# Why “Natural” Is the New Normal: Clinical evidence of Own Voice Processing benefits

Catherine Jons, AuD
Signia Clinical Education Specialist

Why “Natural” Is the New Normal: Clinical evidence of Own Voice Processing benefits

Catherine Jons, AuD
Signia Clinical Education Specialist

Life sounds brilliant.

- This course is offered for Continuing Education Units (CEU)s for Total Access Online members.
  - Stay logged in for the duration of the course to be eligible to earn CEU credit.
  - Take the exam following course completion to earn CEU credit.
  - For questions or assistance, contact 800-753-2160.

- Please visit the AudiologyOnline website for other live and recorded events from Signia.

http://www.audiologyonline.com/ce/signia-siemens

Life sounds brilliant.

## Course Objectives

- After attending this session, participants will be able to describe the requirements and process for calibrating OVP.
- After attending this session, participants will be able to describe the benefits of OVP using varied couplings and/or prescriptive methods.
- After attending this session, participants will be able to describe wearer satisfaction with OVP activated compared to competitive products without OVP.

## Signia Nx Audiology
The Own Voice Issue

Life sounds brilliant.

**Negative perception of own voice contributes to the rejection of hearing aids**

- Nearly every wearer experiences a change in own-voice quality
- Especially affected are first-time wearers and individuals with a mild-to-moderate hearing loss
- Many hearing-aid wearers struggle with the unnatural sound
- Some actively complain about the poor sound quality and unnatural impression
- For others, it may lead to the rejection of the hearing instruments


## Signia Nx Audiology
The Own Voice Issue

Life sounds brilliant.

**Evidence exists of an own voice problem for hearing aid wearers**

- MarkeTrak VIII (2010)
  - 1 in 4 wearers complain of an unnatural sounding own voice
- Høydal (2017)
  - Online hearing-aid survey
  - 400 experienced hearing-instrument wearers (>2 years)
  - Mild-to-moderate hearing loss
  - 59% were dissatisfied with the sound quality of their own voice

## Signia Nx Audiology
The Own Voice Issue

Life sounds brilliant.

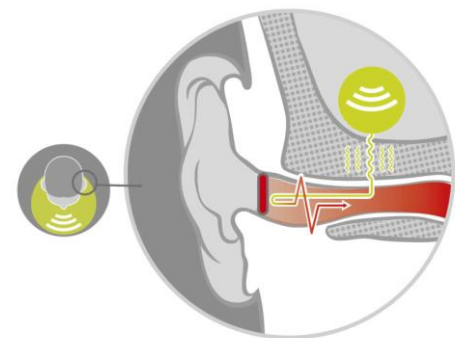

## Signia Nx Audiology
The Own Voice Issue

Life sounds brilliant.

**The Occlusion effect is one cause of the Own Voice Problem**

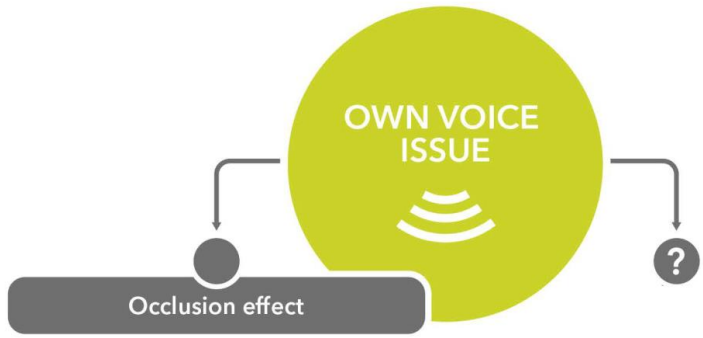
- **Occlusion effect (OE)**

*"Caused by a build up in low frequency energy in the ear canal"*



## Signia Nx Audiology
The Own Voice Issue

Life sounds brilliant.



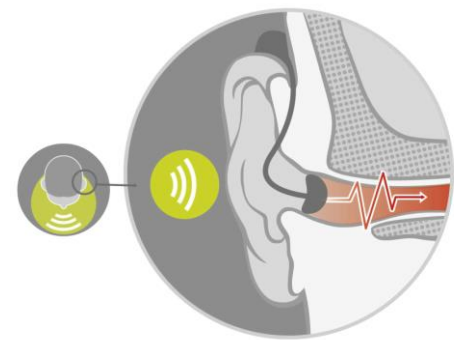

## Signia Nx Audiology
The Own Voice Issue

Life sounds brilliant.

