Testing Amigo Arc as a Multipurpose Neckloop Device for a Heterogeneous Test Group

Adam Weisser, M.Sc., Acoustic Engineer and Technical Audiologist, Oticon A/S

Introduction

Assistive listening devices (ALDs) are an important tool in the rehabilitation of people with sensorineural hearing impairments. Specifically, the frequency modulation (FM) system's performance, importance and convincing principle of operation have been thoroughly established since their commercial introduction by Phonic Ear in the late 1960's (Ross, 1992; Ross and Gioras, 1971). However, FM systems are still owned by a much smaller population (less than 1% of the total hearing aid users in the USA) than the total hearing aid and cochlear implant users (Kochkin, 2005).

oticon PAEDIATRICS

Testing Amigo Arc as a Multipurpose Neckloop Device for a Heterogeneous Test Group

Various factors continue to be challenging for the audiologists who have to define the candidacy for FM systems, beyond the type of impairment and degree of loss, hearing instrument and age of the candidate. Amongst others, they include the relevancy of situations in which the user may benefit from FM, his/her technical aptitude, willingness to carry more instruments, comfort of integrating the devices with the primary amplification, cosmetic concerns and social discomfort. Altogether, demonstrating the efficacy of FM systems goes hand in hand with a yielding, effective design of the FM system, as well as alertness of the clinician to the patient's nuances, so that an optimum solution is achieved.

A vivid example of this was unveiled in a series of studies that dealt with fitting FM to the elderly. A couple of somewhat sporadic and unpromising experiments failed to show acceptance of FM systems by the elderly, despite superior or neutral objective measurements of the combined hearing aid and FM (Jerger et al., 1996; Boothroyd, 2004; Lewis et al., 2005). In a subsequent study that attempted to learn from previous mistakes, Chisholm and colleagues (2007) were able to demonstrate a very impressive acceptance by the test subjects of the FM systems: a cohort of 36 test subjects (mean age 75, all male) out of which 30 maintained use even after 18 months. However, the most important difference in this test compared to its predecessors was the very careful selection of FM candidates with respect to their losses, experience and handicap. Very importantly, extensive training took place throughout the test to ensure that the technical aspect of usage was not a deterrent for the users.

A similar case can be made for school-setting users, who are often more technically adept, but perhaps also more concerned about cosmetics and robust functionality. The specifics for FM candidacy for school children were given in the latest American Academy of Audiology (AAA) guidelines (2008).

Technological Implementation

The FM technology itself and the fundamentals of stable operation have finally matured in the last decade.

For instance, the rationale of fitting FM receivers has been debated and recommendations were updated a number of times and eventually established (ASHA, 1994, 2002; AAA 2008). Nowadays it should be rather straightforward to fit an FM instrument and to obtain the FM advantage, which is the result of the proximate physical placement of the FM microphone, relative to the hearing aid microphone.

Because of the underlying FM audiological and acoustical principles, local broadcasting regulations, hearing aid designs and electroacoustic design constraints of FM systems, many of these systems appear similar in performance.

The difference lies in sound quality with the imposed radio frequency (RF) constraints, comfort, ease of use, cosmetic appeal, electronic and mechanical reliability and ease of integration with the hearing instrument. All in all, there are many significant differences between FM products, which can make them easier or more difficult to use.

Given all of the above, the FM system manufacturer is challenged with the task of designing robust, aesthetic, friendly, sensible, great-sounding devices that make no trade-offs in audiological, electronic, acoustical and mechanical performance in favour of price or target audience.

Coupling FM to the Hearing Instrument via Telecoil

Telecoil (magnetic induction) technology goes back decades. An estimated 62% of hearing aids sold in the US today contain a Telecoil program (Myers, 2008). The operational simplicity and situational versatility of this feature makes it very attractive for users in situations such as talking on the telephone, watching theatre, purchasing at a ticket counter, sitting in an auditorium or a place of worship, etc. Coupling FM systems to hearing devices may be accomplished via a neckloop FM receiver. The audio output signal is conducted through a neckloop, which is positioned so that it can induce the telecoil circuitry of the hearing device. It is one of the oldest and most common ways to connect to the FM receiver (e.g. Hawkins, 1984).

