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As WDRC hearing aids have continued to gain popularity through the 1990s, we have witnessed the introduction of several new prescriptive fitting methods to help us select the gain, output, and compression parameters for these instruments. Several of these methods are geared toward the fitting goal of loudness restoration.

One such method came from a group of 12 audiologists, the Independent Hearing Aid Fitting Forum, and is called the IHAFF (as in, "Do IHAFF to do all that testing?"). Sandwiched between raft trips and serenades, the IHAFF protocol was formally introduced at Jackson Hole, WY, in the summer of 1994.

The IHAFF protocol is not just a hearing aid selection procedure, but rather a complete fitting strategy, which includes guidelines for assessing candidacy and the patient's loudness function, as well as clinical verification and validation procedures. For example, the APHAB recommendations for aided loudness testing and probe-mic measurements are all part of the IHAFF procedure. Page Ten and the IHAFF protocol bonded early: In June 1994, we provided you with the introductory article "Getting ready for the IHAFF." In February 1995, the first complete description of the Contour Test and the VIOLA appeared on these pages. But, many of you have asked: What's happened to the IHAFF protocol since its original introduction 5 years ago? Good question, and Page Ten seems like the ideal place to provide the answer!

While the complete IHAFF protocol was indeed accomplished through the combined efforts of 12 individuals, many of the key components were primarily taken from the work of one person, Robyn Cox. It is appropriate, therefore, that we bring Dr. Cox back to Page Ten to provide us with an IHAFF update.

Robyn Cox, PhD, is professor of audiology at the University of Memphis and director of the Hearing Aid Research Laboratory. At one time or another, she has published on nearly all aspects of hearing aid selection and fitting. Her work is internationally known and respected, so be sure to check out her website www.ausp.memphis.edu/harl to see what she's been up to lately.

I think you'll enjoy Robyn's review of what has and has not happened with the IHAFF fitting protocol. You will see that, although considerable progress has been made, there is still more to learn as we all try to find the best way to select and fit hearing instruments.

Gus Mueller, Editor
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Five years later: An update on the IHAFF fitting protocol

By Robyn M. Cox

1 What exactly is, or was, the Independent Hearing Aid Fitting Forum?

I came to work one day in early 1993 to find a message inviting me to attend a meeting about hearing aid fitting to be held in Denver in March. I went and found myself sitting around a table with an interesting group of people: Lu Beck, Ruth Bentler, David Fabry, Gail Gudmundsen, David Hawkins, Mead Killion, Michael Marion, Gus Mueller, Larry Revit, Margo Skinner, Michael Valente, and Dennis Van Vliet. Margo had to drop out after this meeting because of other commitments. The rest comprised the IHAFF group for the next few years.

The meeting was organized by Dennis Van Vliet and Michael Marion with financial support from several hearing aid manufacturers (who always remained in the background. In fact, I don't even know who they were.) Dennis chaired this, and all other, meetings. As I understood it, the motivation for calling us together sprang from a conversation between Dennis and Michael about the lack of clear direction for clinicians who wanted to make use of the then-new generation of sophisticated non-linear (especially wide dynamic range—WDRC—compression) hearing aids. The overall goal presented to the group was to devise a generic method for fitting these types of instruments.

We knew that we did not have the time or resources to carry out validating research, but we agreed that we could generate something that seemed reasonable and logical, based on the available literature. We all thought it was important to put something out there that clinicians could use right away as a starting place for fitting WDRC hearing aids. We expected that, in due course, well-researched methods would come along that would either validate or replace the procedures we would develop.

The group met several times over the next 18 months to devise the Comprehensive Hearing Aid Fitting Protocol, which was presented in August 1994 at the Audiology Rendezvous in Jackson Hole, WY.

