

Speech in Wind

Phonak Insight

Bringing more than just comfort in wind noise

Wind noise is an inherent consequence of microphone technology. Until now wind noise management in hearing aids has focused simply on bringing comfort to users. Speech in Wind is an innovative new Phonak feature, made possible by Binaural VoiceStream Technology®, that maintains high levels of speech understanding, even in the presence of wind noise.

Introduction

Wind noise is somewhat of a paradox for hearing aid users – an idiosyncrasy of the physics of a microphone. You rarely, if ever, hear people who don't wear hearing aids complain about wind noise. Microphones are designed to pick up sound and are therefore a key component for every hearing aid. They bring many advantages and the introduction of two microphones into the same hearing aid has been a key innovation. At the same time, when in wind, a microphone is susceptible to mistaking air passing over its diaphragm for real sound.

Digital hearing aid technology has allowed significant advances in bringing comfort to hearing aid users, reducing the annoyance

of wind noise through processing capabilities. MarkeTrak¹ data shows that between 2004 and 2010, consumer satisfaction regarding wind noise annoyance improved 7% points. At the same time it still had the lowest satisfaction rating of all sound quality criteria (Figure 1). Surprisingly it even scored worse than both noisy situations and feedback.

Whilst comfort has been the focus in recent times, the topic of intelligibility has been given little attention. With an increasing number of active hearing aid users, intelligibility will be an increasingly important concern during hearing aid selection as many outdoor situations involve communication.

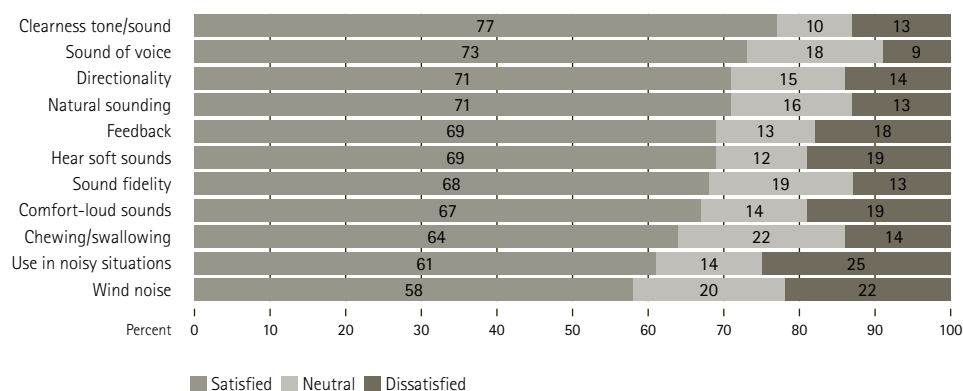


Figure 1
From Hearing Journal, January 2010, Figure 8 (p24).

The irony of wind noise

Consider the difference between sound and noise. Do they mean the same? Can they be used interchangeably? Is sound a desired noise and noise an undesired sound? Why didn't Julie Andrews sing about the hills being alive with the noise of music or AC/DC protest that Rock 'n' Roll ain't sound pollution? Enough questions already! Sound elicits romantic connotations whilst noise tends to suggest annoyance. The challenge for hearing aids, in fact for every device that uses a microphone, is how to keep the noise out whilst letting the sound in.

A true irony is that in the context of hearing aids, and microphones generally, wind noise is neither a sound nor a noise. It's actually a phantom noise caused by vibration of the microphone membrane not from sound pressure fluctuations but rather air fluctuations. This can occur both when the user is moving or on a windy day. This is why an unaided ear does not perceive wind as noisy while exposed microphones do. The flow of air does not need to be significant for the microphone membrane to vibrate sufficiently to create a phantom sound – wind noise. Jogging or a light breeze are sufficient to lead to wind noise at the microphones.

Outdoor audio capture for film and radio is also highly susceptible to annoying wind noise. The most common approach to eliminate or reduce wind noise in these situations is to prevent wind from

directly contacting the microphone membranes – prevention is usually easier than a cure.

Windscreens (Figure 2), which generally look like a fluffy toy, are placed around the microphone to deflect or disrupt wind while allowing sound to pass through.

For pre recorded audio capture, there is the possibility of post-processing to further reduce any audible wind noise. Unfortunately this approach that has been successful in managing wind noise for audio capture is not as well suited to hearing aids. These are luxuries that a hearing aid worn on the ear and working in real time does not have.



