from 34 to 81 years, with a median age of 73 years. Pure-tone air-conduction and bone-conduction thresholds were obtained bilaterally. Test results revealed mean pure-tone thresholds consistent with a bilateral moderate sloping to severe SNHL bilaterally (see Figure 1). Word recognition scores (WRS) were also obtained at the Most Intelligible Listening (MIL) level for each ear, using recorded NU-6 word lists, for all study participants. Test results revealed mean word recognition scores (± 1 standard deviation [SD]) of 73.4% ($\pm 11\%$) and 77.0% ($\pm 7\%$) for the right and left ears, respectively. There were no significant differences between the two ears in terms of pure-tone average (PTA) ($p = 0.730$) and WRS ($p = 0.157$). Subjects were all previous users of binaural amplification (at least one year). All subjects met the following inclusion/exclusion criteria:

1. Ear inspection via otoscopy within normal limits.
2. Normal middle ear function (± 100 decapascals [daPa]) and amplitude (+0.3 to +1.6 cubic centimeters [cc]) bilaterally as indicated by tympanometry.
3. No evidence of conductive or retrocochlear pathology as indicated by pure-tone testing and immittance measurements.
4. Slight (20 to 40 dB HL)-to-severe (65 to 85 dB HL) high-frequency or flat SNHL as indicated by pure-tone test results (250 Hz to 8000 Hz, including 3000 and 6000 Hz).
5. Symmetrical hearing loss that does not differ by more than 15 dB at more than one audiometric test frequency as indicated by pure-tone test results.
6. Word recognition scores of 50% or better in quiet as assessed by recorded versions of NU-6 word lists presented at the subject's MIL.
7. Interested and willing to use the study devices (including the FM system) as reported by the study participant.
8. Native speaker of English as reported by the participant.
9. No history of chronic or terminal illness, psychiatric disturbance, or senile dementia as reported by the participant.
10. No history of being bedfast/chairfast as reported by the participant.
11. Not home or nursing home bound.
12. No history of stroke or cerebral vascular disorder with a paresis or aphasia as reported by the participant.
13. Willing and able to give written informed consent to participate in this investigation, as noted by their signature on the "Informed Consent to Participate in Research" document.

Amplification Systems

All subjects were fit binaurally with digital Phonak Claro 311 dAZ behind-the-ear (BTE) hearing aids. All earmolds had select-a-vent (SAV) venting and #13 or 3 mm horn tubing. In addition to the hearing aids, subjects were fit with Phonak Microlink ML8 FM receivers bilaterally. These FM receivers attach to the bottom of a BTE hearing aid and may be used in either the "FM only" mode, which attenuates the hearing aid microphone by 20 dB, or in the "FM plus hearing aid" mode, which allows for FM input and input of environmental sounds via the hearing aid microphones simultaneously without any attenuation of the hearing aid microphones.

The Phonak TX3 HandyMic FM transmitter served as the FM transmitter. The hearing aids were fit as recommended via the Desired Sensation Level i/o (Seewald, 2000) prescriptive fitting formula on the Phonak Fitting Guideline (PFG) Version 7.3 software. All fittings were verified via probe-microphone measures. Subjects had control of volume and program selection via the WatchPilot remote control.

Communication Profile for the Hearing Impaired (CPHI)

The Communication Profile for the Hearing Impaired (CPHI; Erdman and Demorest, 1990) is a 145-item self-assessment inventory that measures hearing handicap, adjustment to hearing loss, and communication strategies. The CPHI is comprised of 25 subscales that are divided into four major areas: (1) Communication Performance, (2) Communication Environment, (3) Communication Strategies, and (4) Personal Adjustment. Item responses are numbered on a scale from 1 to 5, on a continuum of frequency or agreement/disagreement. In general, a "1" indicates "rarely or almost never" and a "5" indicates "usually or almost always." The following subscales reverse this format: (1) Attitudes of Others, (2) Behaviors of Others, (3) Self-Acceptance, (4) Acceptance of Loss, (5) Anger, (6) Displacement of Responsibility, (7) Exaggeration of Responsibility, (8) Discouragement, (9) Stress, and (10) Withdrawal. This questionnaire has been shown to have high test-retest reliability (Demorest and Erdman, 1988).

