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The Connected Ear

Using Bluetooth to Enhance Audiological Performance and Outcomes

White Paper

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"Connectivity" is a word that is used a lot in today's society, and for good reason. Whether we are connecting with friends and acquaintances on Facebook, using our smartphones to connect to media and news websites, or checking the weather, the theme of connectivity plays a big part in most people's lives. From a technological perspective, connectivity means that information can be shared between different systems, programs, or devices. In general, this has led to improvements in productivity as information has become more accessible, and disparate sources of information can be used in new ways. One technology, launched in 1998, which has played a big part in the rapid increase in connectivity is Bluetooth.

The beginning of Bluetooth in hearing aids . . .

In 2014, when a hearing aid manufacturer introduced a product that could stream audio directly from a smart phone to the wearer's hearing aids without an intermediate streaming device, a wave of excitement rippled through the industry. The product used Apple's proprietary Bluetooth technology, known as the Made for iPhone (MFi) standard. There were at least two reasons for the enthusiasm. First, Bluetooth hearing aids which did not require an inconvenient streaming accessory provided patients with an easy to understand benefit. Second, because direct-streaming hearing aids were associated with a popular technology company, hearing aids could piggyback on the image of a desirable, more youth-oriented consumer product.

. . . and the importance of continuous improvement

We will step away from Bluetooth hearing aids for a moment, and instead look at an interesting characteristic about today's world. Compared to fifty years ago, the array of products and services available to consumers has dramatically expanded. Whether you are shopping for groceries, planning a vacation, or buying a new car, the choice is greater than ever before. The hearing aid industry is no exception, with a larger array of styles and features available today than ten or fifteen years ago. In general, this worldwide trend has been driven by businesses either becoming bigger or more focused. Businesses with the resources to specialize their workforces have developed a competitive advantage over companies who don't have the scale or budget to specialize.

To an extent, these winds of change are also sweeping across the hearing healthcare profession. An example of the general trend of greater scale and specialization has been increased competition in the retail hearing aid space over the last decade. Previously, it was often good enough to be a competent clinician and success would follow. Today, clinicians who run their own clinic have to have a strong grasp of marketing and advertising, the know-how to deliver a convincing overall customer experience, recruit, maintain, and foster engagement with staff, and last but not least, provide a high quality hearing aid selection and fitting process.

While this may seem somewhat gloomy for independent clinicians, one important aspect about our industry has remained quite stable. That is, high quality hearing care depends heavily on the skills—both the technical and counseling skills—of the hearing care professional. As experienced clinicians know, the hearing aid is an important part of the solution, but even the best hearing aid, when poorly fitted, will not provide a satisfactory outcome.

With a view to the trend of increasing specialization, and with an understanding that the clinician is central to good patient outcomes, Signia has developed two solutions which will be discussed in this paper. Both solutions have a common goal: to provide clinicians the tools to improve their fitting process and to enhance fitting outcomes. Both solutions allow clinicians to sharpen their competitive advantage, which is to provide high quality, personalized hearing care. Furthermore, both solutions use Bluetooth technology in a completely new way.

Bluetooth beyond streaming

There is a rapidly growing group of wearers who embrace the convenience of direct-streaming to the extent that this might be a driving force in their purchase decision. However, there remains a large group of traditional wearers who rank signal processing for speech understanding and sound quality as most important. Of course, these two groups are not mutually exclusive—the streaming group demand great sound quality and improved speech recognition too. Signia Pure 13 BT is the only hearing aid to combine binaural directivity (HD binaural), which uses a bidirectional magnetic inductive audio link, with the convenience of direct streaming. Pure 13 BT is also the world's first hearing aid to use motion sensor information from the patient's smart phone. Motion information, in conjunction with the hearing aid's Bluetooth connection, is used to select an optimal signal processing strategy in various environments. The wearer needs an Apple mobile device and the Signia myControl app to benefit from this technology.[1]

