

A decorative graphic consisting of multiple thin, red, wavy lines that flow across the top and right side of the page, creating a sense of motion and depth.

# Real-world assessment of Signia Integrated Xperience with RealTime Conversation Enhancement

## White Paper

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signia

## **Abstract**

Signia developed the Integrated Xperience (IX) platform and its signature feature, RealTime Conversation Enhancement, to provide the wearer with real-world benefits to speech understanding in challenging situations and, ultimately, the ability to contribute to conversations. An international survey was conducted to investigate the real-world performance of Signia IX. A total of 78 experienced hearing aid wearers in the US, Taiwan, Germany, UK, Italy and Australia participated in the survey. All respondents were fitted with Signia IX, and they compared Signia IX to their own hearing aids in their everyday lives. Respondents were asked to complete an online questionnaire that assessed their perceptual, emotional and behavioral experiences provided by the two sets of hearing aids.

The results showed an exceptionally high level of satisfaction with Signia IX and a strong preference for Signia IX compared to respondents' own hearing aids. The positive ratings of Signia IX were observed across both perceptual domains (e.g., speech understanding, sound quality and listening effort) and the emotional and behavioral aspects of participating in a conversation (e.g., ability to contribute, feeling of confidence and not having to withdraw). The benefits of Signia IX observed in conversation-related domains suggest that the benefits of RealTime Conversation Enhancement, which were previously seen in lab studies, transfer to real-world benefits experienced by wearers in their everyday lives.

## **Introduction**

While significant quality-of-life improvements resulting from recent technology advances have been observed over the past years (Picou, 2022), e.g., due to the advent of 'new generation' features such as rechargeable batteries, direct streaming capability and use of smartphone-based apps for wearer control of their hearing aids. (Taylor & Jensen, 2023), wearers still encounter challenges in understanding speech in the presence of background noise. Engaging in conversations and participating in various social activities, especially in the presence of background noise, continue to be an obstacle for hearing aid wearers (Picou, 2022).

Current hearing aid technology aims to amplify sounds, making speech more audible; however, distinguishing and comprehending speech amidst competing background noise remains a complex task. Multiple talkers contribute to a cacophony of auditory signals, making it difficult for individuals with hearing aids to isolate and focus on a single conversation. This challenge is particularly pronounced in situations where spatial and temporal cues, critical for auditory scene analysis, are distorted by ambient noise (Glyde et al., 2011). The intricate interplay between multiple talkers and variable background sounds demands sophisticated signal processing capabilities from hearing aids (Chung, 2004).

Understanding the multifaceted nature of this problem is crucial for developing targeted interventions and improving the efficacy of hearing aids in real-world scenarios. Nicoras et al. (2023) explored the elements contributing to successful conversations and identified "being able to listen easily" as the most crucial factor for both individuals with hearing loss and those with normal hearing. Interestingly, both groups considered this factor more vital in group conversations than in one-on-one interactions. While the ability to hear and comprehend is essential for successful group discussions, their research revealed that active contribution to the conversation, including "sharing information as desired," also plays a significant role.

Traditional hearing aid processing methods designed to improve speech-in-noise performance may fall short of wearer expectations in group conversations. While traditional directional microphone technology (beamforming) can assist in focusing on a specific talker to the front of the wearer in background noise, it often excludes simultaneous talkers from the side and back of the wearer. And adaptive directional systems, which adjust the processing based on secondary measures (e.g., detection of head motion to infer the listening needs), may be too slow and inaccurate to adapt to a group conversation with multiple talkers and rapid turn-taking. Broader (less aggressive) directional microphone systems may capture all talkers, but they usually require more aggressive noise reduction algorithms, which can lead to a possible reduction in gain for the desired speech signal and lead to an unsatisfactory listening experience for the wearer.

Signia has been a pioneer in addressing speech-in-noise challenges for hearing aid wearers. The Signia Augmented Xperience (AX) platform, introduced in 2021, marked a significant advancement by introducing Augmented Focus (Best et al., 2021). This technology uses a split processing approach to separate speech and background noise, offering substantial benefits in challenging communication situations. By incorporating Augmented Focus, AX technology delivered enhanced speech understanding benefits to wearers facing challenging communication situations in background noise (Jensen et al., 2021; Taylor & Jensen, 2022).