Procedures

All subjects were randomly fit with the Phonak amplification systems in one of the following conditions: (1) Phonak 311 dAZ BTE hearing aids only or (2) Phonak 311 dAZ BTE hearing aids used in conjunction with the Phonak Microlink FM system. Twelve of the subjects began the study in the hearing aids alone condition, while the remaining 11 subjects utilized the hearing aids in conjunction with the FM system. The investigator obtaining data on the subject was blinded to condition. Specifically, one investigator fit the hearing aids, while a

different investigator obtained all questionnaire data. This investigation had a crossover design, in which at the end of three months the subjects switched experimental conditions. To control for hearing aid size effects, the FM modules remained attached to the BTE hearing aids in both conditions. Each subject was evaluated with the CPHI one time prior to receiving the experimental amplification systems and three times (one time per month) in each experimental condition. Subjects were given instructions on how to care for and use the hearing aids and the FM system at the time of fitting. All subjects reported using both amplification systems eight to ten hours per day.

RESULTS

A repeated-measures analysis of variance (ANOVA) was conducted to determine if there was an overall statistical significance in regard to listening condition (FM + hearing aids versus hearing aids alone), time, and the interaction between condition and time for each subscale of the CPHI. The repeated-measures ANOVA revealed a statistically significant difference between experimental conditions (FM + hearing aids versus hearing aids alone) for the subscale regarding the Importance of Communication in Work Situations ($F_{1, 21} = 5.67, p < 0.03$). In this condition, the average rating of importance was significantly lower in the experimental condition in which the hearing aids were used in conjunction with the FM system (mean = 3.66; SE = 0.13) than in the condition in which the hearing aids were used alone (mean = 3.74; SE = 0.13). The mean ratings (± 1 SE) for these two conditions are provided in Figure 2. The test-retest difference for this subscale is 0.46 (Demorest and Erdman, 1988). Although the difference between these two conditions was statistically significant, it did not exceed the required test-retest difference to be considered clinically significant.

The ANOVA also revealed statistically significant differences in terms of time for the following subscales of the CPHI: (1) Importance of Communication in Social Situations ($F_{3, 63} = 6.82, p < 0.001$); (2) Importance of Communication in Work Situations ($F_{3, 63} = 5.24, p < 0.003$); (3) Importance of Communication in Home Situations ($F_{3, 63} = 10.00, p < 0.001$);

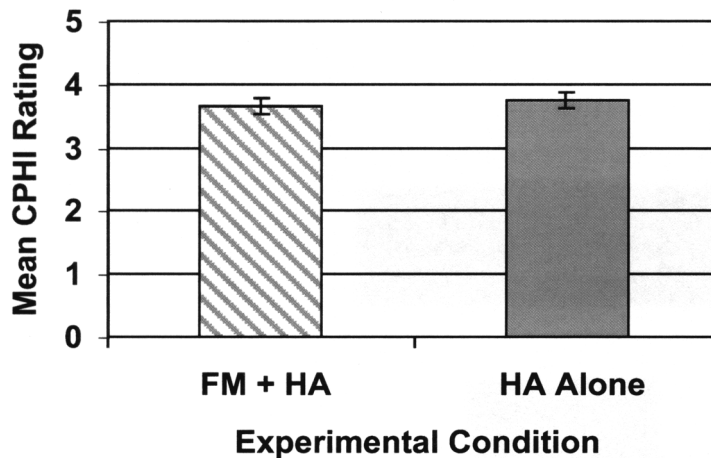


Figure 2. Mean CPHI ratings (± 1 SE) for each experimental condition for the subscale “Communication Importance in Work Situations.”

(4) Problem Awareness ($F_{3,63} = 4.65$, $p < 0.005$); (5) Behaviors of Others ($F_{3,63} = 3.40$, $p < 0.03$); (6) Verbal Strategies ($F_{3,63} = 6.93$, $p < 0.001$) and (7) Stress ($F_{3,63} = 9.16$, $p < 0.001$). Mean ratings for each time period (± 1 standard error [SE]) in the aforementioned subscales is provided in Figures 3–9. Since there proved to be a statistical significance over time, Least Significant Difference multiple comparison procedures (at an alpha level of $p < 0.05$) were performed to determine where these significant differences existed. These post hoc results are summarized in Table 1.

