WHITE PAPER – PRIMO 2013

Creating more **personalised hearing instrument fittings**

ABSTRACT

In the field of hearing instrument fitting, we tend to use an approach where we measure, fit and then fix whatever is wrong or unpleasant to the hearing instrument user. What if we could change this negative, reactive process into an approach that pro actively plans on optimisation of the fitting based on an assessment of the user's reaction to amplified sound? This white paper describes how personalisation can play an important role in user satisfaction and how new tools and features in Oticon Alta support a more personalised hearing instrument fitting.

Donald J. Schum, PhD
Vice President, Audiology &
Professional Relations
Oticon, Inc.

Julie Neel Weile
Clinical Audiologist
Clinical Evidence &
Communication
Oticon A/S

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Part 1:
Why focus on personalisation?

At its essence, our field's overall approach to fitting amplification is predictive. As reflected in *Figure 1*, we measure certain aspects about the user´s hearing, predict what sort of instrument and settings should be best and then fine tune when it becomes clear that the prescribed, standardised fitting approach was not optimal for the individual user. The "fixing" part of the process (fine tuning) has never received as much attention as the prediction part of the process, but the simple reality is that the Hearing Care Professional (HCP) spends a large amount of time in the follow-up, problem solving phase. There is an implicit assumption that prescribed fittings should be "correct" most of the time, but that does not match with the experience of most professionals: significant follow-up is needed for most users.

Further, what can be predicted based on the users' audiometric data only guides the settings of a limited number of instrument parameters. Modern, advanced technology hearing instruments allow for variation on many more dimensions than just gain across frequency as a function of input level. Compression timing, the action of automatic directionality and the action of noise reduction are all examples of parameters that can significantly affect the sound of amplification but cannot be easily predicted based on the audiogram.

The fine tuning process is normally viewed as correcting a somehow inaccurate initial fitting. The reality may rather be that the criteria that the user uses to judge the sound of amplification may simply be different than the criteria used by the HCP to predict what is best. It is not a matter of inaccurate fittings. Instead, it may be that some users are prioritising different dimensions.

With the release of Oticon Alta, we are advocating a change in focus of the fitting process, as reflected in *Figure 2*. There is great value in shifting the emphasis in the fitting process from predicting what should be right for the user towards verifying what sounds and works best for the user. There is still an important place for predicting what should work best for the user. However, given all of the potential factors that may influence the perception of any given user, structured assessment and verification of the combination of settings that creates the overall best sound experience for the user becomes even more important.

Listening preferences

Human beings vary in terms of how they respond to sensory stimuli. What is a positive experience for one person can be negative for another. Across the dimensions of vision, taste, smell, touch and, yes, hearing, different people have differing opinions as to what looks/tastes/smells/feels/sounds pleasurable or not. There are many reasons why humans vary in their response to stimulation, some reasons being physiologically wired, others being based on experience. What determines one person's response to a particular painting or culinary dish or article of clothing or song? No matter what the reason, individual preference is the norm, not the exception.

Hearing health care has been slow to embrace the natural variation from user to user in their response to signal processing. Variations in both the static (frequency response, gain) and dynamic (compression activation, automatic directionality, noise reduction) characteristics of instruments can fundamentally affect how they sound. For example, users are known to vary in their preferred gain and frequency response *(Hornsby & Mueller, 2008; van Burren, Festen & Plomp, 1995)*. Our ability to predict an individual's preference is limited, yet subjective assessment approaches have been shown to be effective in uncovering such preferences *(eg., Hansen, 2002)*. We have the technical ability to create significantly different sound profiles in amplification instruments, but there is no process to make the most of this flexibility. The time has come to turn our attention to creating a better process to uncover the user´s personal listening preferences.

There is only one person who knows how a set of hearing instruments sounds – that is the user. Excellent technology in Oticon Alta goes a long way to meet the challenges of hearing loss across a broad range of environments. Yet, each person experiences sound in a unique way. There are many factors that will affect how the user responds to amplified sound – how their ears work, how they process information, their sound preferences, experiences, etc. The Alta fitting process

Figure 1

uses questions and structured listening experiences to uncover how all of these factors come together in the user´s perception.

