Addressing Critical Hearing Aid User Needs with Binaural Features

The Practical Benefits of Siemens binax

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Introduction

In the last decade or so, hearing aid technology has improved at an astonishing rate. Yet, in this influx of new technology, it is important to remember that new features should not only be innovative, they also need to provide practical benefit for the wearer in daily use without significant drawbacks. In realization, this means that features should work automatically without wearer manipulation, and fast enough in order to be effective in ever-changing real-life situations. In addition, when we are talking about features in tiny hearing aids with even tinier batteries, then these new features also need to be energy efficient. Only when these features can be engaged when necessary without significantly reducing the battery life can they be considered to provide practical benefit.

This article reviews the features offered by binax, the new platform from Siemens, and describes how they are designed to address key wearer concerns and provide practical benefit for wearers in daily use.

The binax platform

With dramatic improvements in hearing aid technology, wearers are becoming increasingly satisfied in most listening situations. However, the latest MarkeTrak study still reports dissatisfaction with listening in noise and in wind more than in any other situations (Kochkin, 2010). binax offers practical features especially targeted to improve wearer satisfaction for these important listening situations.

Ear-to-ear wireless transmission: First of all, binax enables audio transmission between the two hearing aids with e2e wireless 3.0. This allows each hearing aid in a bilateral pair to work with the acoustic signal from the two microphones on its housing, and receive the acoustic signal picked up by the two microphones on the other hearing aid. This way, the two hearing aids are able to gather a more complete and accurate impression of the surrounding acoustic environment, or High Definition Sound Resolution (HDSR). In addition, e2e wireless 3.0 allows the two hearing aids to make decisions in concert and act on these decisions together in a process that is similar to how the brain combines input from both ears to provide binaural advantages. This technology enables a host of binaural features which improve the wearer's listening experience in noise and in wind.

Automatic adaptability: In order to maximize practical wearer benefit, binax features are fully integrated into the automatic Universal program. They engage, disengage, adapt smoothly and automatically in response to the changing acoustic environment, and function synergistically with other existing hearing aid features. They do not require separate programs, additional accessories, or user interaction.

Low current consumption: Audio transmission technology can have a very high current consumption. As a result, it has the potential to significantly reduce battery life of hearing aids. The implementation of binax features ensure that compared with the previous platform, Siemens micon, binax battery consumption remains essentially the same for the normal microphone modes and Bluetooth streaming. The additional binaural features offered by binax increases the battery consumption slightly, but in comparison, similar technology on the market consumes roughly twice as much battery power. As a result of this energy efficiency, the binax wireless audio transfer features can be automatically engaged whenever necessary, and as long as necessary.

Adjustability: MarkeTrak surveys consistently have revealed that hearing aid wearers report that the least satisfactory product feature is “ease of volume adjustment.” In order to improve the ease and discreteness of hearing aid control, all binax hearing aids, regardless of size or performance level, are compatible with innovative remote control solutions, including smart phone options.
Improving the listening experience in noisy situations

It is well known that one of the primary problems the hearing impaired have is understanding speech in background noise. Despite tremendous improvements in directional microphone and noise reduction technology, in the most difficult situations such as the infamous “cocktail party situation” where noise comes from all around the listener, and this “noise” consists of other people talking, those with hearing loss often still have considerably more problems than their normal hearing counterparts.

**Narrow Directionality**

binax Narrow Directionality addresses this problem by narrowing the beam of the microphone focus so that not only is noise from the back attenuated, but essentially everything that is not immediately in front of the listener is now also reduced (Figure 1).

![Figure 1](image1.png)

Figure 1. Compared with monaural directional microphone technology (shaded grey area), Narrow Directionality has a narrower focus beam (shaded purple area) so that sounds outside of what is immediately in front of the wearer are attenuated.

In fact, not only does this advance processing address the problem, hearing impaired listeners fitted with Narrow Directionality may actually understand speech better than their normal hearing counterparts in such a situation. Independent studies conducted at Oldenburg Hörzentrum and University of Northern Colorado showed that average speech reception thresholds (SRT) in cocktail-party-noise situations were up to 2.9 dB better for wearers with mild to moderate hearing loss using binax with Narrow Directionality, compared to people with normal hearing (Figure 2). This difference is statistically significant, and further details can be found in Powers & Froehlich (2014).
Figure 2. Results from studies conducted at Oldenburg Hörzentrum (left panel) and University of Northern Colorado (right panel) show that Speech Reception Thresholds (SRT) in cocktail-party like situations are significantly better for individuals fitted with hearing aids with Narrow Directionality processing compared to people with normal hearing ($p<0.01$).