**Hearing aid output is one cause of the Own Voice Problem**

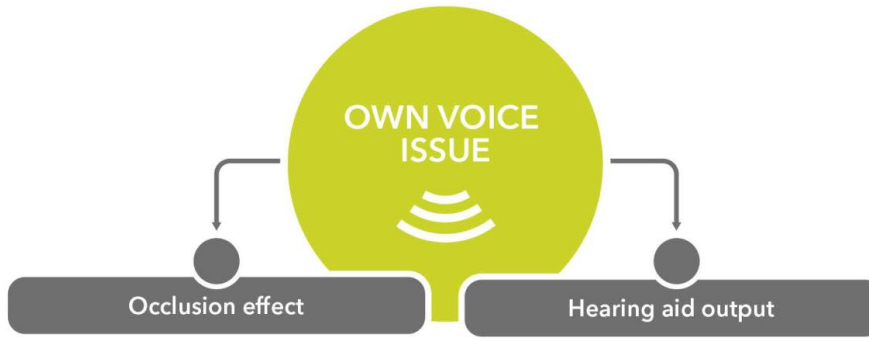
- **Hearing aid output**

*"Caused when the hearing aid amplifies the wearer's own voice"*



## Signia Nx Audiology
The Own Voice Issue

Life sounds brilliant.

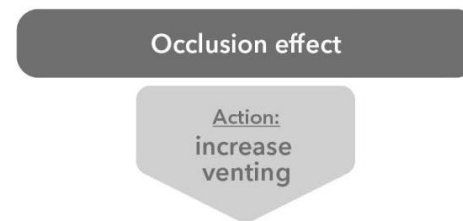



## Signia Nx Audiology
The Own Voice Issue

Life sounds brilliant.

**The own voice can be improved by opening the vent**

- The clinician has many acoustic couplings to choose from and/or modify to increase venting:
  - Modify earmolds
  - Select more open/vented domes/sleeves/tips
  - Increase vent diameter



## Signia Nx Audiology
The Own Voice Issue

signia
Life sounds brilliant.

**The own voice can be improved by reducing gain**

- The clinician has many parameters to adjust:
  - Frequency-specific gain / output
  - Frequency- and input-specific compression
  - Own-voice managers

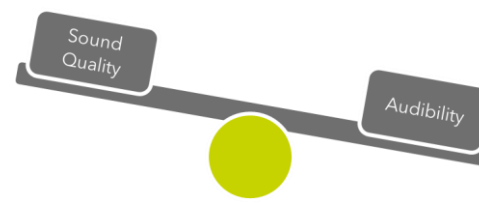

## Signia Nx Audiology
The Own Voice Issue

signia
Life sounds brilliant.

**Current solutions result in a compromise between sound quality and hearing performance**

Increased venting and/or gain reduction

- Increases risk of feedback
- Creates direct path for unprocessed sound affecting speech understanding in noise
- Affects audibility and speech intelligibility
- Compromises directional-microphone and noise-reduction processing

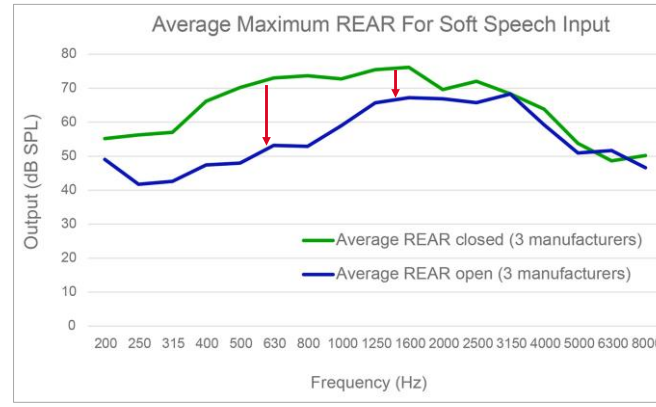


## Signia Nx Audiology
Implications of open fittings

Life sounds brilliant.

### Audibility

- Up to 20 dB reduction in audibility in the low-to-mid frequencies
- A difference can also be seen in the mid-to-high frequencies (1000 - 2500 Hz)
- Ricketts, Bentler, & Mueller (2019), found reducing audibility in the mid-frequency bands significantly impacts speech intelligibility, as measured by the Speech Intelligibility Index (SII)




Herbig, R., and Jacobs, A. (2018). *The Trouble with Open*. Signia Technology Backgrounder.
https://www.signia-library.com/wp-content/uploads/sites/137/2018/03/The-Trouble-with-Open-1.pdf

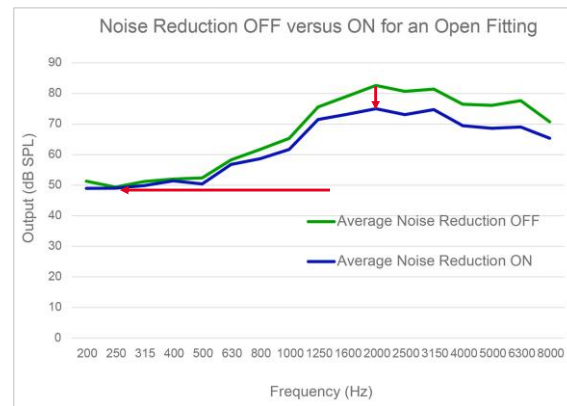


## Signia Nx Audiology
Implications of open fittings

Life sounds brilliant.