Figure 2
Windscreen used to protect film camera microphone from wind noise.

Comfort achieved

Whilst the luxuries of windscreens and post processing are not readily transferrable to hearing aids, the anatomy of the ear can be used to impede wind from contacting the microphone. Some smaller hearing aid styles such as IICs or Lyric lie deeper in the ear canal, practically eliminating wind reaching the microphone. For other ITE styles, RICs and BTEs, the ability to protect the microphone is constrained by cosmetics and handling. A remote microphone offers a discrete option to protect the microphone from wind contact by locating it elsewhere on the body or using a windscreen. Having both of these preventive options may not appeal to everyone and ultimately a sophisticated yet simple solution is needed.

In the presence of wind the input often includes a mix of sound and wind noise as the microphone membranes do not distinguish between the two. Wind noise reduction in current digital hearing aids typically consists of two sequential processing stages – detection and suppression. The detection stage continuously monitors the input from the microphone. The noise that wind alone creates is in the low frequencies, therefore the detection stage focuses only on low frequencies.

Phonak Quest hearing aids use a dual microphone approach for the detection stage. Unlike “true noise” such as traffic or a crowd,

wind noise at the different microphone ports is uncorrelated. So when the hearing aid detects uncorrelated low-frequency noise across its two microphones, it considers this wind noise and invokes the second stage – suppression.

Several approaches are available for suppression. Omni directional microphones are less susceptible to wind noise so the hearing aid can switch to this mode when wind noise is detected². So whilst providing more comfort in wind noise, this approach can quickly compromise speech understanding.

Another approach is to detect which frequencies are affected by wind noise and attenuate these frequencies to provide more comfort for the user. In practice this is done by the hearing aid per frequency channel. So the more frequency channels the hearing aid has, the better it can determine which specific frequencies are affected by wind noise. However, as the hearing aid cannot discern between wind noise and real sounds, real sounds in these frequency channels are attenuated. This can impact speech understanding. Such algorithms can be adjusted by the hearing care professional to be more or less aggressive in terms of suppression in order to find the right level of comfort for a user. The WindBlock feature from Phonak uses such an independent frequency channel approach to suppress only those channels

affected by wind noise and allows the hearing care professional to set the strength during fitting. However, there is always some element of throwing the baby out with the bathwater. Thanks to the sophistication of SoundFlow, the automatic program from Phonak, the strength of WindBlock can be set per sound environment. This means that a "Strong" setting can be used for Comfort in Noise, whereas a "Weak" or even "Off" setting can be used for Speech in Noise when understanding is the focus. This is shown in Figure 3. Such an adaptive approach was established by Phonak with the CORE platform and has been supported by Chung³.

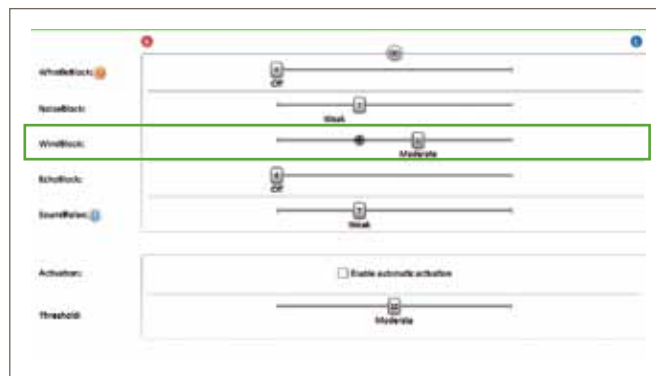


Figure 3
WindBlock setting per SoundFlow environment in Phonak Target™.

Beyond comfort to understanding

Beyond simply comfort in wind noise, the next goal remains to improve speech understanding without sacrificing comfort in any way. Phonak developed the Speech in Wind feature for this exact purpose.