Narrow Directionality is fully integrated into the automatic Universal program and transitions smoothly from the existing standard directional microphone mode to provide the most appropriate directional setting for every situation. It activates and deactivates automatically based on the listening environment, and transitions between these two states smoothly to ensure excellent sound quality even in the transition phase. Not only does that mean wearer interaction is not required, it also maintains power consumption at an industry low benchmark level.

**Spatial SpeechFocus**

Narrow Directionality processing improves speech intelligibility for situations where the target speech originates from the front and noise is from other directions surrounding the listener. There are, however, situations where noise may originate from the front and speech comes from the side or back, but the listener cannot turn his head, such as when in the car. Spatial SpeechFocus is another binax feature which improves the audibility of speech in noisy situations. Depending where the loudest speech source originates, Spatial SpeechFocus offers true directivity to the front, back, or either side automatically when the “Car” situation is detected by the hearing aids’ situation detection system. This means that regardless of where the speaker-of-interest is located in relation to the wearer, Spatial SpeechFocus provides directionality towards the speaker and attenuates noise from the other directions (Figure 3).

For directionality to the back, Spatial SpeechFocus engages an “anti-cardioid” directional pattern which is able to focus on sounds coming from behind the wearer while suppressing signals coming from the frontal hemisphere. For true directionality to the sides, Spatial SpeechFocus utilizes the fundamental principles of ITD and ILD, which is what the brain utilizes for natural localization. When a sound originates from beside the wearer, it typically arrives at one ear before the other, causing an Interaural Time Difference (ITD) which is especially prominent for low frequencies. Also because of “head shadow” effect, the loudness of the signal will be somewhat attenuated before it reaches the other ear. This Interaural Level Difference (ILD) is more prominent for the high frequencies. Both ITD and ILD are utilized to create a directional microphone system which can offer true directionality to the side. The major advantage of offering directionality over mere copying of the preferred ear to the other side is that in this application, spatial cues are kept. That is, even while the focus of the directional microphones change to follow the most dominant speech source, the user can still retain a natural spatial sound impression.

For interested readers, further technical details on both Narrow Directionality and Spatial SpeechFocus can be found in Kamkar-Parsi et al, (2014).
Besides driving, there are numerous other use cases where this feature could be helpful: when walking with someone and carrying on a conversation at the same time (focus to the side), if the wearer is wheelchair bound and needs to hear the caretaker pushing the wheelchair (focus to back), or when shopping together with someone in a store and speech can come from any direction. In the Automatic Universal program, Spatial SpeechFocus is automatically activated when a “Car” situation is detected by the situation detection system. Spatial SpeechFocus is also activated by default in a dedicated Stroll program, in which the directional processing of the hearing aids will automatically switch to any one of the four directions as necessary to maximize speech understanding.

The effectiveness of Spatial SpeechFocus was validated in a clinical study at the University of Iowa with aided speech-in-noise testing for a group of individuals with mild-to-moderate sensorineural hearing loss. Simulating a listening situation for riding in a car, the subjects were required to look forward, but attend to speech signals occurring randomly from either the side or the back (fixed SNR=0 dB). The two test conditions were Spatial SpeechFocus in the automatic program and traditional directional settings. The later was chosen for comparison since this would be the traditional microphone setting automatically activated in the absence of a SpeechFocus feature when a speech-in-noise situation is detected. Additionally, the subjects were also asked to indicate whether the speech originated from the left, right, front, or back, in order to determine if Spatial SpeechFocus compromised sound localization. The results are very encouraging in that not only did Spatial SpeechFocus significantly improve speech intelligibility in such situations, it did so without compromising localization abilities (Figure 4).
Improving the listening experience in windy situations

For hearing aid users, when wind blows across the microphone inlets of their hearing aids, the resulting noise can be loud and distracting. In fact, according to the most recent MarkeTrak study, more than half of hearing aid wearers report dissatisfaction when listening in windy situations (Kochkin, 2010). Yet at the same time, hearing aid wearers are more active than ever, regularly participating in outdoor activities such as taking walks, golfing, or gardening. In a windy situation, not only is the loud fluttering distracting and uncomfortable, it also severely hinders the wearer’s ability to understand speech.