### Noise Reduction

- No more than 8 dB of gain reduction can be observed in the mid-to-high frequencies
- For the frequency region where background noise is the most intrusive, 1000 Hz and below, the effects of noise reduction are negligible
- As reviewed by Mueller, Ricketts and Bentler (2017), real-ear directional processing with open fittings yields minimal directionality for the frequencies of 1500 Hz and below




Herbig, R., and Jacobs, A. (2018). *The Trouble with Open*. Signia Technology Backgrounder.
https://www.signia-library.com/wp-content/uploads/sites/137/2018/03/The-Trouble-with-Open-1.pdf

## Signia Nx Audiology
Implications of open fittings

Life sounds brilliant.

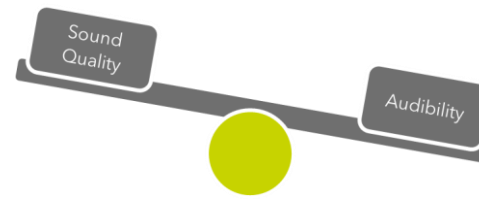
**Advantages vs. disadvantages of open-canal fittings**

Advantages:

- Improved sound quality of wearer's voice

Disadvantages:

- Decreases effectiveness of digital noise reduction and directional-microphone technology




## Signia Nx Audiology
Closed fittings

Life sounds brilliant.

**Does a closed fitting improve speech understanding?**

- 20 subjects (10 male, 10 female; mean age 74 years)
- Bilateral symmetrical downward sloping hearing loss
- Fitted bilaterally with Signia Pure 7 Nx RICs
- Programmed to the Signia Nx-fit algorithm; default parameters
- Target speech material - Oldenburger Satztest (OLSA) sentences presented at 0° azimuth
- Competing background noise – 65 dBA OLSA multitalker babble, 7-speaker array
- Target sentences presented adaptively until SRT-50 was achieved

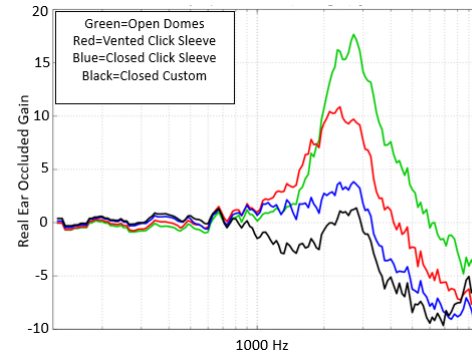
Froehlich, M. and V. Littmann. **Closing the Open Fitting: An Effective Method to Optimize Speech Understanding.**
http://www.hearingreview.com/2019/03/closing-open-fitting-effective-method-optimize-speech-understanding/?ref=fr-title

## Signia Nx Audiology
Closed fittings

Life sounds brilliant.

**Does a closed fitting improve speech understanding?**

- Testing conducted with four different couplings:
  - Signia open domes
  - Signia vented click sleeves
  - Signia closed domes
  - Custom-made canal earmolds
- Before testing, the degree of occlusion for each coupling was evaluated
  - Measured real-ear occluded response (REOR) with a 65dB SPL ISTS input
  - Results indicated a predictable pattern



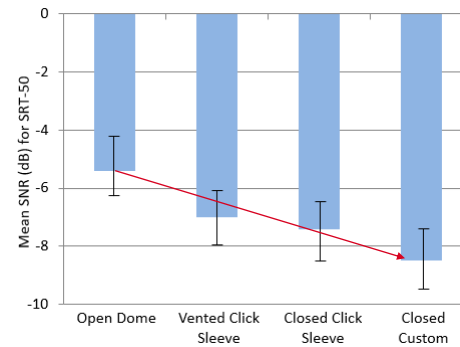



## Signia Nx Audiology
Closed fittings

Life sounds brilliant.

**Does a closed fitting improve speech understanding?**

- Results:
  - Statistically significant difference between the 4 different couplers
  - Statistically significant difference between the open condition and all other conditions
  - Speech recognition SRT-50 improves as coupling becomes more occluding
  - Mean 3 dB SNR advantage found when comparing most open to most closed conditions




Froehlich, M. and V. Littmann. **Closing the Open Fitting: An Effective Method to Optimize Speech Understanding.**
http://www.hearingreview.com/2019/03/closing-open-fitting-effective-method-optimize-speech-understanding/?ref=fr-title

## Signia Nx Audiology
The Own Voice Issue

signia
Life sounds brilliant.

**Does an opening the fitting resolve the own voice issue?**

- No!
- Opening the fitting can have substantial negative effects on audibility and speech understanding in background noise
- Is there a better solution?


## Signia Nx Audiology
The World's Most Advanced Platform

signia
Life sounds brilliant.

The first genuine solution to the own voice issue

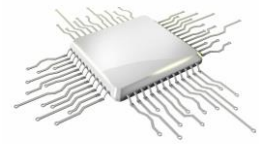
- Nx platform delivers a natural hearing experience for both the wearer's voice and all other external sounds
- Nx delivers uncompromised audibility & speech understanding in noise

## Signia Nx Audiology
Chip Technology

signia
Life sounds brilliant.

**The most sophisticated chip technology**

- Ultra-small 40 nanometer technology
- 75 million transistors
- 500 (MIPS) million instructions per second processing power



- Low-power chip design

## Generation of e2e

signia
Life sounds brilliant.