2 So what was the protocol?

First, I need to mention something very important. From the beginning, it was recognized that hearing aid fitting encompasses much more than just a prescription. We were committed to the ideas of assessing the pre-fitting needs for amplification, verifying the accuracy of the fitting, and validating the final result with outcome measures. That's why the protocol is called "comprehensive." It regards all of these elements as essential to any worthwhile fitting and it includes recommended procedures for all of them. If you are not doing all of it, then you are not following the IHAFF protocol.

Now that I've got that off my chest, Figure 1 is my description of the protocol. There are six essential elements. The IHAFF protocol recommended procedures to assist with five of them. The pre-fit testing began with a needs assessment using the unaided portion

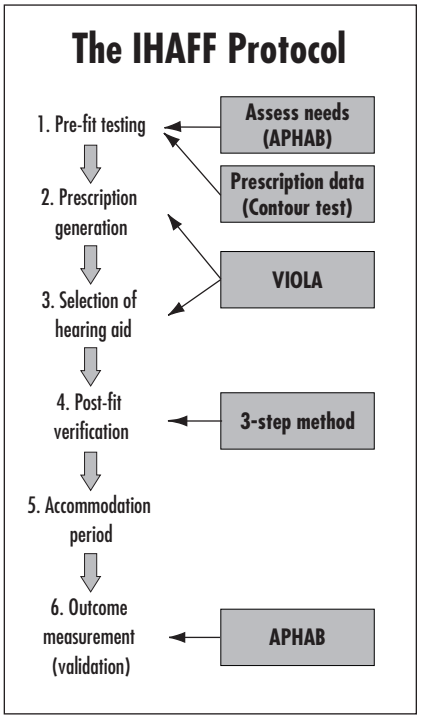

Figure 1. *The six essential elements of the IHAFF protocol are shown on the right. Specific procedures recommended to implement each element are shown on the left.*

of the Abbreviated Profile of Hearing Aid Benefit (APHAB).

The prescription method, VIOLA (Visual Input/Output Locator Algorithm), requires data about loudness perceptions, and these must also be measured during pre-fit testing using the Contour test procedure. Generating the prescription and choosing the hearing aid are facilitated by the VIOLA procedure.

I call the post-fit verification procedure a "three-step method" because it includes test box, probe microphone, and sound field components.

Finally, after the accommodation period, the recommended outcome measure was the benefit obtained by completing the aided portion of the APHAB and comparing the aided scores with the unaided scores from the pre-fit testing. A software package called the IHAFF Suite was written to implement the Contour test, the VIOLA procedure, and the APHAB inventory.

3 So, what you're saying is, the IHAFF protocol is composed of six different elements. Are all these elements still pretty much the same as they were in 1994?

It depends how you look at it. Each of the six essential elements is just as important as ever. However, in the years since the protocol was developed, there has been a lot of evolution in thinking about how each element can and should be implemented.

4 What do you mean? Are there other ways to do a needs assessment, for instance?

Indeed there are. The APHAB assesses disability in a standardized format. This is definitely very useful, but we have come to appreciate that we should be looking also at other matters as well as disability. These can include pre-fitting handicap and expectations.

Also, the potential value of personalized self-report inventories has been recognized. So we have seen new surveys such as the COSI (Client Oriented Scale of Improvement),[1] the GHAPB (Glasgow Hearing Aid Benefit Profile),[2] the HANA (Hearing Aid Needs Assessment),[3] and the ECHO (Expected Consequences of Hearing Aid Ownership).[4] We can now use combinations of these or similar measures to provide a well-rounded needs assessment before we decide if a hearing aid fitting is the best approach for the patient at this time.

5 How about the Contour test? I've heard that individual loudness measurements, including loudness scaling and even loudness discomfort levels (LDLs), are too hard for patients, too time-consuming, and too unreliable. If that's true, how come you made them part of the IHAFF protocol?