Traditionally, HCPs have attempted to maximise speech understanding performance across a range of communication situations. This goal is certainly sensible. However, our field has done little to formalise the assessment and maximisation of the aesthetic dimensions of hearing instrument performance. By "aesthetics" we mean dimensions such as sound quality, pleasantness, clarity, seamlessness, comfort, etc. The most recent MarkeTrak work *(Kochkin, 2010)* has shown that 5 of the top 10 dimensions that are most highly correlated with overall satisfaction would fall under the general category of aesthetics. Examples include "Clarity of Sound", "Natural Sounding" and "Richness or Fidelity of Sound".

HCPs normally either (1) wait until the user complains about problems on one of these dimensions before making adjustments or (2) assess these issues in an unstructured, "how does it sound" manner (perhaps by, for example, crinkling paper or banging keys on the desk). In either case, adjustments are only made if there is a problem with the initial fitting. Few HCPs use a structured approach to try to optimise instrument performance on any of the aesthetic dimensions.

Bech and Zacharov (2006) describe the Filter model of subjective analysis of sound. They describe two layers of filters that are at work when a human assesses the subjective nature of a sound. The first layer of filtering is sensory and reflects an analytical view of the stimulus. In our field, we know this as classic psychoacoustical assessments such as loudness scaling, pitch matching, etc. The second layer of filtering is cognitive and brings in influences such as memory, expectation, mood, etc. At this level, the listener is making judgments that are in the arena of likes and dislikes.

These sorts of individual differences are known to exist in the normally hearing population, being related to factors as disparate as mood, experience, personality, etc *(Belcher, 2010; McDermott, 2012)*.

Importantly, however, individual sound preferences have been determined to be quite stable *(Choisel & Wickelmaier, 2007; Gabrielsson, Hagerman, Bech-Kristensen & Lundberg, 1990; Versfeld, Festen & Houtgast, 2010)*.

For users with hearing loss, the variability becomes even greater. The sensory level of filtering is going to be affected significantly by the peripheral disorder: sensorineural hearing loss will alter how the basic components of sound are perceived. For nearly any psychoacoustic dimension that has been studied, variability in performance of those with sensorineural hearing loss is the norm. At the cognitive level, however, the influences on perception go well beyond the effects of hearing loss. This is the level on which we have spent minimal attention and research and which extends beyond the effects of the hearing loss itself.

The audiogram alone cannot predict the communication difficulties experienced by users. *Weinstein and Ventry (1983)* found great variance in self-perceived hearing handicap measured on the HHIE across audiometric thresholds. The tendency was towards individuals with greater hearing loss perceiving greater handicap and an association between mild hearing losses and no perceived hearing handicap. But the relationship was not complete. Some individuals find a mild hearing loss very handicapping (e.g. 37% of individuals with mild hearing loss in the study experienced mild to significant hearing handicap) and vice versa. Hearing sensitivity was found to account for 31-38% of the variance of the participants' total score on self-assessed hearing handicap. The authors conclude that "despite the significant correlation between audiometric variables and hearing handicap, more than 50% of the variance in self-perceived hearing handicap remains unexplained by the audiometric variables studied." Conclusions from the study were confirmed in a later study by *Chang et al. (2009)*, who found moderate associations between hearing impairment and self-perceived handicap using the HHIE-Screening on a group of 1220 elderly persons.

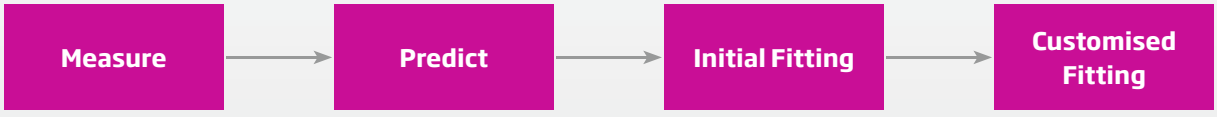

Figure 2

In a review of studies examining the factors that affect speech understanding, *Nelson et al. (2007)* observed that a given pure-tone threshold can have a range of different etiologies that may affect the speech perception of the individual even when audibility is removed from the "equation". The great variability in speech recognition among hearing impaired listeners was attributed to etiology of hearing loss, cognitive factors and personality.