**Ultra HD e2e powers the detection of the wearer's own voice for the most natural experience**

- Continuous full bandwidth binaural link supports the classifier
- Improved wireless-link stability
- Faster data exchange

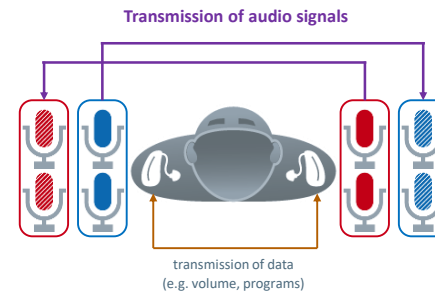
## Signia Nx Connectivity
Ultra HD e2e Binaural Link

signia
Life sounds brilliant.

**Continuous full bandwidth audio processing and data exchange between the hearing aids enables unrivaled performance**

- Data exchange for alignment of wearer controls and classification
- Binaural Audio Processing for Narrow Directionality and Own Voice Processing OVP™

ULTRA HD e2e




## Signia Nx Audiology
Own Voice Processing

signia
Life sounds brilliant.

**Signia Nx provides the first genuine solution to the Own Voice Issue**

The World's first Own Voice Processing

- Delivering unsurpassed first-fit acceptance
- Uncompromised audibility with a natural-sounding own voice
- Improves spontaneous acceptance of own voice for 80% of dissatisfied hearing-aid wearers.*


* 2017 "OVP Study" conducted at University of Northern Colorado examining the effect of own voice processing on spontaneous acceptance after first fit of hearing aids. Further details: www.signia-pro.com/ovp-study

## Signia Nx Audiology
Own Voice Processing - Detection

Life sounds brilliant.

**The sound path of the wearer's own voice can now be detected**

- The wearer's own voice travels on a different path than other voices
- Key to detection is the arrival time of the sounds at the microphones
- Unique for each individual
- OVP requires a bilateral fitting of Signia Nx SLIM-RIC, RIC, or BTE hearing instruments with directional microphones

## Signia Nx Audiology
Ultra HD e2e Binaural Link - OVP

Life sounds brilliant.

**The world's first system to process own voice separately from the remaining soundscape**

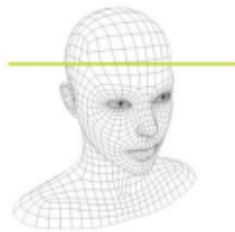
- Conventional hearing aids are optimized primarily for external sounds and voices
- Signia Nx has two separate processing paths:
  - One is optimized for the own voice
  - One is optimized for external sounds, i.e. soundscape
- Wearer enjoys a natural overall experience
  - Natural sounding own voice
  - Clear speech understanding in noise with reduced listening effort

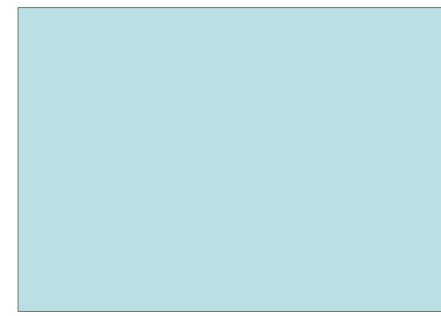
## Signia Nx Connectivity
Ultra HD e2e Binaural Link

Life sounds brilliant.

**Continuous full bandwidth audio processing and data exchange between the hearing aids enables unrivaled performance**

**Ultra HD e2e harnesses binaural beamforming technology to scan precisely for the wearer's own voice**





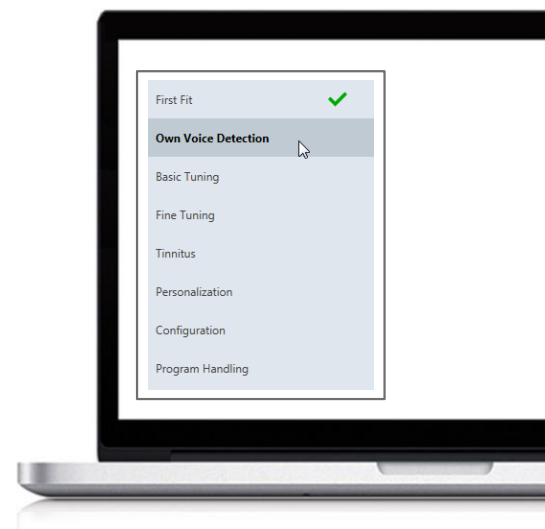


## Signia Nx Audiology
Own Voice Processing - Detection

Life sounds brilliant.