Let me work backwards through that question. The most widely recognized advantage of WDRC hearing aids was, and still is, their ability to make soft sounds audible and average sounds comfortable while keeping loud sounds from becoming too loud. It seems reasonable to tie the prescription method to the idea of using amplification to reconstruct more normal loudness perceptions for the hearing-impaired listener. The most accurate way to do this is to use the individual's own loudness data in the prescription formula.

There has been much research in the last few years asking whether or not it is really worth the time required to make these measures in the clinic. The answers are consistent overall with the classic work of Pascoe published in 1988:[5] For about two-thirds of individuals, we can predict their loudness perception pretty accurately from their thresholds. The other third has unpredictable loudness data because they are either "sound sensitive" or "sound addicts."[6] One way or another, the requirements of this unpredictable group need to be accommodated. Measuring loudness perceptions before the prescription is computed potentially allows us to do it as part of the fitting.

Now for the rest of the question. When loudness measurements are performed by an experienced clinician using a standard protocol, the loudness data are a little less reliable than threshold data, but not enough to destroy their value in a prescription.[7,8] Yes, they do take time from other clinical activities. On the other hand, they may save time by reducing post-fitting adjustments, so it's a trade off. Too hard for some patients? Yes, a small proportion of post-lingually impaired adults don't catch on to the task very well.

6 Now I'm really confused. Should we do loudness measurements or not?

I am recommending a middle ground for now. For most people, it is okay to predict loudness perceptions from thresholds. However, sometimes your pre-fitting interview or your needs assessment suggests that this individual has unusual loudness perceptions. For example, a patient may have an unusually high unaided score on the Aversiveness subscale of the APHAB. In this case, you should go ahead and do the loudness test and try to address loudness problems before the fitting. Meanwhile, we need to develop efficient methods for identifying patients with unusual loudness perceptions. We are doing research in that area in the Hearing Aid Research Laboratory.

7 Doesn't the VIOLA procedure require you to do the Contour test to get loudness perception data?

At first, it did. However, since 1994, we have developed equations to predict the Contour data in two ways: (1) from the thresholds or (2) from a combination of thresholds and uncomfortable loudness levels (UCLs). So now you can choose to measure or predict the loudness scaling data for your patient.

8 Okay, but what is the VIOLA procedure all about, anyway? It looks really different from other prescriptions.

The procedure has two components: The generation of the prescription and the method used to display the targets and select the hearing aid.

Generating the prescription is rather straightforward. The goal is to amplify soft, average, and loud speech to more or less the same loudness for the hearing-impaired person as for the typical normal-hearing listener. I explained this in some detail in a previous paper.[9]

Because there are amplification targets for each of three speech input levels, the selection of a hearing aid is complicated. The VIOLA addresses this problem by displaying the targets on two input/output functions. It then helps you select a hearing aid by comparing the targets with I/O functions for several instruments that you

think might be useful. You specify the values of parameters such as gain, compression threshold, and compression ratio, and the VIOLA draws the I/O function to compare with the targets.

9 I tried that once, but I got frustrated because I could not figure out how to specify the hearing aid parameters to match the targets.

I know what you mean. We have improved that aspect quite a bit in the newest version of the program. In the first version, you had to supply all the parameter values. In the new version, there are three ways to get appropriate parameter values: (1) You can supply them yourself, as always; (2) you can browse through a set of five autocurves, which use built-in rules to choose parameter values; or (3) you can browse through a data base containing data for six of your favorite hearing aids to see which one would be the best fit for the patient. For all options, the program automatically calculates the overall error of the fit to the target to help you choose among the options.

10 I'd like the program to choose the hearing aid for me. Why doesn't it do that?

That's a very good question and brings me to a point that is important to understand about the VIOLA approach. The IHAFF group talked a lot about the best way to choose a hearing aid to fit the targets (because, if possible, we also wanted the program to choose the best hearing aid). In the end, we realized that we simply did not know enough about using WDRC to deal with this issue.

