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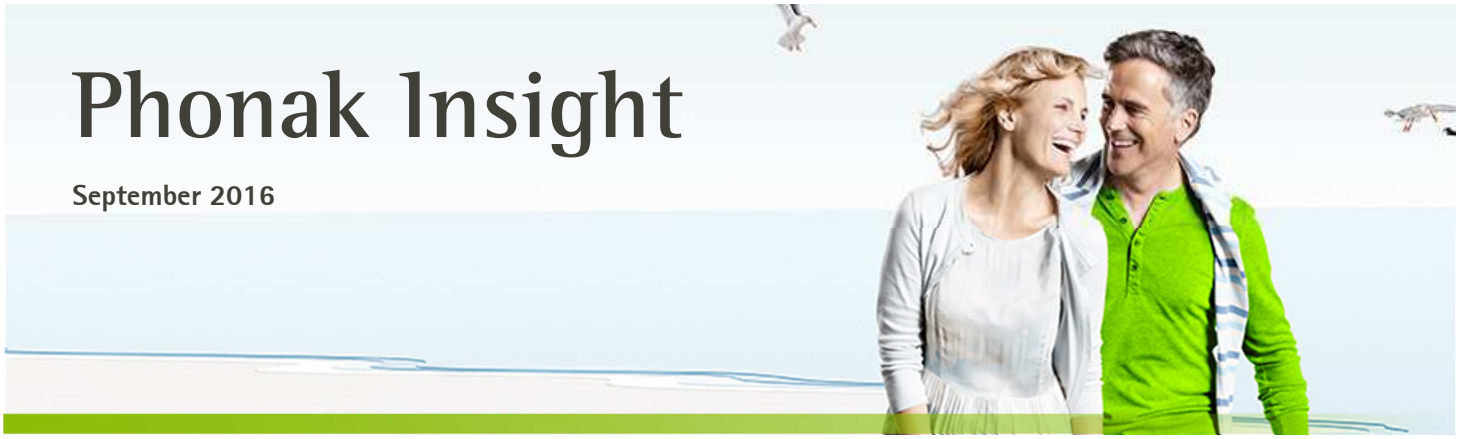

AutoSense OS

Hearing well in every listening environment has never been easier

Introduction

There is no doubt that the scope of hearing aid sophistication has increased dramatically over time. No more are the days of single-channel, analog devices tuned with a screwdriver. Battery life has gotten longer, and hearing aid size has gotten smaller. Hearing aid programs have become more sophisticated and specific to accommodate several unique listening environments, even attuned to subtle nuances such as reverberation. However, with increased complexity comes a need to manage this complexity with no added responsibility on the part of the hearing aid user or audiologist.

Traditionally, it was common for audiologists to equip hearing aid users with two programs: one for "everyday" that enabled an omnidirectional microphone, and one for "noise" that enabled a directional microphone mode. Of course thinking about the speed of life, it is unrealistic to bifurcate listening situations into an "either, or" situation. The nuances of listening environments are rarely this black and white, and of course the acoustics of a particular situation can change at any moment. Hearing aid programs are now customized for specific listening environments; in the case of Phonak, altering time constants, compression, as well as gain and noise reduction depending on the acoustics of an environment.

Automaticity is a necessary aspect to the increasing sophistication and specificity of hearing aid programs. As the number of hearing aid programs designed for specific environments increases, the more difficult the burden of hearing aid program-switching becomes for the hearing aid user. Research shows that compliance and consistency for switching into a traditional "noise" program can be difficult, even for experienced hearing aid users. Further, automaticity is necessary so hearing aid users do not have to think about switching between hearing aid programs. It is the desire of hearing healthcare providers to reintroduce a normal-hearing listening experience, which goes beyond the restoration of audibility. This goal should also extend to the role of the hearing aid in one's life. The hearing aid user should never have to think about his or her hearing aid, the way a normal-hearing listener never thinks about his or her listening environments.

In this way we are relying more heavily on the hearing aid to make its own "decisions" about the listening environment, which requires a very smart "brain" with which the hearing aid makes these decisions. A misclassification of listening environment could very well lead to substandard hearing. Today's automatic systems vary across manufacturers in their ability to detect acoustic characteristics within the environment, and the number of parameters that can be manipulated to accommodate that environment.

How has automatic technology evolved?