An important aspect of Pure 13 BT is the interplay between the motion information from the patient's smartphone, the hearing aid's control system, and the precise steering of the microphone system. Listening behavior and performance can vary depending on a person's motion state. For example, it has been shown that when a person simultaneously listens and walks during a navigation task, hearing loss adversely affects speech recognition to a greater extent than would be predicted from the hearing loss alone.[2] When a person is walking, the wearer's communication needs are likely to be more fluid; in the wearer's immediate vicinity there is less need to focus on speech in a restricted field, especially in environments with better signal-to-noise ratios. In such environments, the hearing aid's control system emphasizes situational awareness over focused speech emphasis. On the other hand, for environments with a challenging signal-to-noise ratio, and when the person is not moving, a higher emphasis is placed on nearby speech activity than situational awareness.

This probabilistic approach of combining activity detection with human communication behavior yields significant benefits in real-world environments, and reflects the brain's natural bias for being less receptive to extraneous speech signals when someone is already engaged in a conversation with nearby people. This special ability of the auditory system is often referred to as the cocktail party effect. Up to a point, a person can follow a particular voice even though other voices and background sounds are present. In this case, the ear is segregating this voice from other sounds (which are integrated), and the mind filters these segregated sounds into an auditory stream.[3].

How Pure 13 BT helps Frank to benefit from the cocktail party effect

The following example shows how Bluetooth enabled motion detection supports people's innate ability to benefit from the cocktail party effect. Frank, who wears Pure 13 BT hearing aids, works in a large building. He has just finished a meeting and is walking back to his office. As Frank passes by the noisy coffee area, he is distracted by a group of people animatedly discussing their favorite coffee blend. Suddenly, another colleague sees Frank and tries to attract his attention. Because Frank's hearing aids already know that Frank is walking, they are configured for enhanced situational awareness. Despite the competing speech from the first group of people, motion detection ensures that the voice from Frank's colleague is easily detected. On the other hand, for hearing aids not using motion information, the competing speech from the group of people would likely be interpreted by the hearing aid as target speech. If Frank had stopped moving near the group of people, this would have been a reasonable assumption because he would probably have wanted to become involved in the discussion. As it happened, Frank kept walking, and it was much more important that he could hear his colleague calling his name, rather than being fully informed about the best coffee blend from Guatemala.

Using Bluetooth to enhance the fitting process

John: Owner of a small but successful hearing aid dispensing practice

After founding his clinic more than 20 years ago, John has built up a small but successful independent audiology practice. Despite increased competition over the years, old fashioned word-of-mouth is still John's most important marketing tool. John's practice is located in a remote area, so it is not unusual for his patients to travel ninety minutes each way, just to attend their appointment. Even though John knows that good clinical practices and personalized service are key reasons for his practice's success, he also understands that many of his patients would prefer to avoid the long drive into town. More often than not, their problem can be resolved with a simple gain adjustment, or even a few words of advice. John had often thought to himself: I wonder if there's a better way to manage fine-tuning adjustments?