**Connexx learns the wearer's unique own voice through a simple calibration**

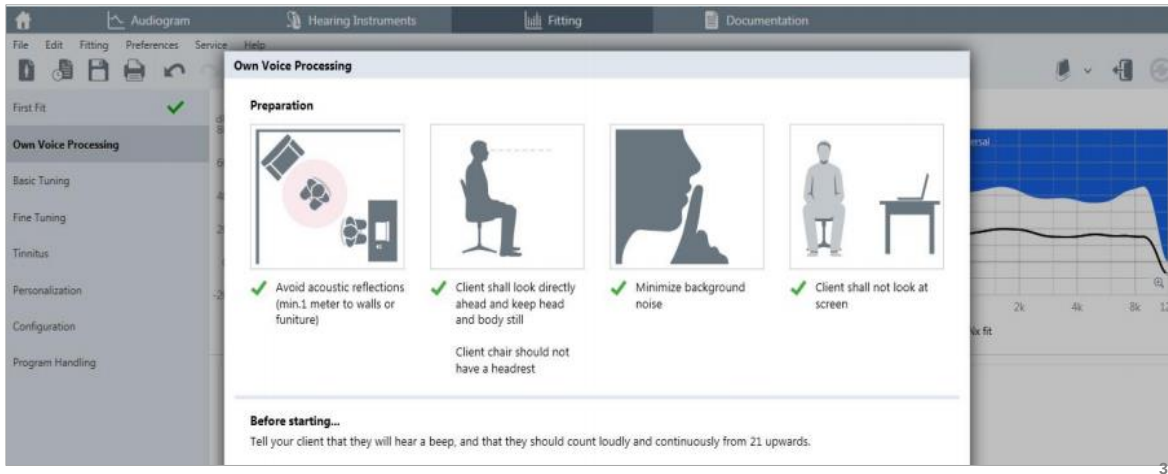
- Readily accessible in Connexx
- No extra equipment required
- Fast and easy measurement



## Signia Nx Audiology
Own Voice Processing - Detection

Life sounds brilliant.

**Connexx learns the wearer's unique own voice through a simple calibration**

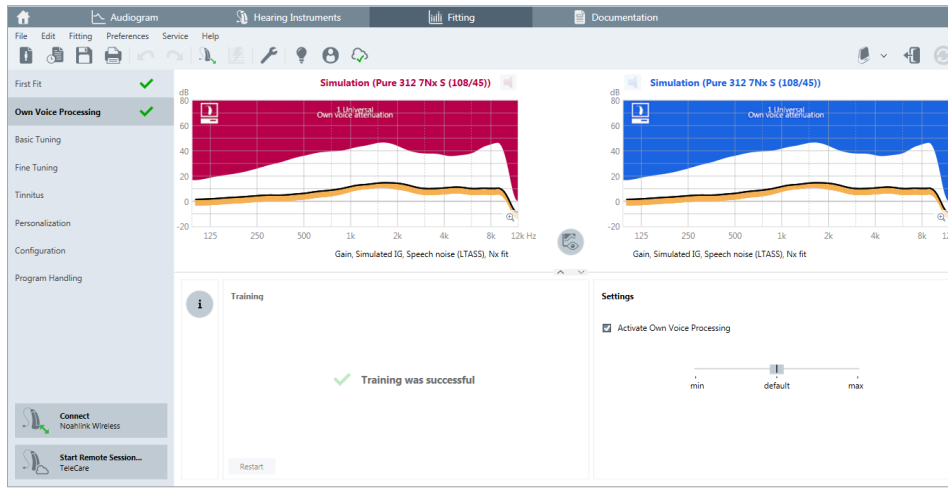





## Signia Nx Audiology
Own Voice Processing - Detection

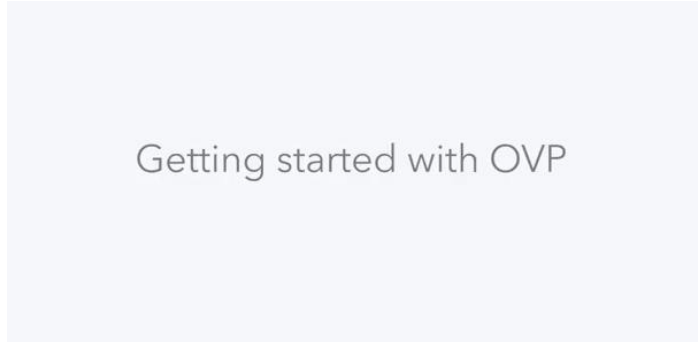
Life sounds brilliant.

**Connexx learns the wearer's unique own voice through a simple calibration**



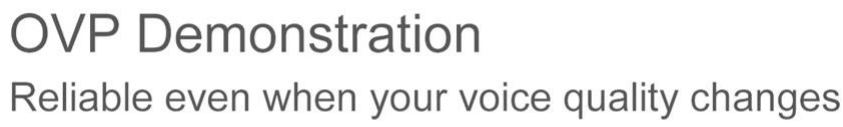
## Getting Started With OVP

Life sounds brilliant.




## OVP
## Reliable when voice quality changes

Life sounds brilliant.



## Signia Nx Audiology
Own Voice Processing – Clinically Proven

signia
Life sounds brilliant.

**Hearing Review – November 2017**

Clinical study, conducted at the University of Northern Colorado

- **OVP improves spontaneous acceptance of own voice**
- **OVP benefits are proven for any acoustic coupling**
- **OVP outperforms the competition with 86% satisfaction**

TECH TOPIC // OWN VOICE PROCESSING

Clinical Study Shows Significant Benefit of Own Voice Processing

By THOMAS POWERS, PhD; MATTHIAS FROEHLICH, PhD; ERIC BRANDA, AuD; and JENNIFER WEBER, AuD

This clinical trial suggests that Signia OVP provides a substantial improvement in own-voice satisfaction, and that this improvement is present for different fitting strategies, and for different ear-canal couplings. Moreover, when the satisfaction with OVP is compared to alternative solutions from competitive products, a significant OVP advantage was seen—to the extent that own-voice satisfaction with OVP using a closed fitting is equal or superior to other products using an open fitting.