As indicated by the Filter Model *(Bech & Zacharov, 2006)*, the response to sound is related to factors beyond those in the perceptual system. Some of these variables interact. For example, sound aversiveness (as defined by the APHAB questionnaire) has been demonstrated to be associated with personality; individuals who score high on extraversion, openness and agreeableness (NEO-IFF personality dimensions) are less likely to report that environmental sounds are unpleasant. Likewise, individuals who score high on neuroticism experience higher sound aversion *(Cox et al., 2007)*. Sound aversion is a good example of a subjective factor that can derail a user experience, as uncomfortable sound is the most frequent reason for unsuccessful hearing instrument fitting *(Kochkin, 2000)*.

The modern user

The modern health care consumer is just that: a consumer. Gone are the days when the users view themselves as a passive participants in the medical process. Instead, modern users in all aspects of health care are taking a more active role in deciding which course of treatment makes best sense. They have made it clear that they expect treatment that is honed to their particular set of circumstances *(Jackson, Chamberlin & Kroenke, 2001)*. They provide favorable ratings to care givers who focus on a personalised approach. Users no longer tolerate practitioners who appear to be detached and unsympathetic. There is simply too much competition. Physicians and other health care providers are no longer treated as all-knowing and unquestionable. The internet and bookstores are filled with information designed to help the user take control of their care. They want to feel like they are the center of the care process and that the course of action recommended is designed with all of their specific, individual factors considered.

There is a growing body of evidence of the value of the Hearing Care Professional in creating a more personalised fitting experience. In the next part of this paper, we will describe how we have re-imagined the Alta fitting process in order to adjust the instruments to best reflect the users unique needs and preferences.

Part 2: Effective personalisation techniques

The overall goal of the Alta fitting process is to reach a higher level of overall satisfaction with the hearing instrument fitting experience. This overall experience is affected by both the performance of the technology and also the care and attention provided by the HCP. We recognise that satisfaction is driven by multiple factors and that each individual user will have a unique combination of these factors. However, attention to individual needs and expectations is the dominating factor impacting satisfaction that is common across users in health care environments *(Jackson et al., 2001)*.

Oticon Alta process steps	Goal	Tool
Initial fitting	• Start the user with appropriate settings based on audiological characteristics • Shape the initial sound based on responses to the new Personal Profile questions • Engage the user to participate in the personalisation process	• Personal Profile • Sound samples - Personalisation tab of sound studio
Active listening	Provide users the opportunity to experience and record their reactions to their daily sound environments while wearing Oticon Alta.	• Oticon Alta Diary
Optimising	Provide users an opportunity to have the instruments personalised further to reflect their unique sound experiences.	• Activity Analyzer/Memory • YouMatic • Sound Samples - Optimisation tab of sound studio • Oticon Alta Diary

Table 1

The Alta fitting process is designed to make it very clear to the user that the fitting is being driven by his/her individual perceptual experience. Each user is given ample opportunity to express opinions about how the instruments are performing. The process is focused on allowing, even encouraging the user to drive how Alta sound. We assume that by having the HCP manage a comprehensive process that includes a high level of user input, the total user experience will be unlike anything that has come before.

One significant new feature to highlight the personalisation process is YouMatic *(Figure 3)*. YouMatic is the natural evolution beyond Identities. It is a control system in Alta, and reflected in the Genie fitting software, designed to match the operation of the complex signal processing systems in Alta to the personal preferences of the user. The user´s Personal Profile will define the setting of YouMatic and YouMatic will then coordinate the complex functioning in the hearing instruments.