Linda: A motivated but not entirely satisfied hearing aid wearer

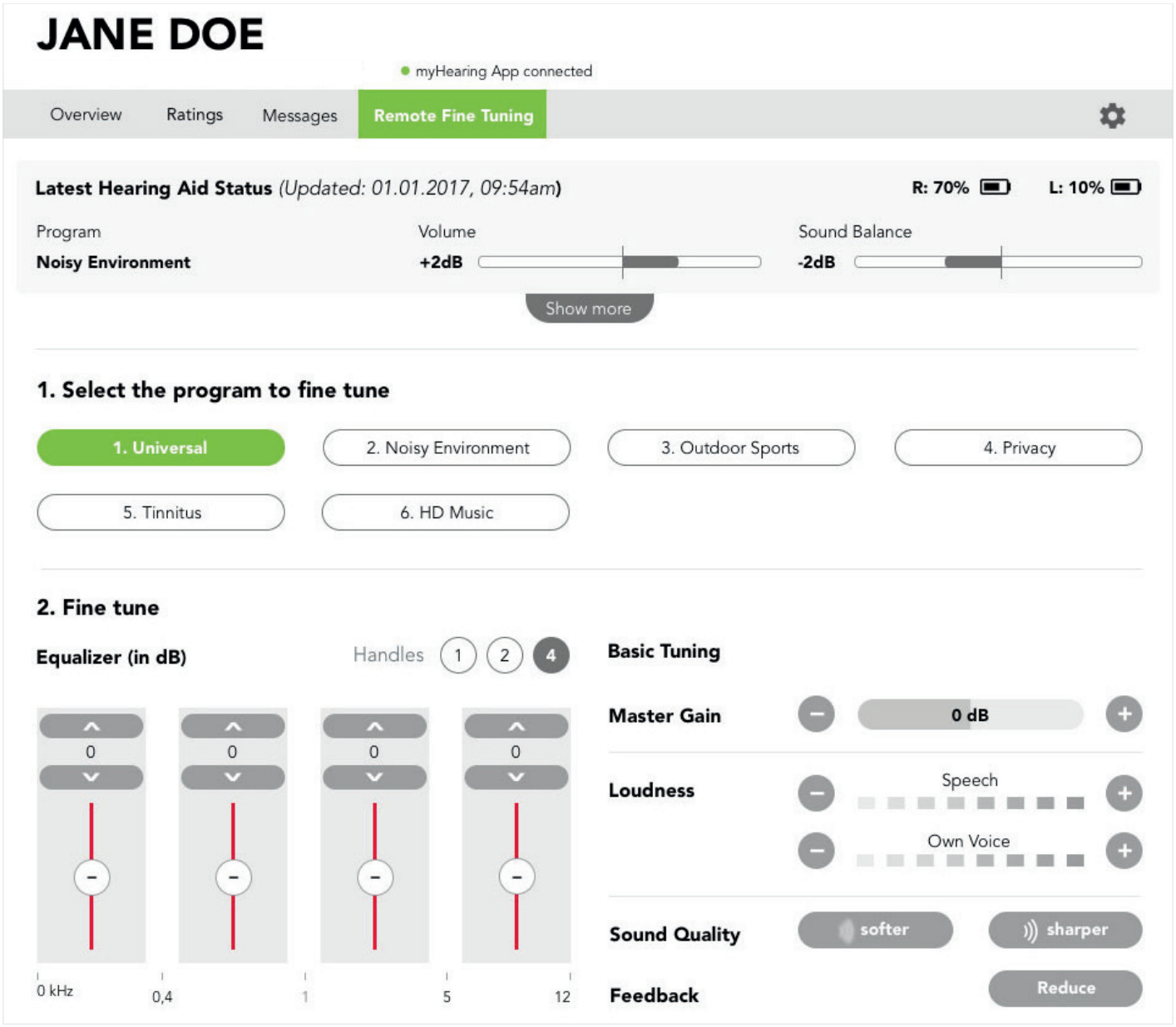
At age sixty, Linda had retired from her job as a math teacher. She had always had the knack of keeping a quiet classroom, which was important because otherwise she would have had difficulty hearing her students' questions. So it came as no great surprise when Linda's clinician had recommended hearing aids, which Linda recently purchased and consistently uses. Linda is happy to admit that her hearing aids help in most situations. That said, Linda knows there are some places, especially in loud background noise, where she struggles to follow the conversation. There are also times when the hearing aids sound slightly strange, but Linda always finds it difficult to recall exactly when and where the problem occurs. Most of all, Linda struggles to describe her impression of the sound in a way that helps her clinician improve her fitting.

The next section of this paper discusses an innovative solution which was designed to enhance the productivity of clinicians such as John, and at the same time maximize satisfaction for patients like Linda.

