Datalogging: A New Paradigm in the Hearing Instrument Fitting Process

by Mark C. Flynn, PhD

Datalogging is designed to provide greater flexibility and validity to hearing aid fitting by keeping the patient at the center of the process.

Recent advances in hearing instrument processing have led to the development of complex environmentally adaptive technology such as multi-band adaptive directionality, dynamic feedback cancellation, and complex speech detection algorithms. Each of these advances, while providing substantial performance benefits, presents a series of challenges for the dispensing professional. First, the professional needs to provide an explanation of the real-world benefits of these features to the client, and second, the client needs to accurately articulate during the fitting process how their instrument is performing in the real world. For example, when a client talks about sound quality in noise, are they referring to gain and compression issues or the effect of directionality and noise management systems on a signal? One recent solution is to use the Syncro Activity Analyzer to provide recorded or logged information about the client's use of the hearing instrument in the real world.

Figure 1. The original Syncro datalogger used in verification studies of advanced hearing instrument systems. Note the two sets of directional microphone inlets so that the impact of two sound processing strategies could be measured simultaneously.

The recording of key aspects of the client's use of the hearing instrument, combined with knowledge of the client's listening situations, further facilitates the shift from problem-based fine-tuning to proactive counseling. Recent research by Flynn and his colleagues[1] reported the interesting phenomenon that, while the Oticon Syncro resulted in less fine-tuning than other premium hearing instruments, many dispensing professionals do not spend significantly less time in the typical fitting process. Delving further into this finding, they found that the clinicians were using the time saved from fine-tuning to spend more time in aftercare through demonstration and counseling on the advanced features of the hearing instrument.

The results that many dispensing professionals have received in terms of client satisfaction and immediate acceptance is explained by the work of various authors[2-5] who demonstrate a significant correlation between time spent fine-tuning and satisfaction with hearing instruments. Therefore, one method to improve client satisfaction is to facilitate the focus from problem-orientated fine-tuning to proactive aftercare. The analysis of recorded data to solve problems before they occur plays a key role in this process.

Datalogging: From Research to Clinical Tool

For the past several years, Oticon has been working with datalogging technology to improve the quality of hearing instrument systems and fitting processes. The research has concentrated on three key areas:

Auditory ecology. This area focuses on describing and understanding the auditory environments of adults with hearing impairment. Datalogging allows us to accurately describe and gain insight to the types of listening environments as well as the listening problems that are encountered by hearing instrument users.[6] The outcome from this work is the development of technology deliberately matched to the acoustic properties of the environments that people with a hearing loss actually find themselves in.

Amplification Preferences. The second application focuses on the link between a person's auditory ecology and their amplification preferences.[7] In Adapto this research was used to obtain information about the client's auditory lifestyle and listening preferences and then prescribe the best hearing instrument fitting rationale. The concept was evolved further in Syncro, where the systems of amplification, noise management, and directionality are all individually prescribed by a unique Syncro Identity. Our research suggests that the ability to match client preferences with a sound processing strategy is one of the key reasons for the high immediate acceptance of the hearing instrument.[1,8]

Testing and Verification. The third application of datalogging is the testing and verification of advanced hearing instrument systems. During the technical development of Syncro, it was important to understand exactly how the various automatic systems operated in the real world. Therefore, we developed a research device (Figure 1) to test and record the performance of the automatic systems with studies in Germany, Denmark, the United States, and the United Kingdom. Following further refinements, this technology was then incorporated into the wearers' hearing instruments and further developed in the Activity Analyzer. Datalogging technology was crucial in ensuring that the best possible configuration of automatic systems was verified in the real world before the release of the product.

Incorporation of Datalogging into a Hearing Instrument

Using datalogging technology in research and development enabled our engineers to gain valuable experience. Specifically, it lent insights into how recorded information might improve the quality of a fitting.

The Syncro Activity Analyzer is a new feature that allows dispensing professionals to benefit from the knowledge of how the hearing instrument has actually performed for the client. The data collected goes beyond the technologically simple recording of instrument usage time and volume control use to the recording of environmental data and how the advanced automatic systems have operated in these environments. The testing indicated key benefits for recording data in terms of:

1. An information source for collaborative counseling;
2. Supporting proactive aftercare; and
3. Providing reassurance that the hearing instrument works as would be expected even in the most challenging of listening environments.