Although these subscales resulted in statistically significant differences between the various time periods, almost all of the differences did not exceed the reported test-retest difference for that CPHI subscale to be considered clinically meaningful. In fact, only the Importance of Communication in Work Situations subscale exceeded the reported test-retest difference. In that subscale, the difference between the mean rating at prefitting (3.455) and the mean rating at the second month with amplification (2.807), and the mean rating at the third month with amplification (2.895) exceeded the test-retest

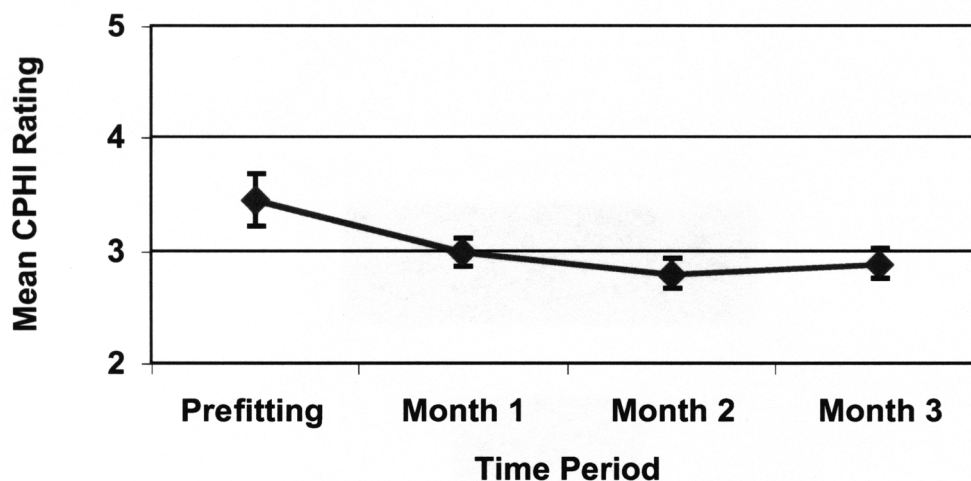


Figure 3. Mean CPHI ratings (± 1 SE) for each time period for the subscale “Communication Importance in Social Situations.”

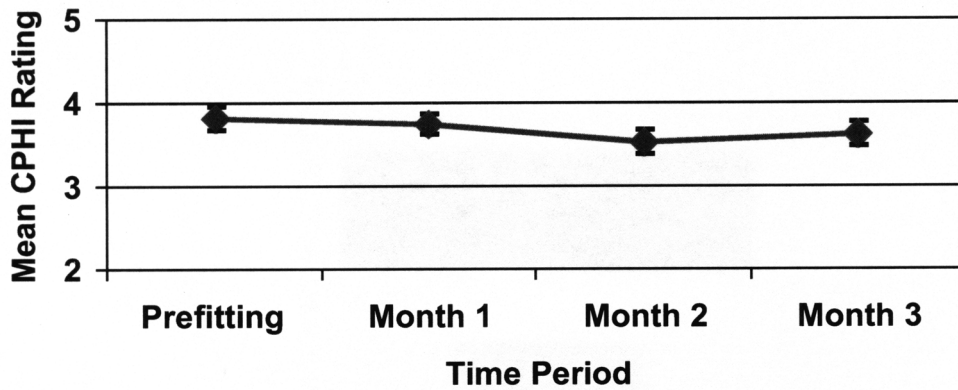


Figure 4. Mean CPHI ratings (± 1 SE) for each time period for the subscale “Communication Importance in Work Situations.”