There are five major Personal Profile settings: lively, exact, balanced, gentle & steady. In addition, there are smaller steps on either side of these five primary settings, leading to a total of 15 potential Personal Profile settings. In general, as you move from the lively setting towards the steady setting, the user will be provided with more support from the automatic systems in Alta. On the lively end, the user will be provided with the most complete, minimally processed representation of the signal. On the steady end, more adjustments will be made by systems such as automatic directionality, noise reduction, transient sound management, etc. Think of the labels as referring to the characteristics of sound after it has been processed by Alta: lively providing a sound that includes the most natural dynamics in the sound environment and Steady providing the most control over the variations in complex sound environments.

As with the Identities, certain user characteristics are used to predict the best initial setting of the Personal Profile. However, with Alta, we are including more of the client's sound preferences in both the Initial Fitting and, most importantly, the follow-up optimising session.

Key Assumptions: The Alta fitting process has been designed based on the following assumptions:

- Users in the healthcare system expect attention to their individual needs and expectations, providing positive satisfaction ratings to providers who are perceived to be tuned into the user as an individual.
- HCPs currently spend a significant amount of time in aftercare, problem solving and making adjustments to the initial fittings. Often, this aftercare is performed within a negative context: "the fitting is not right and needs to be fixed."
- Our ability to predict how any given user perceives amplified sound is limited. We are shifting the focus of obtaining a good fitting more towards the back-end of the process, with less reliance on trying to predict what is best and more reliance on assessing the user´s sound preferences.

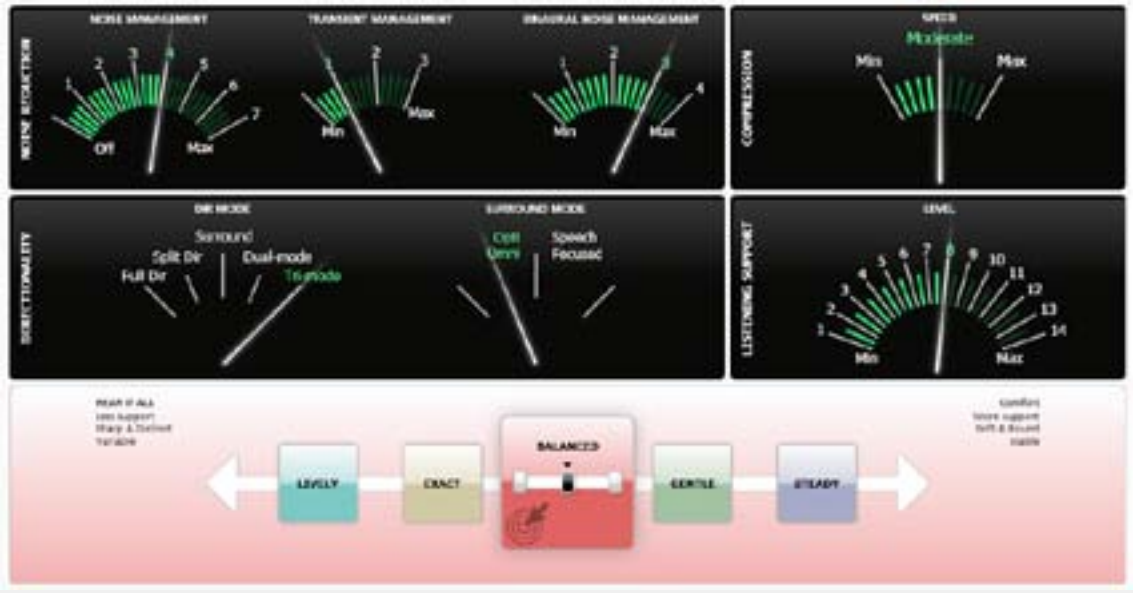

Figure 3

The Alta fitting process consists of three steps: the initial fitting session, the active listening, and the optimising session. *Table 1* provides an overview of each step, the desired goals, and the tools developed to be used during each step. Alta fitting guide provides details of the procedures and techniques that we recommend to support the fitting of Alta. This guide, for example, will provide a variety of support items as indicated in the tools column of *Table 1*.

Initial fitting session

The initial fitting session is intended to be an interactive session between the user and the Hearing Care Professional. The settings of the instruments, including the YouMatic control, will be based on the users age, audiometric information, instrument use history and answers to the newly expanded questions in the Personal Profile.