For example, it is pretty clear that the most accurate fit to the targets (i.e., the one with the smallest error figure) would usually call for a very low compression threshold. However, there was no consensus in the group that this was necessarily the best approach for everyone.

Also, it is possible to get a pretty good fit to the targets with quite a few different combinations of compression thresholds and compression ratios. So, this issue was left to the discretion of the dispenser, who is supposed to use his/her expertise to select the best compromise of parameter settings for each patient.

11 Looking back, was it a good thing that you did not specify an *a priori* method for fitting a hearing aid to the targets?

It certainly was—and still is. Since 1993, there have been many published studies focusing on the best parameter values for WDRC fittings. For example, recent publications from the NAL (National Acoustics Laboratories) group suggest that the best compression threshold for many people might be a medium sort of level, about 65 dB input SPL.[10] Work by the City University of New York (CUNY) group has suggested that it is best to keep the compression ratio low.[11] They have also studied the effects of release time.[12]

These are just some examples of the intense research activity going on. We still do not have a clear understanding of the best ways to use WDRC, but knowledge is gradually accumulating.

12 If we look at the hearing aid prescription portion of the protocol—the VIOLA—how does it compare with the other popular fitting methods of today?

One way of assessing a prescription method for non-linear hearing aids is to compare it with the best established method for fitting linear aids, which is unquestionably the NAL-RP procedure. It makes sense to compare the linear and non-linear prescriptions at the moderate or average input level that both encompass—typically 60 dB SPL.

We compared the VIOLA and NAL prescriptions for BTE hearing aids for four different audiograms that are typical of elderly hearing aid wearers (mild-flat, mild-sloping, moderate-flat, and moderate-sloping). Because the VIOLA does not provide a frequency/gain prescription per se, it is necessary to choose the compression parameters that would be used to attempt to match the targets. For this example, I chose a 40-dB-SPL input compression threshold and a compression ratio of 2.0. By the way, this is usually a pretty good assumption for moderate losses, but can be a bit too much compression for many mild losses.

In addition to looking at the frequency/gain prescription, we also compared the VIOLA maximum output (the UCL) with the maximum MPO (equal to the predicted LDL) that would be prescribed by the new NAL procedure.[13]

Figure 2 illustrates the results using the moderate sloping loss. There were two noteworthy features:

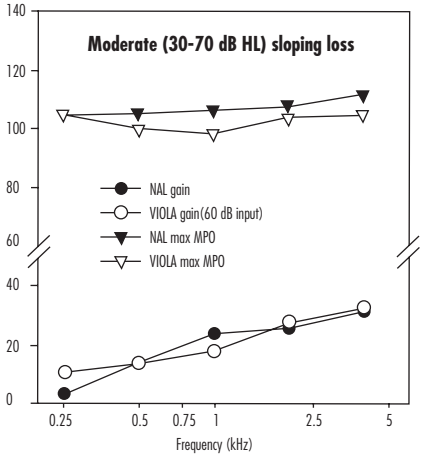

Figure 2. *VIOLA and NAL-RP prescriptions for a moderate, sloping hearing loss. Assumptions for the VIOLA prescription were: input = 60 dB, compression threshold = 40 dB input, compression ratio = 2.0.*

(1) The gain prescriptions for sloping losses were fairly similar, but for flat configurations the VIOLA prescribed a more low-frequency emphasis response. Another comparison of NAL-RP with non-linear prescriptive procedures that are based on loudness data was consistent with this in showing more gain at 250 Hz.[14]

(2) The VIOLA maximum output was less than the NAL maximum MPO, and this difference was greater for mild hearing losses. This is not surprising if we consider the instructions used by the two procedures. The instructions used in the NAL method refer to LDLs as "the very loudest sounds you can tolerate," whereas the Contour test instructions refer to UCL as "louder than you would ever choose on your radio." The NAL instructions should result in higher levels.