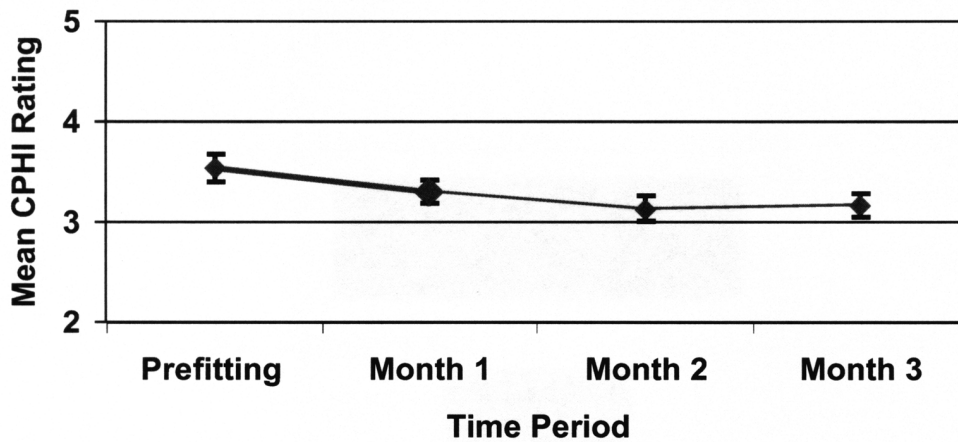


Figure 5. Mean CPHI ratings (± 1 SE) for each time period for the subscale “Communication Importance in Home Situations.”

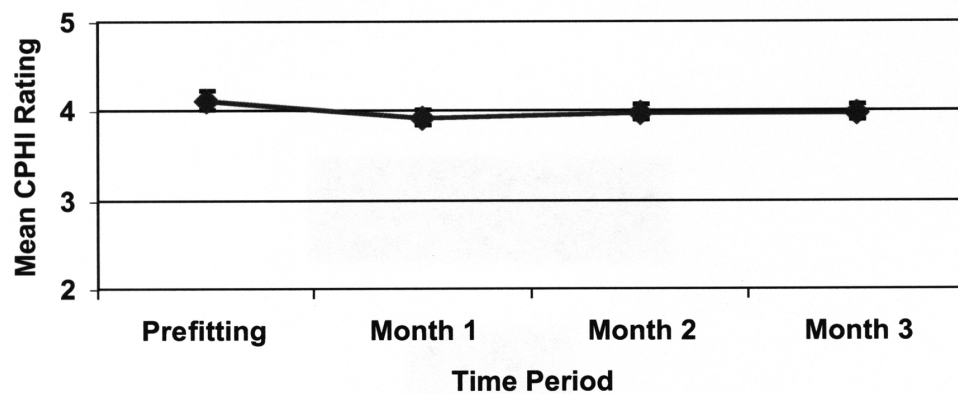


Figure 6. Mean CPHI ratings (± 1 SE) for each time period for the subscale “Problem Awareness.”

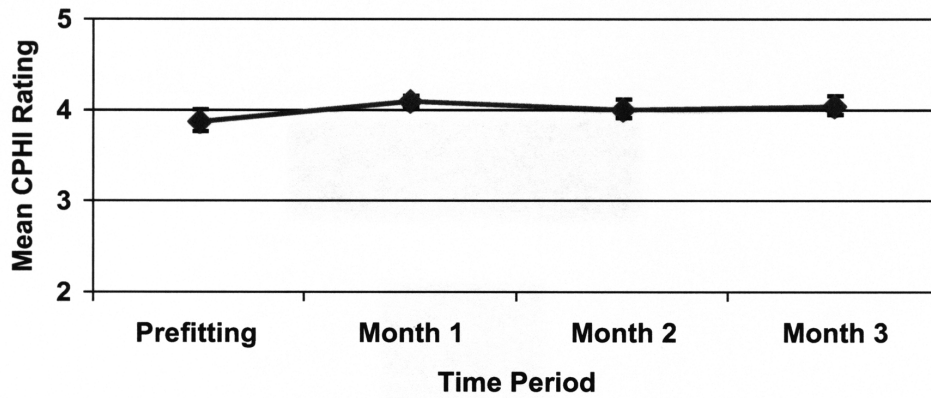


Figure 7. Mean CPHI ratings (± 1 SE) for each time period for the subscale “Behaviors of Others.”