Over the years, considerable research has been devoted to studying the physical characteristics of average conversational speech, and, as a result, we have a well-documented long-term average speech spectrum (LTASS) that can be used for clinical and research purposes. When hearing aid prescriptive fitting methods are developed, the LTASS, along with the patient's hearing thresholds, are used to determine appropriate gain and output. Decisions regarding the frequency-specific amplification of the LTASS involve consideration of several factors including audibility, loudness, sound quality, and most importantly, speech understanding. Today, we have several prescriptive fitting algorithms to choose from, both generic and those developed by individual manufacturers.

But what about when the speech of interest is not from a communication partner, but is the patient's own voice? Because of proximity, head shadow, reflection, and refraction effects, we know that the amplitude and spectrum of the patient's voice at his or her own ear is significantly different from the common LTASS.[1] We also know that, for the patient with the typical mild-to-moderate hearing loss, the loudness of one's voice primarily is monitored through bone conduction, not air conduction. And finally, hearing aids are programmed with the primary goal of improving speech understanding, which usually involves significant gain for the higher speech frequencies. But when we listen to our own voice, speech recognition is not a concern, as hopefully we know what the words are before the utterance. With these thoughts in mind, a reasonable conclusion would be that a hearing aid fitting optimized for processing the speech of others, is probably not optimized for the patient's own voice. This is commonly observed by clinicians, and research has also shown that this is true.

In a large survey of audiologists on the topic of hearing aid troubleshooting issues, Jenstad et al[2] reported that own-voice concerns were one of the most common post-fitting problems that required attention. The own-voice issue also was addressed in the MarkeTrak VIII survey. Kochkin[3] reported that only 58% of respondents gave the rating of "satisfied" or "very satisfied" for the sound of their own voice. Recently, Hayes[4] reported on a survey of nearly 400 hearing aid users; 78% had used their hearing aids for more than 2 years. The majority had mild-moderate loss, and although not stated in the report, we suspect that many, if not most, had open fittings. The participants rated their own-voice satisfaction on a 7-point scale (1=Very Dissatisfied to 7=Very Satisfied). The results revealed that the problem may be even greater than the findings of Kochkin: only 41% were satisfied with the sound of their own voice.

So, as we would expect, problems exist regarding patients' perception of their own voice when fitted with hearing aids. This is a critical aspect of sound quality in general, and is often weighted heavily regarding initial acceptance of hearing aid use. If the user's voice is not acceptable, this alone can prevent routine hearing use, and even lead to hearing aid rejection. If the patient does use his or her hearing aids, the negative own-voice effect might reduce confidence in their own voice (eg, "Do I really sound like this?"), and discourage vocal participation in conversations.

In the past, the clinical treatment of this problem has been fraught with negative consequences, such as turning down frequency-specific gain—which then has the unintended effect of reducing speech understanding. Some patients simply start talking softer, which also is not a reasonable solution. Yet another undesirable treatment is to fit the patient with a more open-ear coupling. While this might solve the own-voice issue, leaving the ear canal open has a negative effect on both directional and noise reduction processing—sounds that otherwise would be attenuated now pass directly to the eardrum. As a result, the patient does not have the expected signal-to-noise ratio (SNR) improvement in background noise, which, in turn, also reduces overall satisfaction with amplification.

Thomas Powers, PhD, is Chief Audiology Consultant at Signia in Piscataway, NJ. Matthias Froehlich, PhD, is Head of Audiology Marketing at Sivantos GmbH in Erlangen, Germany. Eric Branda, AuD, is Director of Product Management at Signia, and Jennifer Weber, AuD, is a Professor in the Program of Audiology and Speech-Language Sciences at the University of Northern Colorado, Greeley, Colo.

30 HEARINGREVIEW.COM | NOVEMBER 2017

* 2017 "OVP Study" conducted at University of Northern Colorado examining the effect of own voice processing on spontaneous acceptance after first fit of hearing aids. Further details: www.signia-pro.com/ovp-study



## Signia Nx Audiology
Own Voice Processing

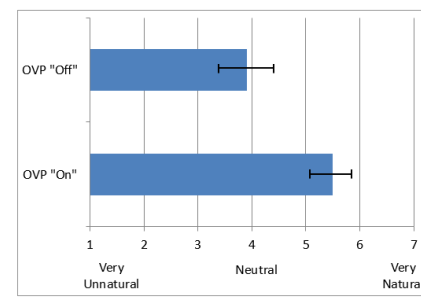
signia
Life sounds brilliant.