Keep in mind that to make this comparison I had to predict the loudness data using the audiogram thresholds. So this comparison is valid only for the typical patient and for the compression parameter values I assumed. If individual loudness measures are taken for the patient, and the VIOLA fitting is based on them, the comparison between the VIOLA and NAL-RP prescriptions could easily be quite different.

13 Looking back at Figure 1, I noticed that, so far, we have talked about the first three elements of the procedure. There are still three more to go. It's hard for me to go along with the idea that the fitting is only half done when I have put the hearing aid on the patient.

Actually, some of the most important parts of the protocol are still to come. You need to make sure that the hearing aid is doing what you intended (verification) and then you need to make sure that it is helping to solve the patient's problems in daily life (validation).

14 I notice you called the IHAFF verification procedure the three-step method. What's that about?

The three steps are:

(1) test box adjustment of the instrument to match the I/O functions you chose for the two test frequencies, to make sure that the OSPL90 level does not exceed the UCL, and to confirm that distortion for high input levels does not exceed 10%;

(2) real-ear probe-microphone measure of REAR to ensure that the bandwidth is appropriate and the response is fairly smooth;

(3) sound field checks of the specific goals of the procedure for low, average, and high levels of speech and for potentially uncomfortable sounds.

15 I understood the first two steps, but what do you mean by step 3? What sound field checks?

This is the most interesting part. Somehow, your verification procedure should provide a *direct* test of the goals of the fitting. In the IHAFF procedure, the goals are for soft sounds to be audible, average speech to be comfortable, and loud speech to be loud but not uncomfortable. In addition, everyday obnoxious sounds should not be uncomfortable.

We verify reaching these goals by measuring aided sound field thresholds for soft sounds, and by having the patient provide loudness judgments of speech presented at 65 dB SPL and 85 dB SPL to judge average and loud speech. Actually, I noticed an interesting paper describing these speech-based verification procedures in this journal a few months ago.[15] You might want to look at that for a more detailed discussion. Finally, we use some commonplace objects to make noises and ask the patient whether they are uncomfortable.

16 That last part about using everyday objects to make noises sounds very unscientific. How can you recommend something like that?

I agree, it does sound a bit uncontrollable. However, presenting real, everyday sounds to patients to test the maximum output of their hearing aids has been recommended by several of the best clinicians I know. So we did a study in which eight clinicians made noisemakers from simple instructions that we provided. Then they used their noisemakers in a test room and we measured the level and spectrum of the noise at the patient's position.

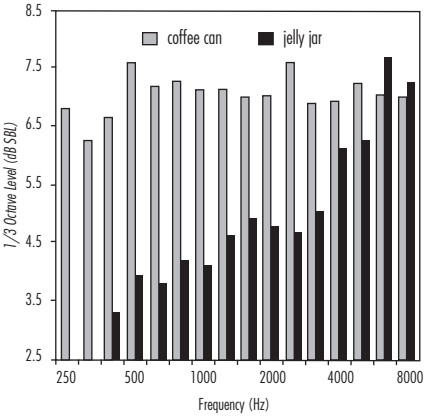

Figure 3. *One-third octave band spectra for two noisemakers.*

The question was, would the different noisemaker/clinician combinations produce similar noises? In fact, they did. The standard deviation of the 1/3-octave band levels was 3 dB, on average, across clinicians using their noisemakers. Figure 3 shows the level data for two noisemakers that seem like a good combination to me (the coffee can containing bolts and the jelly jar containing pennies). They produce noises of almost the same overall level (84 dB SPL and 81 dB SPL, respectively), and they have similar high-frequency spectra but very different low-frequency content.

We presented some of these data at the 1998 AAA convention.[16] You can get the poster from our web page and make your own HARL noisemaker kit. Be sure to use exactly the materials we describe and to operate the noisemakers according to the instructions. Otherwise your noises might be different from ours.

17 Okay, I'll do that and try some of those noises for myself. In the meantime, what about the accommodation period (element 5 in Figure 1)? Why didn't the IHAFF group recommend anything for that step? Is it not very important?