Sound classification systems originated well outside the area of hearing aids; first used for transcribing dictation, as well as security and military applications. Sound classification was first implemented into hearing aids in the 1990's, with the underlying processing of this classification modeled after acoustic feature analysis used by the human auditory system. Simply, this system worked by pulling acoustic characteristics from the environment, and matching these characteristics to a set of predefined acoustic scenes. Since the introduction of automatic auditory classification, these algorithms for identifying environments have become increasingly advanced, and the number of parameters adapted per environment has increased dramatically. In the case of hearing aid automatic

systems, not only is it now a priority to optimize speech intelligibility, but acoustic classification also needs to take comfort and sound quality into account when determining the best adaptation of parameters for a given environment.

The limitations and challenges faced in the development of an accurate and fast-acting automatic classification system are numerous. Working within the time and power constraints of a hearing aid poses a considerable challenge. Additionally, correct identification of an environment is essential, as a misclassification can lead to erroneous activation of algorithms that could be potentially detrimental for speech understanding or comfort. Further, quick and drastic changes in acoustic environments may occur, which not only needs to be detected by the automatic classifier, but also requires a quick response and change in hearing aid settings with little or no audible artifact. Phonak classification systems have become increasingly more sophisticated and complex in these domains since their introduction over a decade ago.

How do automatic classification systems work?

Acoustic classification systems are designed initially through a "training" process, during which a large data set of sound scenes, each characterized as a representation of a distinct listening environment (i.e. calm situation) are recorded. It is essential that a broad range of sounds and several examples of a particular acoustic scene are represented. From these prototypic sound scenes, several specific acoustic characteristics are identified that can be considered defining acoustic characteristics for that scene type. For example, the degree of synchrony of temporal onsets across frequency bands, level differences across frequency bands, estimated signal-to-noise ratio across frequency bands, and amplitude and frequency spectrum information can all be identifying features that define a sound scene type. Then, in real time, the hearing aid extracts these same characteristics from the surrounding environment, and compares the sampled acoustic characteristics to the pre-defined characteristics defined in the training process. In AutoSense OS this is done probabilistically, with the degree of match to the defining acoustic parameters calculated. This allows for the possibility of a blend between programs, depending on how much of a match is detected across acoustic classifications. These systems must be robust, in that they must generalize a broad range of sound types and scene types into defined acoustic classes, but detailed enough to identify acoustic nuances that may be specific to a certain type of environment.

The power and flexibility of AutoSense OS

The first Phonak automatic sound classification system, AutoSelect, could select between two programs in accordance with the environment. One program employed an omnidirectional microphone mode, designed for quiet situations, and the other, used for noisy environments enabled a directional microphone and noise suppression. AutoPilot built upon the foundation of AutoSelect with several improvements. This system was able to engage three different sound classes: Calm, Speech in Noise, and Comfort in Noise. Later a fourth class was added: Music. The limitation of this system was that only one class could be assigned to each listening environment, and transitions between classes led to audible artifact. SoundFlow, the next generation of Phonak automaticity, was designed for improved accuracy in sound classification, as well as smoothed transitions during sound class changes. Not only were five discrete sound classes available, but also mixing between classes was possible.

AutoSense OS

AutoSense OS selects the best settings to maximize hearing performance automatically so that your clients don't have to. It is the latest generation of the Phonak automatic classification system. The advanced proprietary chip allows for faster processing, as well as greater memory capacity and less power consumption. Currently there are seven unique sound classes: Calm Situation, Speech in Noise, Speech in Loud Noise, Speech in Car, Comfort in Noise, Comfort in Echo, and Music. Three of the programs, Speech in Noise, Music, and Speech in Car, are "exclusive classes," in that, when these scenes are encountered, the hearing aid will smoothly transition fully into an exclusive program specifically designed for the scene. Any of the other four programs can be activated as a blend, in the case of more complex, realistic scenes that cannot be defined by one acoustic classification. For example, Comfort in Echo and Calm Situation can be blended with respect to how much each of these classifications are detected in the environment. AutoSense OS is unique from other automatic classification systems in several different ways. Firstly, the distinctive array of available programs to improve listening and comfort in the most complex and difficult listening situations provides the basis of AutoSense OS. These programs span a wide variety of listening situations, and uniquely include a program and parameterization for reverberant environments. It is from this vast array of environmentally-optimized programs that AutoSense OS draws upon in real time. Further, audiologists can customize the blending characteristics of AutoSense OS itself, but also have control over several parameters within

each individual program to best suit the needs of a particular hearing aid user, within the fitting software.

The speed and accuracy of AutoSense OS blending behavior allows for the hearing aid to specifically adapt to any complex listening situation. This results in numerous iterations and blends of hearing aid programs that would never be available through a manual push button. The transitions between programs occur seamlessly so the changes, even between programs of drastically different gain models and parameterizations, is inaudible to the hearing aid user.