To support these aims, data is collected in two main areas. First, information about the hearing instrument running time and use. Second, information about the actions of the Voice Priority Processing system is recorded.

Information on Instrument Running Time & Patient Use

Often it is difficult to fully understand how the client is using the hearing instrument. Previously, we had to rely on diaries, the client's memory, and the quality of their post-fitting counseling with the client. While all of these techniques have served us well for many years, we can now take advantage of technology that allows us to actually observe how the hearing instrument has been operated by the wearer.

Information is available, such as the time the hearing instrument is used per day, the relative amount of program use, and information about how the wearer has used the hearing instrument in each program. Data about hearing instrument usage time is often used as a measure of fitting success, with various reports indicating a high degree of relationship between time of use and satisfaction.[9,10] The datalogging system easily allows the dispensing professional to view any changes that occur over time to quantify hearing aid benefit (eg, to plot an increase or decrease in hearing instrument use over time).

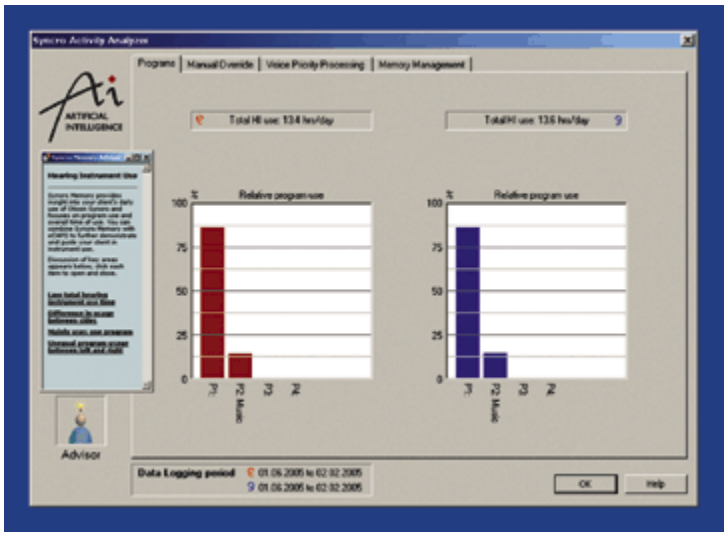

Figure 2. The average time the instrument is used per day, as well as the client's use of the program switch are easily observed.

During the fitting process, the clinician and client can jointly examine the way the hearing instrument is used (Figure 2). For example, it may show the client prefers one program over another or does not make use of a certain program. Here the data is available to support the counseling process, where the dispensing professional can easily reorder, delete, or add additional programs. Alternatively, it may be that the client is uncertain of the use of the program button or in what listening situation to use a second program. By allowing the practitioner to review with the client the use of certain controls, such as the program switch, the client becomes more educated and involved in the fitting process.

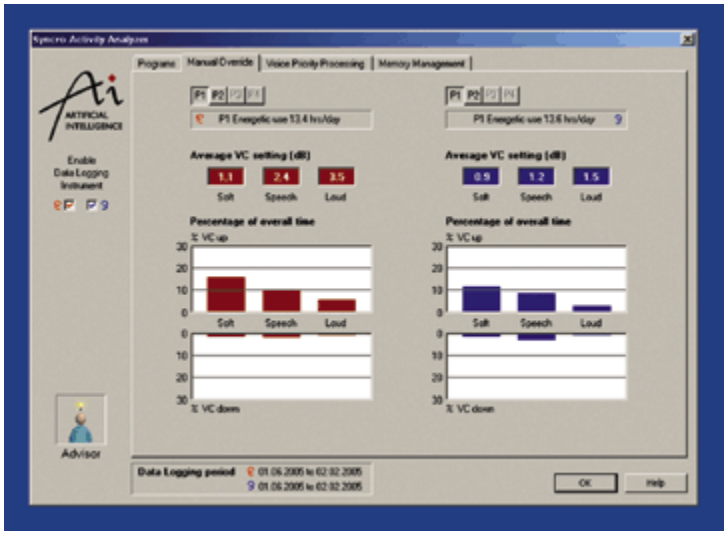

Figure 3. For each program the volume control is reported in terms of average deviation and percentage of time. To further aid fine-tuning, this data is presented across three input levels (soft, speech, and loud).