Quite the contrary. Evidence is accumulating to suggest that what you do during the immediate post-fitting period often determines the success or failure of the fitting. It is pretty clear that as few as two or three post-fitting counseling sessions—preferably with a group of hearing-impaired persons and significant others—is associated with considerably improved odds of a more satisfied patient who makes more use of the hearing aid.[17-19] There is a wealth of helpful literature out there.[20]

If you have difficulty convincing your patients to participate, try offering a rebate to those who do. I heard of this at a recent meeting and the clinician maintained that the rebates are more than compensated for by the reduced return rate from patients who go through the program.

18 I have heard more and more about outcome measures lately, and I notice that element 6 in Figure 1 is Outcome measurement. What has happened in this area since 1994?

You are so right that outcome measurement has taken on a new importance in recent years. Dispensers have started to look carefully at what patients say about their hearing aids and the help they provide. The IHAFF procedure recommended the APHAB as an outcome measure, and it is still a useful tool for measuring disability reduction. Also, the COSI and the GHAPB, mentioned earlier, can be completed after the fitting to provide outcome data.

In addition, several new outcome tests have been developed to measure other aspects of outcome. For example, we have developed a satisfaction measure called the SADL (Satisfaction with Amplification in Daily Life),[21] and loudness perceptions can be measured using the PAL (Perception of Aided Loudness).[22] Also, the HHIE (Hearing Handicap Inventory for the Elderly) is

quite widely used both pre- and post-fitting to measure handicap reduction.[23] All of these are quite brief and can be squeezed into most clinical routines. So pick your favorite or use a combination of several.

19 What's happened to the IHAFF Suite software? Has it been updated?

The original IHAFF suite consisted of three components (the Contour test, VIOLA, and APHAB) integrated together so that all the data for a patient could be stored in the same file. This software is still available from Dennis Van Vliet, but it has not been updated since 1994 and runs in DOS mode.

In my lab, our work with loudness measurement has led us to abandon the idea of computerized loudness testing because it is too error-prone. You really need an experienced and insightful human brain overseeing a loudness test. So now I recommend that any loudness testing require human administration. You can use software to score the test.

The VIOLA has undergone two major developments and several minor ones. The major ones are the procedure for predicting loudness data, if you wish, and the additional methods for selecting compression parameters—the auto-curves and the hearing aid data base. Minor ones include things like adjustments for binaural fittings and CIC styles. The newest software version runs in Windows.

The APHAB software has also been updated to run in Windows, and we added a few enhancements. You can now compute a global score across the three speech communication subscales. You can also configure the software to compare aided and unaided data from a single hearing aid, or to compare aided data from each of two hearing aids. You can now compare your patient's data with three sets of norms: users of linear hearing aids, elderly "normal" hearers, and young normal hearers. Finally, there is a new streamlined clinician-scoring mode for entering responses from completed paper-and-pencil questionnaires. I have also published an article that will help you learn more about the administration and interpretation of the APHAB.[24]

You can get the new APHAB and VIOLA software through our web page at www.ausp.memphis.edu/harl.

20 Is anybody really using this protocol to select and fit hearing aids?

I'm not sure. I know that it is taught in several academic programs, and we have received quite a few requests for the APHAB and VIOLA software. Several other generic prescription methods for fitting non-linear hearing aids are now widely available (FIG6, DSL4.1, and NAL-NL1).

Looking back on it from this vantage point, I think the most significant contribution of the IHAFF group was to insist that a hearing aid fitting entails much more than generating a prescription and matching a set of targets. The six elements shown in Figure 1 can be implemented in a variety of ways. It is probably more important to pay due attention to each of the elements than to insist on doing any one of them in a particular way. Just remember, when people say they're using the IHAFF procedure, it should mean that they are using the complete comprehensive protocol. Anything less is not the IHAFF protocol.

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