Since the first time user has not experienced sound through hearing instruments before, the discussion should focus on their reaction to sound and sound environments in general. For the experienced user, the discussion should focus on past experiences with sound through amplification, and how they would like it to be different.

It is important that you engage the user with the four Personal Profile questions. Explain the purpose of each question. Some of the questions may have to be reworded or rephrased for the user to fully appreciate what is being asked. Alta fitting guide provides some rewording suggestions.

New sound samples (located under the Personalisation tab in sound studio) are provided to help make the questions easier for the user to understand. Before playing any sound sample, explain what the user should be listening for. For example, the dialogue below presents one example of how to use sharp vs. soft sound sample:

"Mr. Smith, I am going to play two sound samples for you, A and B. These two samples represent two different ways in which your instruments can be set. I want you to pay attention to how clear and distinct speech sounds in each sample. When the samples are done playing, I would like you to tell me in which sample you thought speech sounded more clear without being unpleasant, A or B. This will help us begin to personalise the instruments to your sound preferences "

You may have to make some immediate fine tuning changes as needed. Any adjustments made at this point should be for immediate comfort/feedback/acceptability concerns. Remember, the user will have the opportunity to do more comprehensive adjustments in the follow-up optimising session.

Gaining listening experience

Active listening is intended to provide the user with an opportunity to experience different sound environments while wearing his/her new instruments. Before sending the user home, provide detailed instructions on how to evaluate the sound and performance of the instruments. Explain that they should visit situations encountered most often and/or that are most important to them. They should focus on both easier, quieter situations as well as more challenging ones.

For experienced hearing instruments users, the active listening experience evaluation period should last from one to two weeks. The evaluation period for first time users should be the same as the automatic adaptation manager settings (typically between two and four weeks).

The Alta diary has been developed to be a take home tool that can be used during the listening experience. The guide is designed to provide instructions and reminders to the user about the types of environments to be assessed.

The optimising session

The optimising process forms the cornerstone of the Alta fitting process. The process consists of two steps, the debrief and structured listening experience. During the debrief, information is gathered from clients about their active listening experience. This information will be utilised during structured listening which walks users through a series of listening tasks in an effort to match their sound preferences to the instrument settings, thus truly personalising the fitting.

Debrief: The goal of the debriefing is to collect any useful information from the user´s first few weeks of experiencing the sound of Alta. This can be based on spontaneous comments made by the user, review of the Alta diary and, perhaps, the Activity Analyzer. As with all good interactions with users, the Hearing Care Professional needs to accumulate all sources of relevant information. For example, it is important to differentiate between a report and a complaint. Additionally, it will be a good time to develop a sense of which sound dimensions seem to be most important to the user.

One habit that many Hearing Care Professionals demonstrate is to allow the focus of follow-up sessions to be only about the negative experiences of the users. In essence, the philosophy historically has often been "if the user does not complain, the fitting must be fine." A major aspect of the Alta fitting process is to go from an acceptable fitting to an excellent fitting: to take an initial fitting of a product with state-of-the-art technologies and further refine the sound to best match the preferences of the user. As such, debriefing of the user should not focus only on the negatives ("what did not work", "where did you struggle", "what didn't you like about the sound"). It is, of course, important to recognise if there are any aspects that are dissatisfying to the user. However, it is equally important to probe about the successes that the user achieved and what was appreciated about the sound.

We suggest that any changes in the Personal Profile setting should take place before more precise fine tuning. The reason is that a major change in sound processing that could take place with a change in the Personal Profile could make the more specific fine tuning unnecessary. During the debriefing, the Hearing Care Professional should take note of potentially needed fine tuning, but should save those adjustments until after the structured listening experience.

The structured listening experience involves playing sound samples for the user in two different YouMatic settings, instructing them on which dimensions to listen to, and then asking for a judgment between the two settings. The structured listening experience is not intended to be an endless search for the "perfect sound", rather it is intended to take a good fitting and personalise it further.