There are two factors to consider with volume control use (Figure 3). First, is the percentage of time that the volume control is either turned up or down, and the direction. Second, when the volume control is used, the average deviation away from the default position also needs to be considered. In the Activity Analyzer, this information is presented for three input levels (soft, speech, and loud) which match the fitting controls. Therefore, it is easy for the dispensing professional to take the data about volume control use and apply it directly in the fitting screen.

The volume control adjustment should not be seen simply in a single dimension (ie, global increase or decrease in volume). Examination of client's actual use of the volume control demonstrates that differences occur at different listening levels, and it is crucial to examine both the degree of change, as well as the duration of time that volume was in a certain position. Avenues of discussion apart from fine-tuning the gain of the hearing instrument could relate to:

n Environmental factors: It may be that, for an individual client when confronted with similar acoustic environments, he/she may tune the hearing aid up or down depending on listening needs (eg, fatigue at the end of the day versus listening in a meeting room). Or alternatively, some clients may turn up or down the volume when listening to particular speakers.

n Adaptation Process: The use of the volume control may not reflect a fine-tuning need but that the client is progressing through the adaptation process at a different speed than first anticipated.

n Advanced systems: The client may use the volume control as an adjustment to the automatic systems. For example, they may alter the degree of noise management in a complex listening situation. In these cases, the best form of management may be to suggest a different Syncro Identity rather than make global changes to the volume control.

The Activity Analyzer enhances the role of the dispensing professional during the fitting process by providing him/her with the ability to assimilate logged information with the reports of the client then determine the best possible fitting solution. Automated solutions, while convenient, undervalue the importance of the professional/client dialogue. It should be up to the dispensing professional to decide how the information is used and for what purpose.

Information for Analyzing Automatic Systems Functions

Various studies have recently discussed the workings of advanced features in hearing instruments, highlighting the importance that automatic systems work in parallel with the needs of the hearing-impaired listener.[11] A unique feature of the Activity Analyzer is that it provides data beyond basic usage statistics. Further information is provided about the environment and the Voice Priority Processing System (Voice Aligned Compression, Multi-band Adaptive Directionality, and TriState Noise Management).

This ability to view the actual working of the hearing instrument in the client's daily life complements Syncro Live, where the working of the instrument can be viewed live in the clinic. With this, the dispensing professional can examine the Artificial Intelligence of the Voice Priority Processing (VPP) system[12] working in the client's everyday listening environment. A graphic is available which displays the range of sound input levels. This can be analyzed further into displays of the TriState Noise Management states and Multi-band Adaptive Directionality modes against input level over time. Similarly, this same presentation is available for each program so the clinician and client can examine if one program was preferred over another in certain listening situations.

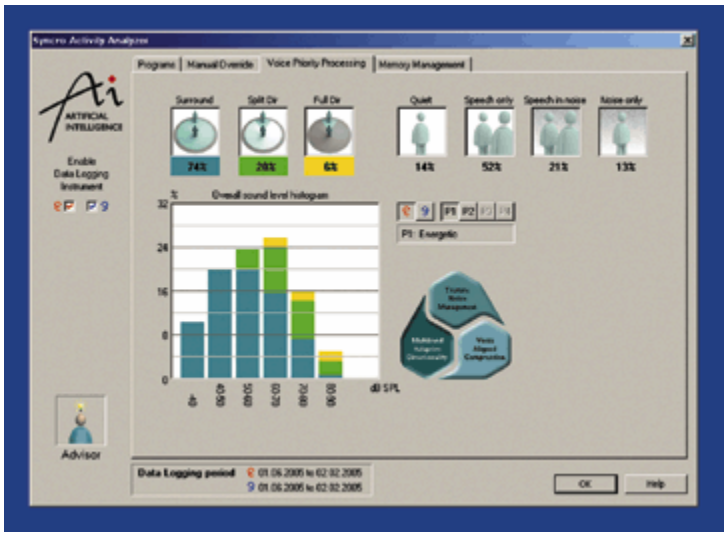

Figure 4. Analysis of actions of the Multi-band Adaptive Directionality system showing how the underlying Artificial Intelligence selects the best setting in any given sound environment.