Binaural VoiceStream Technology® from Phonak consists of a network of four microphones using the two hearing aids of a binaural fitting. Different to "true noise", wind noise is often only picked up by a single microphone or both microphones on the same hearing aid – that is asymmetrically. In the context of wind noise, as shown in Figure 4, this four-microphone network provides a level of redundancy such that selected parts of the speech signal can be shared from the hearing aid least affected by wind noise with the other hearing aid that is more affected. When

Speech in Wind detects an asymmetric wind noise situation (A), it automatically streams the full audio signal from the hearing aid least affected by wind noise to the other hearing aid (B). This hearing aid then exchanges its low frequencies with those from the streamed signal of the other hearing aid to maintain a high level of speech understanding. High frequencies are not exchanged so spatial cues needed for localization are preserved (C). Speech in Wind is highly sensitive to wind asymmetries, such that even an asymmetry created by a light wind against one hearing aid can result in streaming from the less affected side. No longer do the hearing aids need to sacrifice clarity for comfort in wind noise as both are possible.

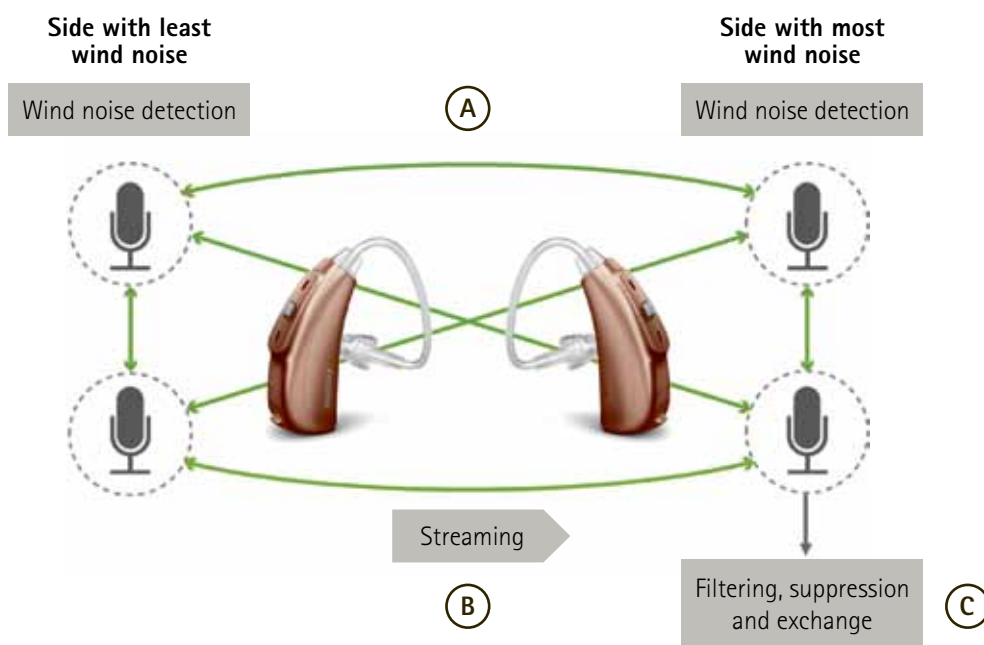


Figure 4
Processing stages for Speech in Wind.

Everyday asymmetric wind noise situations

Asymmetrical wind noise situations aren't as rare as they may sound, they happen quite naturally and are actually quite intuitive to create. Consider riding a bike and approaching an intersection. Looking directly ahead there is wind flowing equally across both ears. This is considered a symmetric wind noise situation. Intuitively we realize that turning our head sideways just a little reduces wind noise at one ear which allows us to more clearly listen for any traffic at the approaching intersection. Validation subjects found that using Speech in Wind is just as intuitive.

Furthermore they showed improvement up to 40% in speech intelligibility testing in the presence of wind.

Consider the following situations – a leisurely round of golf with a business colleague, flying a kite with a grandchild or a romantic stroll along the beach with a loved one. These are all everyday situations where communication is critical but where wind noise can seriously hamper this. These are also all asymmetric wind noise situations and ideally suited to the binaural advantage afforded by Speech in Wind.



Summary

Phonak Quest opens up a new frontier for hearing aid users. No longer is comfort the benchmark, speech understanding is now also possible in the presence of wind noise. Available as a manual program in all Phonak Q90 wireless aids with dual microphones, Speech in Wind is unique to Phonak.

References

- [1] Kochkin S, MarkeTrak VIII: Consumer satisfaction with hearing aids is slowly increasing; The Hearing Journal; Vol. 63, No. 1, January 2010.
- [2] Bentler, Digital Noise Reduction; Trends in Amplification, 2006, p79.
- [3] Chung K, Wind noise in hearing aids: I. Effect of wide dynamic range compression and modulation-based noise reduction; International Journal of Audiology 2012, p26.