The sound samples for the structured listening experience are located under the optimisation tab in the sound studio. For purposes of the structured listening experience the sound samples will be divided into two groups: group 1 – comparison sounds and group 2 – confirmation and fine tuning sounds. Sounds in group 1 will be used as part of the structured listening task when changes in the Personal Profile setting may take place. Sounds in group 2 will be used for confirmation of the Personal Profile changes and perhaps for further fine tuning.

As indicated above, users will assess amplification on both performance and aesthetic dimensions. We believe that it is difficult for the user to adequately judge the performance of amplification during the structured listening session. We believe that the structured listening session is a great opportunity for the user to assess the aesthetic dimensions. Sometimes it will be difficult to properly recreate complex environments in the counseling setting. However, the assessment of aesthetics is less dependent on the ability to recreate any sort of realistic environment. Of course, appropriate adjustments should be made to try to maximise performance with Alta. However, since the aesthetics of the sound experience will also affect overall satisfaction, the structured listening session is a unique opportunity to focus on this aspect.

We also believe that it is a good idea to have the user make simple A versus B comparisons. This approach is common in studies of subjective assessment of sound *(e.g. Choisel & Wickelmaier , 2007; Versfeld et al., 2010)*. A simple two-alternative choice is the easiest cognitive task, as opposed to rating or other approaches that require more memory or analysis. The two alternatives should start far enough apart to give the user a clear contrast (perhaps one or two full YouMatic steps). Once a judgment is made, then comparisons of two options that are closer together may be warranted if it seems that the user is responding to something that they hear. Bracketing should never become so precise that the user becomes frustrated or confused.

Further, we suggest that you have the user focus on specific aspects of the sound experience when listening to sound samples. Specifically, we suggest you have the user pick the sound sample that better provides a "clear and pleasant" speech signal. These two terms have been used extensively in past investigations of hearing instrument processed signals *(e.g., Hagerman & Gabrielsson, 1985; Moore, Fullgrabe & Stone, 2011)*. "Clarity" has been identified to be strongly related to the overall perception of sound quality *(Hagerman & Gabrielsson, 1985; Versfeld et al., 2010)*. Further, these two terms work well together for the following reason. In an attempt to maximise speech clarity, the user may make adjustments that have the tendency to create a potentially harsh sound picture.

On the other hand, trying to maximise pleasantness may create a sound picture that obscures speech details. By having the user make judgments that take both dimensions into account at the same time, it forces the user to make a personal balance of these two important dimensions.

There is no specific number of steps or clearly specified path through the structured listening session. The Hearing Care Professional must use good judgment as to how many samples to use, how big of a comparison between two settings, how much narrowing of the bracket should take place, etc. Remember, the user has already been fit with excellent hearing technology. The goals of the structured listening are to (1) attain insights into which dimensions seem to matter the most to the user , (2) give the user a greater sense of inclusion in the process and, (3) when possible, create a fitting that better reflects the user´s preferences. If the listening process is providing good information that the Hearing Care Professional can use to improve the fitting, then it is time well spent. If the process seems to be getting bogged down or if the user is confused or frustrated, then the Hearing Care Professional should gracefully move on to other tasks.

Final thoughts

The key audiological component of Oticon Alta is the clear focus on creating an individualised high-performance solution for the user. Within Alta, there are many options to change the sound processing approach on several performance dimensions, and no single combination of settings will be optimal for all users. The combination of the flexibility built into the product along with our strong recommendations on how to personalise the fitting process are designed to make it clear to the Alta user that these instruments are designed for them as an individual. There are two main reasons why hearing instruments should be fit on an individualised basis:

- There are true, legitimate reasons why different users will want the instruments to perform in different ways – individual preferences are to be expected.
- Users respond well when they feel that the health care process is tailored to their individual needs and wants.

For too long, our profession has been fighting against the reality that hearing instruments have to be customised. Users who do not respond optimally to prescribed settings have frustrated the professional. With Alta, the focus is on embracing the user´s need for personalisation by creating a product and fitting process in which the professional acts as the guide to discovering the optimal solution for each and every user.

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