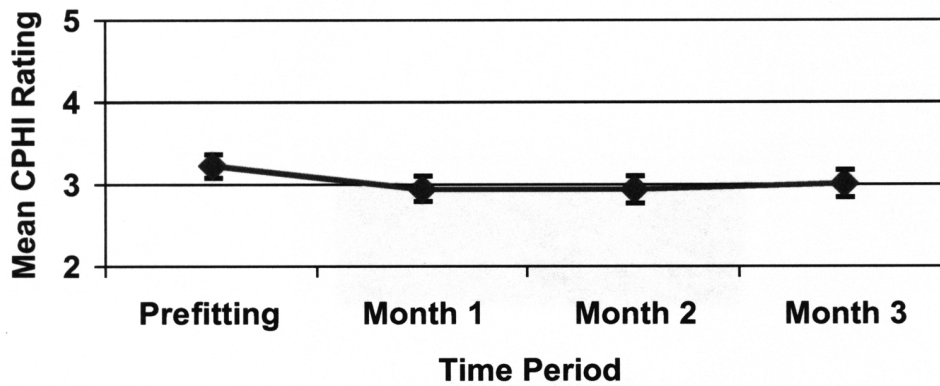


Figure 8. Mean CPHI ratings (± 1 SE) for each time period for the subscale “Verbal Strategies.”

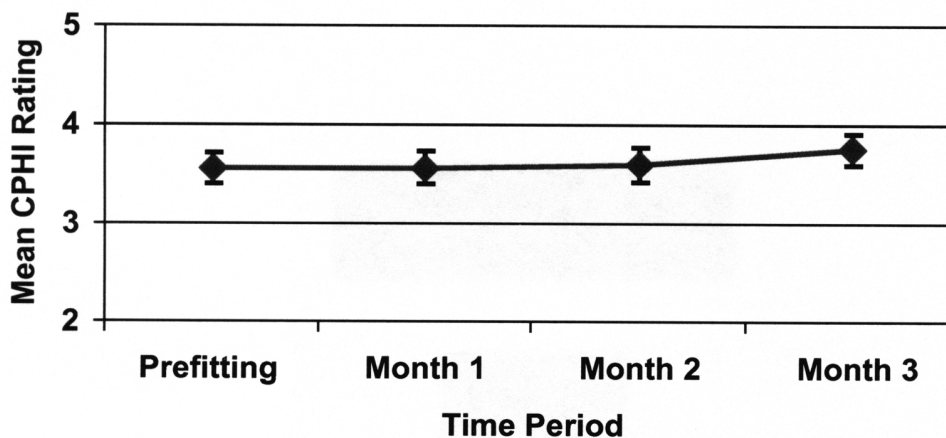


Figure 9. Mean CPHI ratings (± 1 SE) for each time period for the subscale “Stress.”

Table 1. Mean Score (\pm 1 SE) Obtained for All Significant Subscales of the CPHI Over Time

CPHI Subscale	Prefitting	Month 1	Month 2	Month 3
Importance of Communication in Social Situations	3.46 (\pm 0.23) ^{2,3,4}	2.99 (\pm 0.13) ^{1,3}	2.81 (\pm 0.14) ^{1,2}	2.9 (\pm 0.14) ¹
Importance of Communication in Work Situations	3.84 (\pm 0.15) ^{3,4}	3.77 (\pm 0.12) ³	3.55 (\pm 0.14) ^{1,2}	3.65 (\pm 0.14) ¹
Importance of Communication in Home Situation	3.55 (\pm 0.13) ^{2,3,4}	3.32 (\pm 0.12) ^{1,4}	3.14 (\pm 0.13) ¹	3.17 (\pm 0.12) ^{1,2}
Problem Awareness	4.13 (\pm 0.10) ^{2,3,4}	3.92 (\pm 0.09) ¹	3.99 (\pm 0.09) ¹	3.97 (\pm 0.09) ¹
Behaviors of Others	3.90 (\pm 0.12) ^{2,4}	4.11 (\pm 0.07) ¹	4.02 (\pm 0.10) ⁵	4.06 (\pm 0.10) ¹
Verbal Strategies	3.25 (\pm 0.14) ^{2,3,4}	2.96 (\pm 0.15) ¹	2.96 (\pm 0.17) ¹	3.03 (\pm 0.17) ¹
Stress	3.57 (\pm 0.15) ⁴	3.58 (\pm 0.16) ⁴	3.61 (\pm 0.18) ⁴	3.77 (\pm 0.15) ^{1,2,3}

Legend:

1 = Mean score is significantly different from the mean score obtained at prefitting.