A distinctive feature of Augmented Focus lies in its utilization of advanced directional technology to divide incoming sounds into two separate streams. The front (focus) stream primarily focuses on speech, allowing wearers to attend to the intended conversation, originating from the front of the wearer. In contrast, the back stream primarily handles background noise to the sides and the rear of the wearer, providing a comfortable and non-distracting surrounding stream. While this approach successfully addresses issues associated with traditional directional processing and demonstrates considerable benefits across various scenarios, it does have a limitation. The focus stream is processed without knowledge of the wearer's exact communication situation – such as the number of people involved, their locations and the dynamics of the conversation. Consequently, Augmented Focus, while broadly enhancing speech with minimal distortion, cannot add contrast and enhance individual talkers. With the launch of Signia IX, this limitation has now been addressed.

The introduction of RealTime Conversation Enhancement with Signia IX hearing aids provides a significant improvement in conversation processing in background noise. Built on a multi-stream architecture, it offers a fundamentally new approach to analyzing and processing conversational situations.

In this white paper, we report the results of an international survey in which Signia IX with RealTime Conversation Enhancement was evaluated in respondents' own daily listening environments. Before delving into the findings from the survey, we first explain how Signia IX technology works, and summarize the evidence already available from studies done in controlled laboratory conditions.

## **Signia IX with RealTime Conversation Enhancement**

This section offers a quick introduction to the RealTime Conversation Enhancement (RTCE) technology. More detailed information on the background and function of RTCE is provided by Jensen et al. (2023b).

An overarching goal of RTCE is to improve the audibility of conversation partners in noisy environments, allowing the wearer to focus on the other talkers, while keeping the surrounding sound environments as natural as possible. A simplified illustration of RTCE is shown in Figure 1. As indicated in the left part of the figure, RTCE works in combination with the Augmented Focus split processing, which was introduced on the Signia Augmented Xperience (AX) platform (Branda, 2021). The split processing facilitates the unique RTCE three-stage approach, which is illustrated in Figure 1.

In the first stage, *Analyze*, the complete conversation layout is determined when relevant speech is detected in the front hemisphere. The analysis includes localization of the talkers involved in the conversation and assessment of the conversation dynamics. In the second stage, *Augment*, advanced binaural processing is used to create three independent focus streams, which are added to the existing focus stream from the split processing. This allows talkers in the conversation to be enhanced, while background noise is processed independently as a surrounding stream. In the third stage, *Adapt*, the streams are combined to create a conversation sphere that changes adaptively according to changes in the conversation layout, e.g., when conversation partners take turns speaking, when they move or even when the wearer turns their head.

The ability to directly detect and enhance the different talkers in a group conversation and seamlessly adapt to any changes in the conversation layout in real time allows the wearer to focus on and contribute to the conversation. As opposed to traditional hearing aids, the RTCE technology does not need a long time for adaptive systems to settle before the wearer gets the support they need in the given situation. The adaptation takes place in real time, allowing the wearer to always remain in the conversation and converse naturally.