Some users may have good reasons for not choosing an ear-level FM receiver. For these users a sturdy neckloop receiver is a good alternative for the following reasons: it may be compatible with various instruments that do not have a direct audio input (DAI) program/shoe such as cochlear implants (CIs) and in-the-ear (ITE) aids; it does not change the hearing device mechanically or cosmetically; it offers full and visible control over its functionality and level; it has a separate power supply etc.

In the case of young children, the risk of losing tiny, ear-level receivers is reduced, and the tamper-resist feature becomes easy to implement. In the case of technically-apprehensive elderly users, bigger buttons and physically apparent functions (unlike some invisibly programmed features) are clearly advantageous. Finally, the ability to control the volume of the FM channel dependently is critical in some situations for most populations, and yet impossible to achieve with ear-level receivers. Due to their larger size the price of neckloop FM receivers is usually more attractive than ear-level receivers.

However, problems with the neckloop/telecoil method of FM coupling can also be seen. For instance, due to electronic limitations of size and the power consumption of the telecoil transformer inside the device, its frequency response at bass frequencies often rolls off at a higher cutoff than when using a DAI interface. Susceptibility to hum noise also impels hearing aid manufacturers to roll off the telecoil program bass response. This may lead to a somewhat smaller FM advantage at the lowest frequencies (e.g. Schafer, 2006). However, although the listeners may receive a less amplified speech fundamental frequency (F0), this limitation will have very little effect on the prominent segmental information that lies in the formants above it. To date, no speech intelligibility study has been conducted to test actual differences in performance due to FM coupling methods, but much like in hearing aid amplification, and even normal telephony audio bandwidth (300-3400 Hz), the relatively high bass cutoff is unlikely to impede the speech intelligibility.

This may not be the case when listening to music though, since thorough enjoyment from the full bandwidth experience is at stake. Therefore, in music mode there may be a definite advantage in creating an extended frequency range beyond that of speech.

Testing Amigo Arc as a Multipurpose Neckloop Device for a Heterogeneous Test Group

Amigo Arc

As the newest member of the Amigo family, Amigo Arc is a multipurpose neckloop FM receiver. In addition to its FM functionality it also interfaces audio inputs from standard line level devices such as MP3 players, television and radio sets, stereo and computer sound cards. Amigo Arc is a universal receiver and accepts transmission not only from Amigo transmitters but also standardised channels. However, in order to program it, an Amigo wireless receiver programmer (WRP) is needed.

Throughout the early development phase of Amigo Arc, an initial battery of pilot tests was carried out and showed no significant difference in sound quality, usability and functionality from conventional FM receivers already on the market. Importantly, performance measured through the Client-Oriented Scale of Improvement (COSI, Dillon et al. 1997) between the Amigo Arc and a similar device currently on the market also showed no significant difference between the devices. Users exhibited no particular preference as to which device was superior.

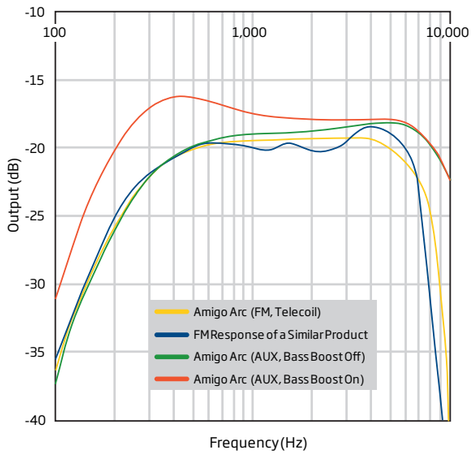
User comments from those tests were then integrated into the subsequent design, engineering it to eventually supersede the previous targets and set a new standard for telecoil-based FM receivers. Advances were made in the sound quality of the FM and auxiliary channels, user interactivity, the cosmetic and mechanical design, immunity to noise and overall reliability of the device.

Study Goals

The purpose of this study was to test the acceptance of the new Amigo Arc FM neckloop receiver by a heterogeneous test group. Focusing on experienced FM users of various ages with different types of hearing loss, the challenge was to find out whether their rehabilitative needs could be enhanced and facilitated by this novel instrument.

Having previously established that the device sounds at least as good as other neckloop systems currently on the market, these follow-up questions were tested:

1. Can a single receiver design serve and appeal to a very broad range of ages and losses?
2. Would satisfied or dissatisfied FM users be interested in replacing their currently owned systems with the new one – and why?
3. Would elderly users experience any technical difficulties when adapting to a new system, and could these be resolved through adequate training in order to achieve satisfaction?