Further, AutoSense OS is designed to minimize misclassification, with certain misclassification errors weighted more heavily than others to prevent the hearing aids from making errors detrimental to comfort or speech understanding. A complex set of statistical rules provides an overlay to the entire system, in that the hearing aids must detect a particular type of environment for a certain amount of time, and at a particular level, prior to a complete switch to prevent constant changing of programs. AutoSense OS balances this with the necessity of not having too much of a delay in hearing aid switching, as the device user could be missing conversation during this period of delay. The transition behavior, itself, is just as important as the sophistication of features within the hearing aid.

Automatic technology for pediatric ears

The use of additional manual programs for pediatric hearing aid users is uncommon (1). Most audiologists will equip pediatric patients with a Calm Situation or FM program as the startup. It can be a great concern that if equipped with a directional microphone, a child may inadvertently switch into this program and potentially experience a degraded listening situation, or have less opportunity for incidental learning if using the directional microphone when not appropriate. An automatic program alleviates these concerns by enabling the directional microphone only when dictated by the environment.

Additionally, research has shown that the listening environments encountered by children are very different than those encountered by adults. A study conducted by Phonak found environments such as a classroom, working in small groups and the sound of children yelling are very specific sounds encountered by children on a daily basis. (1) Automatic systems designed for adult hearing aid users are not optimized for these types of listening situations.

AutoSense OS Sky, the new automatic technology in Phonak Sky Venture products, has been specifically designed to better detect group work situations, peer conversations, and improve comfort in situations where children are yelling in the background. AutoSense OS Sky is the first automatic system designed with the listening needs of children in mind.

The implications of an automatic classification system for children are tremendous. The use of this type of technology can provide children with an array of listening programs designed for the very situations a child encounters on a daily basis. This can provide a listening experience that yields greater comfort and speech understanding over a single manual program that is typically provided to children.

Evidence for AutoSense OS accuracy

Recent studies at the Phonak Audiology Research Center (PARC) have been designed specifically to assess the accuracy of AutoSense OS and the resulting speech understanding performance of research participants as compared to manual hearing aid programs. This study was designed to assess the performance of hearing aid research participants in environments that they encounter in everyday life. Three real-world, challenging listening situations were defined, and specifically chosen due to their complexity, difficulty, and real-life applicability. Participants completed tests of speech understanding and reported subjective feedback while riding in a car, at a coffee shop, and in a reverberant room at PARC. The outcome of this study ultimately showed equivalency in speech understanding performance and subjective ratings between the program selected by AutoSense OS and the manual program, which reveals the power of this technology (2).

Benefit driven

The ability of AutoSense OS to detect and manipulate the parameters of the hearing aid in real-world listening environments should allow audiologists to feel comfortable in giving patients any number of hearing aid programs, which may not have been a possibility had the hearing aid user been switching the programs manually. It should also allow audiologists to feel comfortable in knowing that AutoSense OS is not a compromise, and in fact, can provide a much more consistent, appropriate listening setting than even a savvy hearing aid user could attain with a push button. (4)

Automaticity is a major contributing factor to an individual's experience with hearing aids, which is why for Phonak it is a priority. A "hands-free" listening experience allows hearing

aid users to be truly present in every moment, and enjoy all of life in its complexity, without the interruption of a button-push.

Summary

AutoSense OS is the latest generation of the Phonak automatic classification system. In addition to faster processing, AutoSense OS is increasingly advanced in its ability to quickly detect the acoustic environment in real time, and seamlessly adjust nuanced algorithms in the hearing aid, accordingly. This sophistication, and the transparency and flexibility available to the audiologist, makes AutoSense OS unique. This powerful technology has now been implemented into the Phonak Sky V product line, and has been further customized to recognize environments specifically encountered by pediatric hearing aid users. The hearing aid user should never have to think about his or her hearing aid, the way a normal-hearing listener never thinks about his or her listening environments.

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Author

Lori Rakita has been a research audiologist at the Phonak Audiology Research Center since July of 2014. Lori performs technical measurements of hearing devices and features, and uses this information to develop protocols and assess these features through participant testing. Previous topics of investigation have included TV listening, directional microphones, and CROS devices. Lori has presented these and other topics at a variety of Phonak internal meetings, as well as national and international conferences. Lori received her Bachelor of Science degree in Psychology from the University of Wisconsin-Madison, and her Doctorate of Audiology from Washington University in St. Louis.