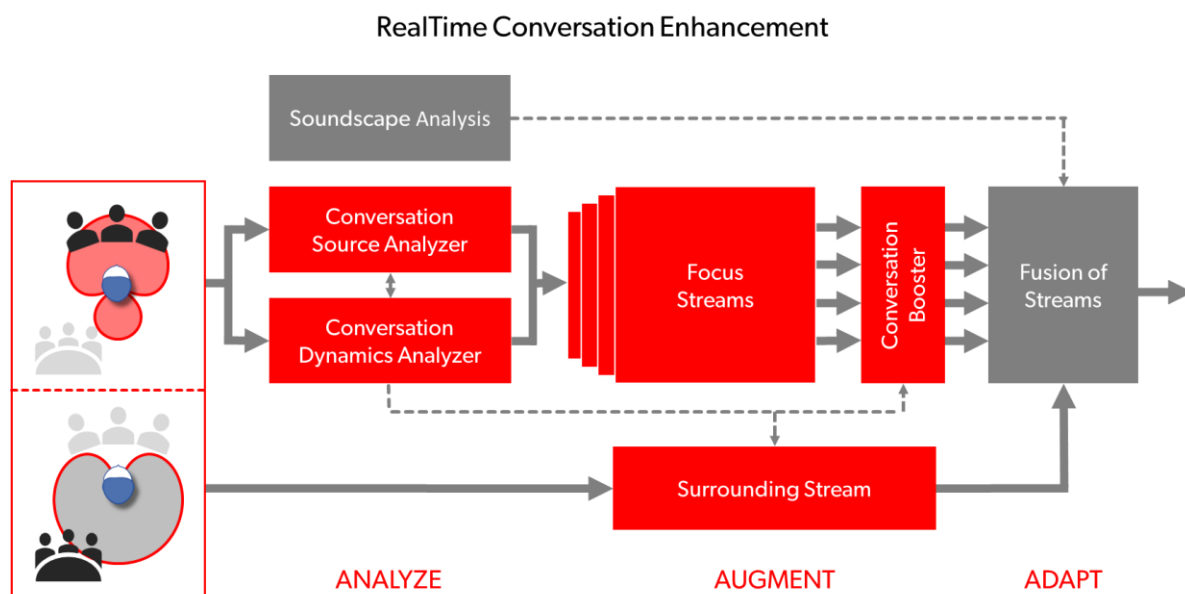


Figure 1. Simplified diagram showing the functionality of the RealTime Conversation Enhancement technology. Bold lines and arrows indicate the flow of the streams, while thin dotted lines and arrows indicate control paths.

The perceptual benefits of Signia IX with RTCE were investigated in a study performed at Hörzentrum Oldenburg in Germany (Jensen et al., 2023a; Jensen et al., 2023b). The performance was investigated using different implementations of a standardized speech-

in-noise test. In tests simulating both a one-on-one conversation and a more challenging group conversation with multiple talkers, the study results showed statistically significant benefits in speech understanding in background noise of Signia IX with RTCE activated compared to a setting in which RTCE was turned off. In the test simulating a group conversation scenario, 95% of the participants showed improved speech-in-noise performance with RTCE activated.

In a study investigating the signal-to-noise ratio (SNR) on the output side of the hearing aids when placed on a KEMAR manikin in a sound scene simulating a group conversation in background noise with multiple talkers and frequent turn taking, Signia IX performed significantly better than four different competitor hearing aids (Jensen et al., 2023d). Compared to the best performing competitor hearing aid, Signia IX provided a 4.1 dB improvement in the overall conversation SNR. An SNR improvement of this magnitude is likely to cause a substantial improvement in speech understanding.

While the reported studies provide solid evidence for the performance of Signia IX with RTCE, both studies were conducted in a laboratory environment where the test conditions could be fully controlled. However, hearing aids are developed to be used in listening situations which often deviate from the situations created in the lab; consequently, data from actual wearers, participating in daily activities, was needed. To obtain deeper insights in the real-world performance of Signia IX, we conducted an international survey in which experienced hearing aid wearers were fitted with Signia IX and asked to assess the performance in their everyday lives and compare it with the performance of their own hearing aids. In the remaining part of this paper, we describe the survey and discuss the results and clinical implications.

## **Survey methods**

To conduct the survey, we asked several hearing care professionals (HCPs) in six different countries to fit some of their own patients with Signia IX; these wearers were respondents in the survey. Their task was to evaluate Signia IX in their own everyday lives and compare the experience and performance to their own hearing aids.

### **Respondents**

In total, 78 respondents across four continents completed the survey (22 in the United States, 21 in Taiwan, 12 in Germany, 11 in the United Kingdom, 7 in Italy and 5 in Australia). The respondents included 31 females and 47 males, and they were between 20 and 89 years old (average: 64 years). The respondents had mild-to-moderate sensorineural hearing loss, and they were all experienced hearing aid wearers, fitted bilaterally with hearing aids of various brands and models. The self-reported average age of their own hearing aids was four years. They were required to be smartphone users to allow easy administration of the online survey questionnaires, which were distributed via emails and text messages.

### **Signia IX fittings**

All respondents were fitted bilaterally with Signia Pure Charge&Go IX receiver-in-the-canal (RIC) hearing aids (equipped with M-receivers). The individual ear coupling was determined by the HCP and based on each respondent's hearing loss and personal preferences. Open, vented and closed couplings were used in the IX fittings. The fitting of the hearing aids was completed in a routine manner, using the Signia IX First Fit

rationale in Connex 9.11. The HCPs could fine-tune the hearing aids if they found it appropriate, according to their normal practice.

The respondents received a charger together with the Signia IX hearing aids. All respondents could use the Signia app, including the Signia Assistant, on their own smartphone during the survey period, but the installation and use of the Signia app and Signia Assistant were not mandatory.

## **Survey protocol**

The survey protocol included one visit to the HCP's clinic, where respondents received information about the survey, signed a consent form and were fitted with Signia IX.