Frequency responses of Amigo Arc in FM (yellow) and AUX modes (green and red). A reference FM response of a similar neckloop product on the market is shown in blue.

Methods

Eight people (six males and two females) with sensorineural hearing loss participated in this study in two different sites in the Greater Copenhagen Area in Denmark. Their mean age was 49 (min=15.5, max=70) and the severity of their losses varied between mild to profound (pure tone average of 56 dB HL at 500 Hz, 67 dB HL at 1000 Hz and 73 dB HL at 2000 Hz). Impairments were either congenital or as a result of presbycusis. Subjects wore various behind-the-ear (BTE) non-linear hearing aids, which were five years old or newer and include a telecoil program.

The test subjects were fitted with a new Amigo Arc receiver and an Amigo T10 transmitter. They were instructed how to operate them together with their hearing aid. The subjects were asked to take the system home where, over the course of 13 to 16 days, they used it in a variety of situations. At the end of this period they were asked to share their impressions – also compared to their own FM systems.

Some of the responses from the test subjects are recounted below. Together they cover almost all aspects of feedback that were obtained.

The discreetness of the Amigo Arc's design was appreciated, which is partly due to the fact that it can be concealed in its neck-worn position, and the fact that the neckloop itself is connected to the receiver from both sides was very positively pointed out.

It was noticed though that when things were quiet, a slight hum could be heard in the ¬system.

This is a remnant of the stray magnetic induction of the telecoil circuitry of the hearing aid. Obviously, this type of noise is not present when coupling the FM to the hearing aids via DAI.

It also turned out that having the option of adjusting the output volume of the Amigo Arc, which is impossible to do with an ear-level receiver, had a major impact on the satisfaction with the entire system.

One test subject was particularly enthusiastic as the sound quality from the FM was perceived to be better than the hearing aid microphone. This is somewhat baffling, but could be because, for the specific situations in which this test subject used the system (music listening, TV watching, computer), the direct audio simply gave superior input to the hearing aid preamplifier than the degraded signal that would have come through the hearing aid microphone. This is not unlikely, given the bass boost and the extended high frequency response through the Amigo Arc. If the hearing aid responded to this extended audio bandwidth, this could have played a role in the perceived improvement.

It was reported back that using the Amigo Arc gave test subjects the ability to hear distant voices easier. Perhaps because of the directionality of the Amigo T10 transmitter. Otherwise, the Amigo Arc was used by test subjects when listening to the radio – for both music and speech – also here they reported to be enjoying the experience.

A test subject pointed out the flexibility and freedom that came from not having to mechanically fit the ear level receiver to the aid and also found the neckloop arrangement much more discreet. The same subject appreciated being able to customise the Amigo Arc colour plate.

General Findings

Many of the above comments were repeated by the others in the test groups. For instance, six out of the eight subjects were interested in purchasing the system, and one subject wanted to carry on using the FM system after the test. Only one person was not interested in using it after the test, and did not think he would use it regularly in the future. This was consistent with his usage pattern of FM in the past.

Testing Amigo Arc as a Multipurpose Neckloop Device for a Heterogeneous Test Group

Conclusions

The results confirmed that the new Amigo Arc FM receiver fulfills its designated purpose. Experienced FM users demonstrated remarkably high acceptance, often preferring Amigo Arc over their own FM systems.

The conclusions to the study questions and design goals are as follows:

1. Where age and hearing loss are concerned, there seems to be no specific target audience for this system. The system is generic enough to have been accepted and used by people with anything from a mild to profound hearing loss.
2. Current FM users were prepared to replace their current systems with a new one. Reasons included the more discreet appearance that, unlike an ear-level receiver, does not extend the hearing aid; better sound quality; a user friendly interface and flexibility to cover various listening situations.
3. The non-technical, elderly users encountered some technical problems, but this was not necessarily the rule. In one case, extra training helped the user to become thoroughly familiar with the system. In another case, a user was reluctant to use the system regularly. In yet another case the new receiver was introduced to the user with the need for additional training.