Wind noise is created when the air turbulence moves across the hearing aid microphone ports, causing a vibration of the microphone membrane which generates a noise predominantly in the lower frequencies. Fortunately, this can be significantly reduced through binaural signal processing. Depending on how much wind noise is detected in each channel, eWindScreen binaural first utilizes Wiener Filter technology (a noise reduction algorithm) to reduce the noise in that channel instantaneously and separately in both hearing aids. Thanks to the high frequency resolution offered by the 48-channel filterbank in binax aids, this suppression is extremely sensitive and frequency specific. And because Wiener Filters can respond very quickly and efficiently, this method of wind noise reduction is especially effective in real life situations where wind gusts are often intermittent, of varying intensity, and come from different directions, all in a short time period.

More likely than not, wind noise tends to be asymmetric, since even when wind comes directly from the front, we tend to turn our heads slightly to the side. In asymmetric wind conditions, eWindScreen binaural activates e2e wireless 3.0 and streams part of the signal from the side with less intense wind to the other side where the wind is stronger (Figure 5). And since the Wiener Filter is already active, the transmitted signal is already the "cleaned up” signal. The entire detection and adaptation process is fast and effective so that wind noise is reduced and speech intelligibility is maintained. And because only the relevant part of the signal is streamed from one side to the other, spatial perception is maintained.
eWindScreen binaural is activated automatically when necessary and no wearer interaction is required. eWindScreen binaural is available in all programs, including the Universal program. This means that the wearer will always benefit from the wind noise algorithm. Clinical trials with eWindScreen binaural conducted at the Oldenburg Hörzentrum revealed that 97% of the participants preferred eWindScreen binaural over monaural wind noise reduction. For further details, refer to Berghorn, Wilson, & Pischel (2014).

Figure 5. eWindScreen binaural works by streaming the low frequency signal from the side with less wind to the side with stronger wind. The effect is immediate reduction of wind noise without compromising speech intelligibility or spatial perception.

Giving control back to the wearers

In addition to being available for special use cases in dedicated programs, the new binax features are integrated into the automatic program, requiring no user interaction. Together with the situation-specific compression learning feature, the need for even basic controls of volume and program is minimized. However, no matter how intelligent technology can be, there will always be occasional situations where the wearer would still like to be able control his hearing aids.

Acoustic Wireless Control & the touchControl App

As mentioned earlier, the hearing aid feature rated lowest by MarkeTrak respondents was “ease of volume adjustment”; only 60% of hearing aid users were satisfied. In fact, of those who had not been fitted with a volume control or remote, only 27% were satisfied with the fitting arrangement (Kochkin, 2010). In order to allow wearers to control their binax hearing aids, regardless of aid size or the presence of a traditional wireless coil, binax offers the Acoustic Wireless Control. Instead of relying on the traditional wireless coil as a receiver, the new Acoustic Wireless Control utilizes what every hearing aid has: microphones. This new feature allows the hearing aid to use dedicated ultra-high frequency signals sent by a smart phone to be picked up by the hearing aid microphone as wearer commands, such as volume and program change. As a transmitter, the corresponding touchControl App (available for download from the iOS and Android playstores, Figure 6) is designed to turn any smart phone into a remote control by emitting these ultra-high frequency command signals. In other words, at the wearer’s discretion, all binax hearing aids can be remotely controlled via the touchControl App on a smart phone.
The benefit offered by the Acoustic Wireless Control is manifold. As long as the wearer is a smart phone user, he or she no longer needs to purchase and carry around an extra dedicated hearing aid remote control. For more image-conscious wearers, hearing aid adjustments are now disguised as smart phone operations, which are more discreet than using any dedicated hearing aid remote control. For those individuals with dexterity problems, touch screens offer an alternative to small buttons on the hearing aid housing or traditional remote controls. The bigger screen on a smart phone means that the control interface is easier to see and understand. Even if the hearing aids have space for onboard controls, the touchControl App is more intuitive than trying to remember which aid control does what, and always offers both volume control and program change functionality. When applicable, SoundBalance and tinnitus therapy noise volume can also be adjusted with the touchControl App. For further details on the Acoustic Wireless Control and the corresponding touchControl App, refer to Sauer, Dickel, & Lotter (2014).