After agreeing to participate in the survey, respondents were asked to complete an online questionnaire with some background questions (about age, gender, etc.) along with a series of questions about their experience wearing their own hearing aids. They were then asked to wear the Signia IX hearing aids for three weeks. After a few days, the HCPs were encouraged to contact respondents to ensure they did not experience any noticeable problems with the new hearing aids.

At the end of the three-week trial period, respondents received a link to a second online questionnaire, in which they answered the same questions about their experience with Signia IX that they had answered about their own hearing aids. Additionally, the questionnaire included a few questions on their use of the Signia Assistant. After completing the questionnaire, respondents were asked to switch back to their own hearing aids and wear them for two weeks, after which they received a link to a third questionnaire, asking for the third time the same survey questions. After completion, respondents were asked to switch to the Signia IX hearing aids and wear them for a final test period of two weeks, before completing the fourth and final questionnaire.

In addition to the same survey questions that appeared in the previous three questionnaires, the final questionnaire also included the same questions about Signia Assistant, which were asked in the second questionnaire. They were also asked a series of questions in which respondents could state their preference between Signia IX and their own hearing aids in different domains, based on their experiences during the entire trial period.

## **Questionnaires**

All four questionnaires were administered online and could be completed using a smartphone, tablet or laptop, by following a link that was sent directly to respondents via both email and text message.

The four questionnaires in the hearing aid experience included different sections of questions, including questions about their:

- satisfaction with the hearing aids in different domains
- experience of participating in conversations
- willingness to recommend and keep the hearing aids
- use of Signia Assistant (in the second and fourth questionnaire)
- preference between Signia IX and respondents' own hearing aids in different domains (only final questionnaire)

The questions about satisfaction were answered on a 7-point Likert scale with the response categories "very unsatisfied," "unsatisfied," "somewhat unsatisfied," "neutral (neither satisfied not unsatisfied)," "somewhat satisfied," "satisfied" and "very satisfied."

Each question about conversation experience involved a given statement (e.g., “Wearing the Signia IX hearing aids, I can contribute to conversations”), and respondents were asked to state their level of agreement or disagreement with the statement on another 7-point Likert scale with the categories “strongly disagree,” “disagree,” “somewhat disagree,” “neutral (neither agree nor disagree),” “somewhat agree,” “agree” and “strongly agree.”

The remaining questions mainly used dichotomous scales, with response options being either “yes/no” or “Own HA/Signia IX” (for the preference questions).

The specific wordings of the questions are listed in connection with the following examination of the results.

## Results

### High satisfaction

In each of the four questionnaires, respondents answered the following questions about their satisfaction with the hearing aids they had just worn:

- Overall, how satisfied are you with the hearing aids?
- How satisfied are you with the overall sound quality of the hearing aids?
- How satisfied are you with your overall ability to understand speech with the hearing aids?
- How satisfied are you with the sound of your own voice with the hearing aids?
- How satisfied are you with how the hearing aids look when you wear them?
- How satisfied are you with the physical comfort of the hearing aids?

In the following, we report the results from the final assessment of respondents’ own hearing aids and Signia IX. Specifically, these are the ratings made in the third and fourth questionnaire after respondents had trialed both sets of hearing aids and were familiarized with the questionnaire and fully acclimatized to Signia IX.

Respondents rated all the questions on a 7-point Likert scale, and the results are reported as Top 3 box scores. Note that the Top 3 box score is the percentage of respondents who opted for one of the three highest ratings on the scale, allowing them to be classified as ‘satisfied’ wearers. For each of the six questions, the satisfaction rates, i.e., the percentage of respondents indicating to be satisfied with their own hearing aids and Signia IX, respectively, are plotted in Figure 2.

In general, Figure 2 shows substantially higher satisfaction rates with Signia IX than with respondents’ own hearing aids. For the question about overall satisfaction, an impressive 86% of respondents stated that they were satisfied with Signia IX, whereas only 58% were satisfied with their own hearing aids. This result suggests that Signia IX provided a noticeable improvement in respondents’ everyday lives. The results from other sections of the questionnaire (see below) provide further evidence to support this conclusion.

For the other questions, between 79% and 92% of respondents were satisfied with Signia IX, compared to satisfaction rates between 47% and 69% for respondents’ own hearing aids. The higher satisfaction rates for Signia IX were observed for both the questions about the perceptual listening experience (sound quality, speech understanding, own voice perception) and for the questions about physical appearance and physical comfort.