The most crucial information displayed is the actual working of the VPP system and how often the instrument is in each state (Figure 4). Importantly, this display highlights that it is not the percentage of time that a hearing instrument is in a certain mode or state that is important. For example, an instrument that relies solely on prediction or sound scene analysis[13,14] is liable to switch to a directional mode too often, because an environment which contains a high level of noise will be classified as one where directional microphones may provide benefit.

Conversely, recent studies by Walden et al.[15] suggest that, even in high levels of noise (eg, where the speaker is behind or at a distance relative to the listener), the omnidirectional settings are preferred over the directional setting. In all, only about 30% of listening environments are suitable for the directional setting (ie, the directional setting is preferred by the user). The analysis of the VPP system reassures the clinician and demonstrates to the client that the Artificial Intelligence underlying the hearing instrument is, in fact, choosing the optimum sound processing solution.

Another important aspect to the display of the client's listening environment is to verify the selected Syncro Identity. For example, examination of the client's actual (versus reported) auditory ecology may reveal that the client is in an environment that is either more dynamic or more stable than was expected from prior reports. In these cases, the dispensing professional can discuss the workings of the VPP system with reference to the client's listening environment data and develop a deeper understanding of his/her needs. Following the discussion, it may be that a different Syncro Identity provides a better match to the client's actual listening ecology. In this case, it is easy to provide a different Syncro Identity (through adding a second program for instance) and then testing using SyncroLive whether the new Identity provides a better match to the client's listening preferences.

It is supporting the client through this type of proactive aftercare that provides the greatest rewards from viewing the previously logged data.

Facilitating Proactive Aftercare

The development of the Activity Analyzer supports the emerging paradigm shift from problem-focused fine tuning to proactive aftercare. We have observed that, as hearing instruments become more intelligent and technologically advanced, it becomes increasingly difficult for the client to articulate the difficulties he/she may experience. By providing the dispensing professional with the hearing aid performance data, the words of the client can be used to gain a deeper understanding of actual hearing instrument use. Therefore, the use of the Activity Analyzer should be a part of every fitting process—not just when the client reports a problem. It facilitates the way that the client and dispensing professional can work together in the aftercare process.

The various options of the Activity Analyzer can be used in many ways. For example, the dispensing professional can observe the frequency of program use and make judgments about whether that program should be removed or if the patient needs further instruction on its use. At a more detailed level, the clinician can examine the performance of the hearing aid in various communication environments and use that information in dialog with the client to further understand his/her communication and amplification needs. Similarly, using the statistics function, it is possible to examine the types of environments in which the client was in at a previous visit and look for any changes in use (eg, using the hearing instrument in more diverse listening environments).

A key to the success of using previously recorded data in the fitting process is through using the Syncro Advisor (Figure 5). For each analysis, the Advisor is available to provide the dispensing professional with possible reasons for trends observed in the data, as well as further suggestions for counseling and fine-tuning.