2 = Mean score is significantly different from the mean score obtained at Month 1.

3 = Mean score is significantly different from the mean score obtained at Month 2.

4 = Mean score is significantly different from the mean score obtained at Month 3.

5 = Mean score is not significantly different from the mean score obtained at any other time period.

difference of this subscale. All the other differences in mean ratings over time for this subscale were not clinically significant.

The interaction term of condition and time was not statistically significant for any of the CPHI subscales.

DISCUSSION

Results from this investigation revealed a statistically significant difference between experimental conditions (FM + hearing aids versus hearing aids alone) for the Importance of Communication in Work Situations subscale, with the importance being lower for the condition in which the FM system was used. Additionally, statistically significant differences over time were noted in the following CPHI domains: (1) Importance of Communication in Social Situations, (2) Importance of Communication in Work Situations, (3) Importance of Communication in Home Situations, (4) Problem Awareness, (5) Behaviors of Others, (6) Verbal Strategies, and (7) Stress. In general, communication importance, awareness of problems, and stress declined with the utilization of amplification. Also, communication partners made less accommodations and subjects used less verbal strategies with the utilization of amplification. No significant interactions were noted.

Although statistical significance was obtained in the aforementioned subscales of the CPHI, Demorest and Erdman (1988) evaluated test-retest differences of the CPHI in a sample of 101 active-duty military personnel. In this sample, positive test-retest differences exceeded by 10% (i.e., 90% confidence interval) of the group ranged from 0.46 to 0.88 points (depending on the subscale). In other words, a difference between test administrations must exceed these values in order to conclude with 90% confidence that benefit was truly obtained by the intervention strategy. Not all statistically significant differences previously reported exceeded the 90% confidence interval for the CPHI. In fact, only one of the reported subscales, the Importance of Communication in Work Situations, exceeded the reported differences for the CPHI. In this subscale, the difference between the mean rating at prefitting (3.455), the mean rating at the second month with amplification (2.807), and the mean rating at the third month with amplification (2.895) exceeded the test-retest difference of 0.46 for this subscale. Based on this information, one can conclude with 90% confidence that this reduction in importance was a result of using amplification.

The clinical significance in the Importance of Communication in Work Situations subscale may also be questionable. In 1993, the CPHI was revised. In this revision, the Communication Performance

and the Communication Importance subscales were modified. In the original version (which was used in the present investigation), subjects were asked to rate the importance of a given communication situation at the same time they were rating their performance in that environment. This phrasing may have led to individuals rating Communication Performance and Communication Importance similarly. In the current version, the items are presented twice, which has improved the validity of the responses for the Communication Importance subscales (Erdman and Demorest, 1998). Since the original version of the CPHI was used in this investigation, it cannot be ruled out that this may have had an effect on the results.

As previously mentioned, the median age of the study participants was 73 years. As such, it is possible that the majority of study participants were retired and/or did not participate in activities relevant to the work situations included on the CPHI. Unfortunately, these subjects were not queried about their current lifestyle, as this may have been a factor regarding the results obtained in this investigation. Future investigations should examine the effect of lifestyle on these results.

Based on the test-retest differences established for the CPHI and the reduced validity of the Communication Importance subscale of the original version of the CPHI, it is probable that the statistically significant results obtained in this investigation are not clinically meaningful. Possible reasons for this lack of clinical significance include (but are not limited to): (1) ceiling and floor effects; (2) the use of a homogeneous study sample; (3) a relatively small sample size; (4) the CPHI not being a sensitive test measure for the changes that occurred in this investigation and/or the lifestyle of the subject; (5) insufficient training with the FM system; and (6) the utilization of mean data. Each of these factors will be described in detail in the subsequent paragraphs.