**Does OVP provide a significant benefit in the perception of own-voice naturalness using a closed dome?**

- 21 subjects with no previous hearing-aid experience
- Bilateral symmetrical downward sloping hearing loss
- Signia Nx programmed to NAL-NL2 with a closed dome
- Fitted bilaterally with Signia Pure Nx RICs
- OVP calibrated; subjects selected preferred setting
- Rated own-voice naturalness while reading nursery rhymes with OVP-On and OVP-Off

**Clinical importance –**

- There are significant improvements in own-voice naturalness with OVP activated
- Individual data revealed OVP improved spontaneous acceptance of own voice for 80% of dissatisfied subjects




Mean own-voice naturalness ratings for OVP-Off vs. OVP-On. Participants were fitted using closed domes with Signia Nx programmed to the NAL-NL2. Naturalness was rated on a 13-point scale (1=Very Unnatural, 4 = Neutral, and 7= Very Natural).

## Signia Nx Audiology
Own Voice Processing

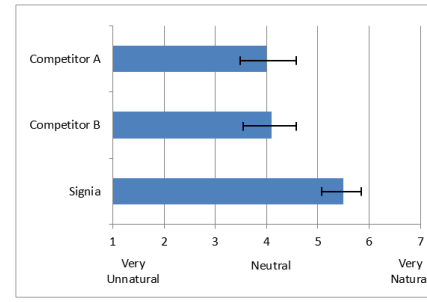
Life sounds brilliant.

**Does Signia OVP provide a significant benefit in the perception of own-voice naturalness over best-in-class competitive products using closed domes?**

- Signia Nx and two premier mini-BTE RIC products were selected
- Fitted to NAL-NL2 (verified with probe-mic measures)
- Manufacturer-specific closed dome
  - "Closed" fittings verified with real-ear occluded response
- Mean naturalness ratings were very similar for Competitor A & B
- Large advantage noted for Signia Nx

**Clinical importance –**

- Signia Nx provides a noticeable benefit in the perception of own-voice naturalness when using closed domes, which has relevance when maximizing noise-reduction & directional-microphone processing is a priority




Mean own-voice naturalness ratings for Signia and two competitive products. Participants were fitted using closed domes and hearing aids were programmed to NAL-NL2. Naturalness was rated on a 13-point scale (1=Very Unnatural, 4 = Neutral, and 7= Very Natural).



## Signia Nx Audiology
Own Voice Processing

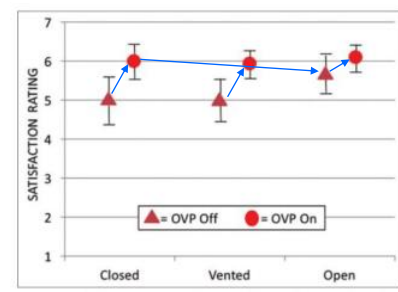
Life sounds brilliant.

**Does the "openness" of the fitting alter the benefit of OVP?**

- This part of the study examined satisfaction ratings for OVP on vs. off for three types of ear-canal couplings, closed, vented, and open.
- Using Signia Nx-fit, satisfaction ratings are higher for the OVP-On than OVP-Off for all three types of coupling
- Nx-fit closed with OVP-On is better than Nx-fit open with OVP-Off

**Clinical importance –**

- Fit with any dome/sleeve/tip and achieve the same level of acceptance while gaining improved hearing performance




Mean values for own voice processing (OVP) on vs. off for three types of ear-canal coup0ling: closed, vented, and open.

## Signia Nx Audiology
Own Voice Processing

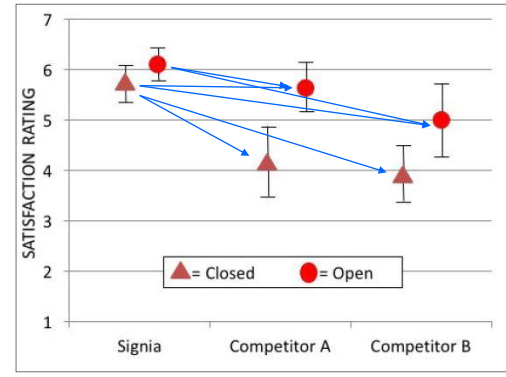
Life sounds brilliant.

**Does the fitting approach, open versus closed, alter the benefit of OVP?**

- Satisfaction ratings are higher for the Signia Nx closed condition compared to both Competitors A and B
- Satisfaction ratings are higher for the Signia open condition compared to both Competitors A and B

**Clinical importance -**

- Signia Nx closed is equal to the open fitting of Competitor A, and superior to the open fitting of Competitor B in terms of satisfaction




Closed data are from NAL-NL2 verified fittings; open data are from each manufacturer's proprietary algorithm

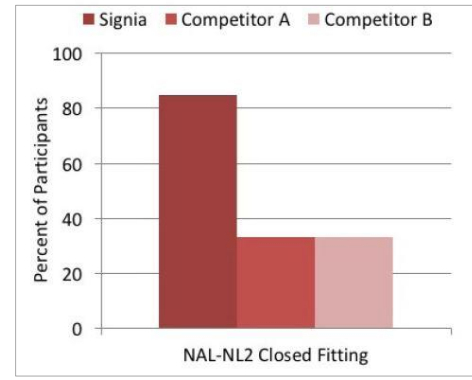


## Signia Nx Audiology
Own Voice Processing

Life sounds brilliant.