The solution for John and Linda

TeleCare brings patients and clinicians closer together during the important trial period, and helps to convert hearing impaired patients to satisfied customers. In Linda's case, TeleCare would make it easier to collect troubleshooting information in environments where her hearing aids are not performing to her expectations. The myHearing app invites wearers to provide accurate and timely feedback on their hearing aid's performance, both good and bad, in diverse listening environments. Importantly, wearers can rate their hearing experience at the very moment it occurs. This process is commonly referred to as ecological momentary assessment (EMA), and has been shown to be a reliable method to assess and record events and subjective impressions in natural settings. Research has shown that EMA can be used as a successful outcome measure following the hearing aid fitting.[4] When the wearer's EMA feedback is not positive, the app asks the wearer simple targeted questions. Their wearer's answers provide the clinician with relevant troubleshooting information. Overall, TeleCare enhances the communication flow between the patient and the clinician, and contributes to improved troubleshooting outcomes.[5]

In John's case, TeleCare would allow him to monitor and manage Linda's progress via a web-based interface[5]. Importantly, TeleCare offers remote fine-tuning functionality. Clinicians can remotely send adjustments to their patient's hearing aids. When the patient accepts the changes in the myHearing app the adjustment process is complete.



The TeleCare web interface allows clinicians to perform remote fine-tuning in any program. Clinicians can adjust the master gain, plus gain individually in up to four frequency bands. Frequency-specific adjustments relating to the loudness of speech or the patient's own voice are available, in addition to general adjustments for high-frequency amplification.

In case you hadn't guessed, John is Linda's audiologist. While John and Linda have different perspectives on the fitting process, both could benefit substantially from TeleCare. In John's case, TeleCare makes it possible for him to provide all his patients with more convenient and timely troubleshooting. In Linda's case, the myHearing app alleviates the burden of precisely describing her subjective judgement on her hearing aid's performance in various environments. In turn, this helps John identify how Linda's fitting could be improved.

Pure 13 BT adds another layer of depth to TeleCare by using the hearing aid's Bluetooth capability to hone the clinician's troubleshooting skills. Previously, TeleCare collected only the wearer's rating information via the myHearing app. When used in conjunction with Pure 13 BT, TeleCare can capture contextual and objective information from the hearing aid itself. This includes a history of daily wearing time, the wearer's program use, and the proportion of time in different acoustic environments. The Bluetooth link also allows the clinician to monitor the wearer's adjustments of program setting, volume setting, and SoundBalance (a feature which allows the user to adjust the high-frequency gain within a specified range), in addition to battery level, recent information on the acoustic environment, and ambient noise level. Combining high quality, subjective wearer-sourced data with objective data from the hearing aids offers clinicians a more compelling way to troubleshoot fittings.

Furthermore, TeleCare gives clinicians improved visibility of the environments where the hearing aids provided a high degree of benefit. Instead of the patient making a general remark at their follow-up appointment that they are "very happy" with their new hearing aids, Bluetooth connectivity provides clinicians with objective data when the wearer gives a positive rating. This helps clinicians

refine their fitting protocol and better understand how a particular hearing aid is performing. This information becomes useful for counseling future patients, especially in the context of assisting patients who are not completely satisfied in everyday situations, like Linda.

The addition of Bluetooth connectivity to enhance the TeleCare experience can improve the timeliness and quality of troubleshooting. TeleCare gives clinicians a tool to better understand the cause of their patient's successes and disappointments. Remote fine-tuning is a powerful tool to improve convenience for the patient and to enhance the clinician's efficiency when making routine hearing aid adjustments. As a complete package, TeleCare provides clinicians with a convincing toolkit to improve patient outcomes and improve clinical efficiency.

Conclusion

As we saw in John and Linda's story, Signia provides clinicians with the tools to sharpen their competitive advantage and to deliver the best possible hearing care. In the area of hearing aid performance, significant advancements were achieved by using Bluetooth to enhance the data exchange between the patient's smartphone and their hearing aids. As Frank's story demonstrated, this has made it possible to use the wearer's motion profile to enhance situational awareness in real world environments. Second, binaural audiolink technology (HD binaural) allows exceptionally precise microphone steering in environments with adverse signal to noise ratios. In the area of fitting workflow, TeleCare has been enhanced by using Bluetooth to enable high-resolution troubleshooting information for convenient and efficient remote fine-tuning, which ultimately benefits both clinicians and their patients

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