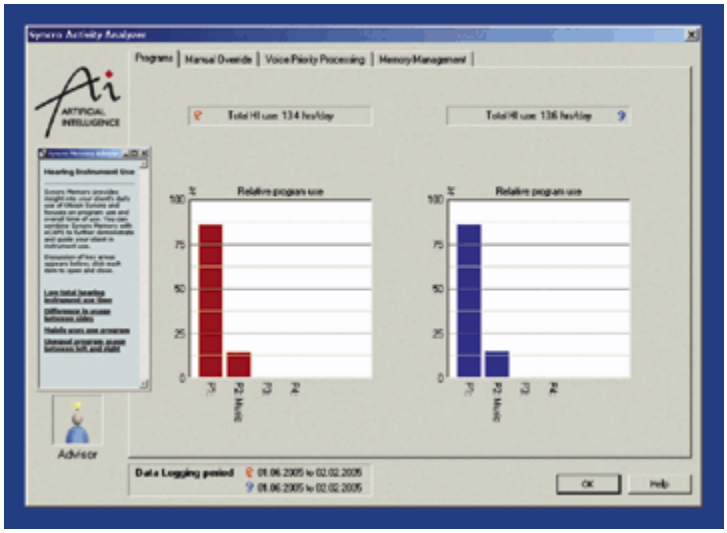

Figure 5. For each section of the Activity Analyzer, the Syncro Advisor is available to help understand the recorded data.

The Syncro Activity Analyzer used with the Syncro Advisor is designed to improve the fitting process. The previously logged data provides a focal point between the professional and the client which gives counseling new direction. By discussing with the client the use of controls (eg, volume) and the performance of Syncro in various communication environments, it helps the client remember and reinforces key features of the hearing instrument. Syncro Counseling and SyncroLive assists with the initial discussion of hearing instrument features, and the Activity Analyzer presents the data on the actual hearing instrument use to facilitate the dialogue during the fitting and aftercare process.

Currently, there seems to be efforts in the hearing care field to automate completely the fitting process. However, it is important that the patient remains at the center of the fitting process and the skills of the dispensing professional are not replaced by an automated solution. Using the Activity Analyzer, the dispensing professional works in synergy with the objective data provided by the hearing instrument and the subjective data provided by the client. This approach, in comparison to a laboratory-predicted fine-tuning solutions, is designed to provide greater validity and flexibility to the fitting process.

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References

1. Flynn MC, Pogash RR, Schum DJ. Multinational clinical evaluation of Oticon Syncro. News from Oticon. 2005; February.
2. Kargas S, Doyle J. Patient satisfaction with time use in audiological consultations. Brit Jour Audiol. 1996;30(6):355-61.
3. Kochkin S. Reducing hearing instrument returns with consumer education. Hearing Review. 1999;6(10):10-1.
4. Kochkin S. MarkeTrak VI: Factors impacting consumer choice of dispenser and hearing aid brand. Hearing Review. 2002;9(12):14-23.
5. Northern J, Beyer C. Reducing hearing aid returns through patient education. Audiol Today. 1999;11(2):10-1.
6. Jensen NS, Petersen GS, Nielsen C. Auditory ecology in a group of experienced hearing-aid users. In: Scientific Meeting of the American Auditory Society; 2005 March 20-22, 2005; Scottsdale, Ariz.
7. Gatehouse S, Naylor G, Elberling C. Benefits from hearing aids in relation to the interaction between the user and the environment. Intl Jour Audiol. 2003;42(Suppl 1):S77-85.
8. Flynn MC, Lunner T. Clinical evidence for the benefits of Oticon Syncro. News from Oticon. 2004;November:1-10.
9. Humes LE. Dimensions of hearing aid outcome. J Am Acad Audiol. 1999;10(1):26-39.
10. Humes LE, Christensen L, Thomas T, Bess FH, Hedley-Williams A, Bentler R. A comparison of the aided performance and benefit provided by a linear and a two-channel wide dynamic range compression hearing aid. J Speech Lang Hear Res. 1999;42(1):65-79.
11. Walden BE, Surr RK, Cord MT. Real-world performance of directional microphone hearing aids. Hearing Jour. 2003;56(11):40-7.
12. Flynn MC. Maximizing the Voice-to-Noise ratio (VNR) via Voice Priority Processing. Hearing Review. 2004;11(4):54-9.
13. Kates JM. Classification of background noises for hearing aid applications. J Acoust Soc Amer. 1995;97:461-70.
14. Bregman AS. Auditory Scene Analysis: The Perceptual Organization of Sound. Cambridge, MA: The MIT Press; 1994.
15. Walden BE, Surr RK, Cord MT, Dyrlund O. Predicting hearing aid microphone preference in everyday listening. J Am Acad Audiol. 2004;15(5):365-96.