**Does own-voice satisfaction with Signia OVP compare favorably to satisfaction with competitive products without OVP?**

- All products programmed to the NAL-NL2 fitting algorithm closed
- 86% of the participants rated Signia "somewhat satisfied" or higher
- Only 33% of the participants rated the other two manufacturers "somewhat satisfied" or higher



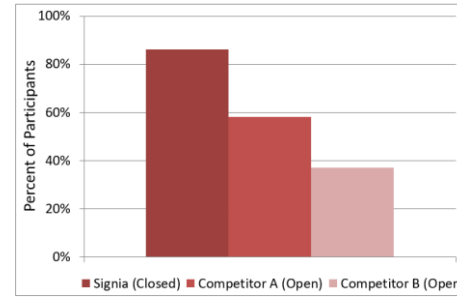

Distribution of percent of participants with an own-voice satisfaction rating of #5 (Somewhat Satisfied) or higher for Signia and two leading competitors. All products were fitted using closed domes to the NAL-NL2 prescriptive method.

## Signia Nx Audiology
Own Voice Processing

Life sounds brilliant.

**Does own-voice satisfaction with Signia OVP with a closed dome compare favorably to satisfaction with competitive products using open domes?**

- All products programmed to the manufacturer's proprietary fitting algorithm
  - Signia > closed fitting
  - Other manufacturer's > open fitting
- For participants who reported own-voice satisfaction rating of "Satisfied" or "Very Satisfied"
  - Signa Nx closed outperforms the competition with 86% satisfaction!
  - Competitor A open at 58% and Competitor B open at 37%




Distribution of percent of participants with an own-voice satisfaction rating of #6 (Satisfied) or higher for Signia and two leading competitors. All products were fitted using the manufacturer's proprietary algorithms.



## Signia Nx Audiology
Own Voice Processing

Life sounds brilliant.

**Does Signia own-voice processing encourage increased communication?**

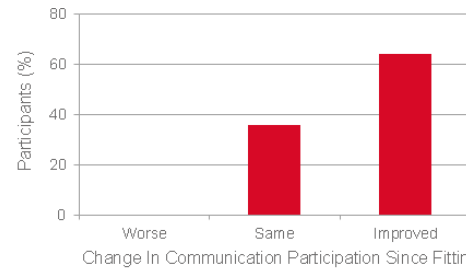
- First fit to Signia Nx-fit; Signia OVP activated
- Using a COSI-like form, all participants selected 2-4 listening situations where they believed that they could be more active in the conversation; importance of situations were rank-ordered.
- 42 different situations reported
- Ratings were obtained 3-weeks and 6-weeks following the initial fitting for a total of 76 ratings

## Signia Nx Audiology
Own Voice Processing

Life sounds brilliant.

**Signia Nx with OVP encourages increased communication**

- All changes in communication ratings obtained at three weeks and at six weeks were either Same or Improved
- No subjects rated the change in communication as Worse
- 64% of participants found an improvement in their real-world listening/communication situations, i.e. they were more actively participating




Preliminary Findings: Ratings obtained at three weeks and at six weeks following the fitting. 76 ratings; 42 different communication situations

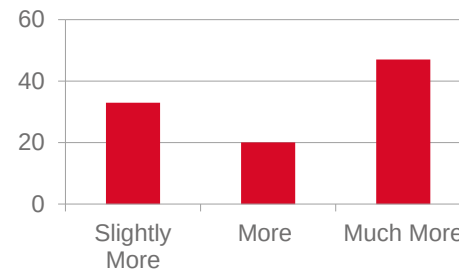


## Signia Nx Audiology
Own Voice Processing

Life sounds brilliant.

**Signia Nx with OVP encourages increased communication**

- Of the 64% of participants, approximately half rated the improvement in communication following the fitting was Much More
- **Preliminary findings -** suggests that the Signia Nx with OVP activated encourages communication




Preliminary Findings: Distribution for the 64% of ratings where improvement was noted following the fitting. 76 ratings; 42 different communication situations.

## Signia Own Voice Processing
Summary

Life sounds brilliant.

**Clinical Study Results**

- While OVP does not solve own-voice problems due to the occlusion effect, it addresses own-voice issues caused by amplification
- OVP can greatly improve the wearer's perception of their own-voice without the need for venting or gain adjustments
- OVP allows for more closed fittings that can improve the benefit of noise reduction and directional-microphone technology
- OVP is clinically proven to improve the acceptance of own voice for 80% of dissatisfied wearers
- OVP reduces the need to troubleshoot own-voice issues, resulting in fewer clinical visits
- Having a natural-sounding own voice may encourage communication and social interaction



## Signia Nx Products
OVP

Life sounds brilliant.

**Meeting the needs of even more wearers**

| Pure 312 Nx | Pure 13 Nx | Pure & Motion Charge&Go Nx | Motion 13 Nx | Motion 13P Nx | Styletto Connect |
|---|---|---|---|---|---|
| OVP | OVP | OVP | OVP | OVP | OVP |

signia
Life sounds brilliant.

# Thank you!