Ceiling or floor effects inherent in the CPHI may have been a limitation in this investigation. To illustrate, one subject reported a rating of 5 at prefitting in the Stress subscale of the CPHI. As this is the highest rating possible (suggesting minimal stress due to reverse scoring on this subscale), it would have been impossible for this study

participant to report significant clinical improvement with the utilization of amplification over the prefitting condition as there is no room to move up on the scale. Hence, the utilization of mean data in combination with the ceiling/floor effect of the CPHI may have influenced the lack of clinical significance reported in this investigation.

Erdman and Demorest (1998) recommend that investigations regarding the psychosocial and behavioral adjustments to hearing loss use a demographically and audiometrically heterogeneous sample. This was not the case in the present investigation. Study participants were all recruited from the same clinical site, were predominately older adults, and had fairly similar degrees and configurations of SNHL. Additionally, a relatively small number of subjects were evaluated. Recall that this investigation only evaluated responses from 23 subjects. To better understand the effect of hearing aids and FM technology on hearing handicap, adjustment to hearing loss, and communication strategies, future investigations should examine a larger, more heterogeneous sample.

A prior investigation reported by Lewis et al (2003, 2004) revealed that the SNR with the use of binaural Phonak Claro 311 dAZ BTE hearing aids was improved by 5 to 8 dB over the unaided listening condition. The utilization of FM technology improved the SNR by an additional 17 dB over the hearing aids alone listening conditions. Additionally, a companion investigation examined the communicative benefits of hearing aid and FM technology (Lewis, Crandell, Valente, 2004). Significant communicative benefit, as measured via the Abbreviated Profile of Hearing Aid Benefit (APHAB; Cox and Alexander, 1995), was obtained with the utilization of amplification. There were no significant differences between the two experimental conditions: (1) hearing aids alone and (2) hearing aids plus FM technology. From these investigations, it is apparent that these two technologies had some benefit for the study participants. Therefore, it is possible that the lack of clinical significance reported in the present investigation was a result of the CPHI's inability to sensitively measure the benefits obtained with these hearing devices and/or the lifestyle of the study participants. The reader is referred to Demorest and Erdman



(1987) and Erdman and Demorest (1990) for specific details regarding the questions used in the CPHI.

As mentioned previously, study participants were counseled regarding the use and care of the hearing aids and FM system at their fitting appointment. It is possible that this training paradigm was not sufficient to allow the subjects to maximize use of the experimental devices in their everyday listening situations. Recently, Chisolm (2003) evaluated the effect of an extensive training program on the benefits of using FM technology. In this investigation, communication performance, as measured by the CPHI, was significantly better with the FM system over the use of the hearing aids alone. Hence, extensive training with the FM system may improve user outcome, as measured by the CPHI.

In 2002, the World Health Organization developed the International Classification of Function (ICF; World Health Organization, 2002). This new classification scheme changed the focus of health conditions from its cause to the impact a health condition has on the individual's daily life. A health condition's impact is influenced by environmental and personal factors. These factors are likely to vary from person to person. As such, Gagne et al (1999) stress that the goal of audiologic rehabilitation should be to alleviate the problems encountered by a particular individual. Therefore, these authors caution against the sole utilization of generic questionnaires, such as the CPHI, in studies regarding the benefits of hearing devices, as individual-specific problems are difficult to ascertain in closed-set questionnaires.

Clinical Implications

Despite the perceptual advantages afforded by the utilization of FM technology, a clinically significant difference was not noted in terms of hearing handicap, adjustment to hearing loss, and communication strategies between the hearing aids alone condition and the hearing aids and FM condition. This result corresponds well with the findings reported by Jerger et al (1996). Although the Phonak Microlink is more cosmetically appealing than the hearing assistive technology used in the Jerger study, these subjects still reported a number of difficulties associated with its

use. These difficulties included: (1) expense; (2) inconvenience (e.g., need to charge the transmitter each night); (3) cosmetic issues (e.g., need to point the transmitter near the mouth of the talker). Unfortunately, because of these reported difficulties, none of the study participants at the Washington University School of Medicine purchased the study devices at the end of the investigation. It is hoped that new advances in FM technology will help eliminate these types of difficulties so that more individuals with hearing loss will want to take advantage of the perceptual improvements obtainable with FM technology.

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