This study reaffirms that the combination of two straightforward technologies – FM and Telecoil – may yield quite powerful results. The availability of Telecoil programs in hearing aids allows for a great deal of flexibility when fitting FM solutions. Even though Telecoil is more susceptible to magnetic interference (induction) noise, considering its other advantages this is just a minor issue.

Specifically in Amigo Arc, the discreet and cosmetically appealing design removes some of the key psychological concerns users can have regarding appearance. Furthermore, the superior sound it delivers to the hearing aid offers an important, clear channel to users who like to take advantage of modern media. In the same vein, schools may harness this device as a generic solution when teaching through a PC, for instance, where the hassle of presetting and pre-fitting the hearing aid for FM or DAI cable may be alleviated.

Acknowledgments

Thanks to Heidi Kofod, Clinical Audiologist, Oticon A/S for her efforts in collecting data for this study.

References

American Academy of Audiology, "Clinical Practice Guidelines: Remote Microphone Hearing Assistance Technologies for Children and Youth Birth to 21 Years.", April 2008. Retrieved from http://www.audiology.org/resources/documentlibrary/Documents/HATGuideline.pdf 21.6.2010.

American Speech-Language-Hearing Association. "Guidelines for fitting and monitoring FM systems". AHSA, 36 (Suppl. 12), 1-9, 1994.

American Speech-Language-Hearing Association, "Guidelines for fitting and monitoring FM systems", ASHA Desk Reference, 151-171, 2002.

Boothroyd, A., "Hearing Aid Accessories for Adults: The Remote FM Microphone", Ear and Hearing, 25, 22-33, 2004.

Chisholm, T. H., Noe, C. McArdle, R.. and Abrams, H., "Evidence for the Use of Hearing Assistive Technology by Adults: The Role of the FM System", Trends in Amplification, 11, 73-89, 2007.

Crandell, C. C. and Smaldino, J. J., "Classroom Acoustics for Children With Normal Hearing and With Hearing Impairment", Language, Speech and Hearing Services in Schools, 31, 362-370, 2000.

Dillon, H., James, A and Ginis, J. A. "The Client-Oriented Scale of Improvement (COSI) and its relationship to several other measures of benefit and satisfaction provided by hearing aids", Journal of the American Academy of Audiology, 8, 27-43, 1997.

Hawkins, D. And Schum, D., "Some Effects of FM-System Coupling on Hearing Aid Characteristics" Journal of Speech and Hearing Disorders, 50, 132-141, 1985.

Kochkin, S., "MarkeTrak VII: Customer Satisfaction with Hearing Instruments in the Digital Age", The Hearing Journal, 58, 30-43, 2005.

Jerger, J., Chmiel, R., Florin, E., Pirozzolo, F., Wilson, N. "Comparison of Conventional Amplification and an Assistive Listening Device in Elderly Persons", Ear and Hearing, 17, 490-506, 1996.

Lewis, M. S., Valente, M., J. E., Horn, Crandell, C., "The Effect of Hearing Aids and Frequency Modulation Technology on Results from the Communication Profile for the Hearing Impaired", Journal of the American Academy of Audiology, 16, 250-261, 2005.

Myers, D. G., "Experts Discuss Telecoils and the Future of Hearing Aid-Compatible Assistive Devices", The Hearing Journal, 61, 40-47, Oct, 2008.

Ross, M. (Ed.) "FM Auditory Training Systems: Characteristics, Selection and Use", 1st ed., Timonium, MD: York Press, Inc, 1992.

Ross, M. and Giolas, T. G., "Effects of Three Classroom Listening Conditions on Speech Intelligibility", American Annals of the Deaf, 580-584, Dec., 1971.

Schafer, E. C., Thibodeau, L. M., Whalen, H. S., Overson, G. J., "Electroacoustic Evaluation of Frequency-Modulated Receivers Interfaced With Personal Hearing Aids", Language, Speech and Hearing Services in Schools, 38, 315-326, Oct, 2007.

child friendly hearing care

It takes a truly dedicated approach to help children with hearing problems achieve their full potential. That's why we deliver the solutions and services that professionals and caregivers need to provide children the opportunities they deserve. This is what child-friendly hearing care is all about.

107337UK / 10.10 Printed on FSC™ recycled paper, Cert no. SW-COC-004644, www.fsc.org

www.oticonpaediatrics.com

oticon PAEDIATRICS