

# VOICE iQ – MULTIVARIATE BENEFITS

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Publication of research findings on single microphone noise reduction (SMNR) in hearing aids largely began in 2006. However, in telecommunications, research and development of similar noise reduction strategies began much earlier. The research done on SMNR in telecommunications was largely an engineering exercise with limited data to describe how a listener's experience was improved. What's more, the applications outside of hearing aids are developed for normal hearing listeners and not the person with hearing loss who would be a candidate for hearing aids. Thus, it's largely from research with hearing aids and hearing loss that we have come to understand the clinical benefits of SMNR strategies.

(Note: single microphone noise reduction distinguishes from multimicrophone noise reduction that is often associated with directional microphones.)

Voice iQ is a proprietary form of SMNR developed by Starkey Hearing Technologies. The implementation of Voice iQ most closely resembles a noise reduction technique called spectral subtraction. In this approach, the hearing aid constantly maintains separate estimates of speech and noise signals as they are processed through the hearing aid. The noise estimate is used to inform the algorithm behavior, which attempts to subtract that noise estimate from the overall input to the hearing aid. The net effect is the near-instant reduction of gain in the absence of speech content and the application of prescribed gain for segments of speech inputs. Several years of research were applied to the optimization of this algorithm; in other words, a balance was achieved between

the greatest amount of noise reduction that could be applied while retaining sound quality and audibility of speech.

The first volley of SMNR literature clearly showed benefits relating to decreasing annoyance, improving sound quality and increasing a patient's willingness to accept background noise when listening to speech (Palmer, Bentler & Mueller, 2006; Mueller, Weber & Hornsby, 2006). Research on clinical outcomes of Voice iQ quickly confirmed similar benefits to those evidenced in the existing literature: patients demonstrated robust audibility of soft speech sounds while experiencing concomitant improvements in comfort, sound quality and willingness to accept background noise. However, these benefits were only initial insights into the benefits of this algorithm.



A joint publication between the Starkey Hearing Research Center and the University of California at Berkeley provided some of the first insights into the fact that Voice iQ eases listening effort for patients (Sarampalis, Kalluri, Edwards & Hafter, 2009). This observation is easily stated but points towards complex cognitive benefits. For example, one of our most challenging listening environments is following speech when there is competing noise and distraction. The opportunity to reduce listening effort suggests that a patient may be able to more easily ignore a distracting sound and focus on a target talker or, conversely, ignore distracting talkers and better focus on an important task (e.g., reading, writing). The implications of these findings were significant enough that the publication received an editor's award from the American Speech and Hearing Association. Since that first publication, independent research has echoed these findings (Desjardin & Dougherty, 2012). In a study completed at the University of Syracuse, listeners repeated speech-in-noise while completing a secondary task of object tracking on a computer screen. Participants showed significantly improved ability to complete the secondary task, an indication that additional cognitive resources were available when Voice iQ was activated.

Nearly all research on SMNR has used a steady-state (nonfluctuating) background noise. The reason for this can be understood by reviewing the algorithm behavior. In a system designed to estimate environmental noise, steady state noises prove to be an easier signal to characterize and reduce, while sounds that fluctuate in level and frequency prove more challenging. In a recent study at the University of South Florida, Eddins, Klein, Arnold and Ellison (2013) demonstrated the first significant benefits of SMNR in a background of speech babble, showing that Voice iQ improved acceptance of noise in one of the most challenging listening situations. The study by Eddins and colleagues also provided unique insight into the benefits of SMNR as they related to individuals who are less or more susceptible to being affected by

background noise. The authors recruited study participants who demonstrated low, medium and high acceptance of background noise levels. These participants each experienced the same test battery, revealing previously undocumented results. Those who demonstrated the lowest acceptance of background noise had the greatest benefit of SMNR, while those most accepting of background noise showed the least benefit from SMNR. From a clinical perspective, this confirms the natural intuition that patients with sensitivity to noise should be the ones who are prescribed the most effective noise management solutions.

These are several insights into the range of benefits that have been evidenced with the Voice iQ noise reduction algorithm. Other reports have been published, reviewing topics such as pediatric speech recognition ability and the benefits observed across open and occluded hearing aid fitting configurations (Stelmachowicz et al., 2010; Harianawala & Galster, 2012).

These studies remind us that learning is an ongoing experience. Though years are invested in the development and optimization of an algorithm, there should be little expectation that the extent of possible benefits from a technology are fully understood early in the technology's life. Thus, it's essential that work continue — possibly for years — after a feature is released in a hearing aid. Each new research effort presents an opportunity for learning and improved understanding of patient benefits. The culmination of these efforts are most often algorithm enhancement and, when possible, the development of improved recommendations for clinical practice.

## References

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