![Figure 6. TouchControl App on Android and iOS smart phones.](image)

**Spatial Configurator**

Beyond simple volume control or program adjustments, there also could be instances, where the wearer's listening intent may be different from the typical use case, and the automated feature behavior as steered by the Universal program may be undesirable. Therefore, binax Spatial Configurator is the user control by which the experienced wearer can steer his hearing aids in ambiguous situations according to his listening preferences. Spatial Configurator has two dimensions: Span, and Direction.

Imagine you’re sitting in a café with your morning coffee and the daily paper. However, there's a couple sitting at the table in front of you carrying on a lively conversation. Typically the hearing aids would classify this situation as Speech-in-Noise, and engage directional microphones to focus on the talking couple so that you can understand speech in a noisy environment. Unfortunately, you’re not interested in this conversation, but simply want to concentrate on your paper or take in the general atmosphere around you. This is exactly a situation where Spatial Configurator Span would be helpful. Spatial Configurator Span allows the wearer to override the automated functionality and directly control whether the hearing aids should focus on the speaker from the front, pick up the soundscape from all around him, or anywhere in between. Using a photographic analogy, this would be the zoom mode or the panorama mode on a camera where the user could progressively “zoom in” and take a picture of something directly in from of him, or “zoom out” take a panoramic picture of everything around him.
In the background, Spatial Configurator Span serves as a manual override for the acoustic situation detection. With one simple control, it adjusts a number of hearing aid features including the directional microphone system with Narrow Directionality, noise reduction, frequency shaping, and compression. Specifically, when the wearer chooses to focus more towards the front, the directional strength of the directional microphone system would increase, the reduction of noises, particularly from the sides and the back, would increase, and the general frequency response and compression would increasingly emphasize the speech band. On the other hand, when the wearer chooses to hear more from all around him, then the directional microphone would gradually become more omnidirectional, noise reduction would weaken, and the frequency response of the hearing aids would become more broadband.

The second dimension of Spatial Configurator is Direction. Spatial SpeechFocus in the automatic Universal Program and the dedicated Stroll program can continuously detect and focus on the strongest speech source in the environment, whether it is to the front, back, or either side. Since the most common use case for Spatial SpeechFocus is when the wearer is driving and cannot turn to face the speaker, in the Universal program, it is only activated when a Car situation is detected. But of course there are other use cases for this feature, such as when the wearer is walking with someone and carrying on a conversation at the same time (focus to the side), or if the wearer is wheelchair bound and needs to hear the caretaker pushing the wheelchair (focus to back). Spatial Configurator Direction allows the wearer to dictate the focus of the directional microphones, whether it is the front, back, or either side.

The Spatial Configurator is adjustable via easyTek, the binax streamer accessory, and the easyTek App (Figure 7). Alternatively, a dedicated rocker switch on the hearing aid housing can also be configured to control Spatial Configurator Span. Once activated in Connexx, Spatial Configurator requires no further programming or setup during the fitting session. The feature will simply be available to the wearer whenever unique listening situations arise and the automatic setting in the Universal program is different from the wearer's listening intent.

Figure 7. easyTek App user interface for Spatial Configurator Span (left) and Direction (right).

Summary

The new binax binaural features Narrow Directionality, Spatial SpeechFocus, and eWindScreen binaural address the top concerns of hearing aid wearers today: listening in noise and in wind. Narrow Directionality is so effective
that it allows wearers to outperform their normal-hearing counterparts in cocktail-party like situations. Despite the fact that binaural features which stream signal from one side to other have a high risk of disrupting spatial cues, the e2e wireless 3.0 and the binax steering ensure that all features, monaural and binaural, work in concert. All automatic adjustments are carried out unobtrusively without the wearer noticing any abrupt or jarring changes in the sound impression. The Acoustic Wireless Control and Spatial Configurator allow all binax wearers the possibility to control their hearing aids, regardless of size, or the presence of a wireless coil. With an emphasis on providing practical benefit, these features consume minimal additional power, and are integrated into Universal program, requiring no wearer interaction. All in all, binax effectively combines improved speech recognition for the patient with efficient practical applications for all listening situations.

References