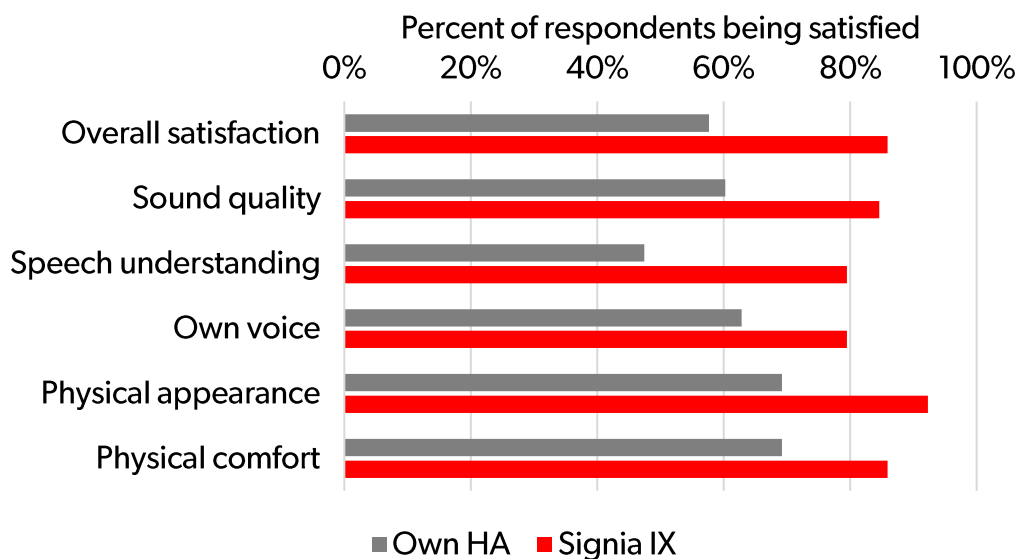


Figure 2. Percentage of respondents expressing satisfaction with own hearing aids and Signia IX, respectively, in each of six questions.

The highest satisfaction rate was observed for the question about physical appearance, indicating the design of the Signia Pure Charge&Go IX hearing aids was highly appreciated by respondents. The largest increase in satisfaction rate was observed for the question about speech understanding, in which the satisfaction rate increased by 32 percentage points (from 47% to 79%). This finding is a strong indication that the speech processing in Signia IX – including RealTime Conversation Enhancement – improves the wearers’ self-perceived ability to understand speech in a variety of situations.

For all the questions, the difference between the satisfaction rates observed for own hearing aids and Signia IX was analyzed with a two-proportion z-test, using a Benjamini-Hochberg correction to control for multiple comparisons. The analysis showed that for all six questions, the proportion of satisfied respondents was significantly higher for Signia IX than for own hearing aids (all  $p < .05$ ). Thus, switching from respondents’ own hearing aids to Signia IX significantly increased the number of satisfied respondents on all the questions.

### Conversation experience (emotional and behavioral aspects)

Since Signia IX, in general, and RTCE, in particular, were developed to support the wearer in challenging conversation situations in the real world, the questionnaires included a special section with items that asked about various aspects of the experience of being in a conversation. These questions went beyond the mere listening experience and addressed some of the important emotional and behavioral elements that are known to be affected by a hearing loss when being in a strenuous conversation situation, e.g., a group conversation in background noise. In this section, the questions were formulated as statements, and respondents were asked to indicate their level of agreement (or disagreement). The statements were:

- Wearing my own hearing aids, I can contribute to conversations.
- Wearing my own hearing aids, I can converse and act freely when being in conversations.
- Wearing my own hearing aids, I feel confident when being in conversations.



- Wearing my own hearing aids, I feel engaged when being in conversations.
- Wearing my own hearing aids, I feel included when being in group conversations.
- Wearing my own hearing aids, I do not feel isolated when being in group conversations.
- Wearing my own hearing aids, I do not feel frustrated when being in group conversations.
- Wearing my own hearing aids, I do not feel fatigued when being in group conversations.
- Wearing my own hearing aids, I do not need to withdraw from group conversations.

Respondents provided their agreement ratings on a 7-point Likert scale, and as for the satisfaction ratings, we report the Top 3 box scores, indicating the percentage of respondents who indicated some level of agreement with each of the statements when wearing their own hearing aids and Signia IX, respectively. These results are shown in Figure 3. Again, we report the results from the third and fourth questionnaire.

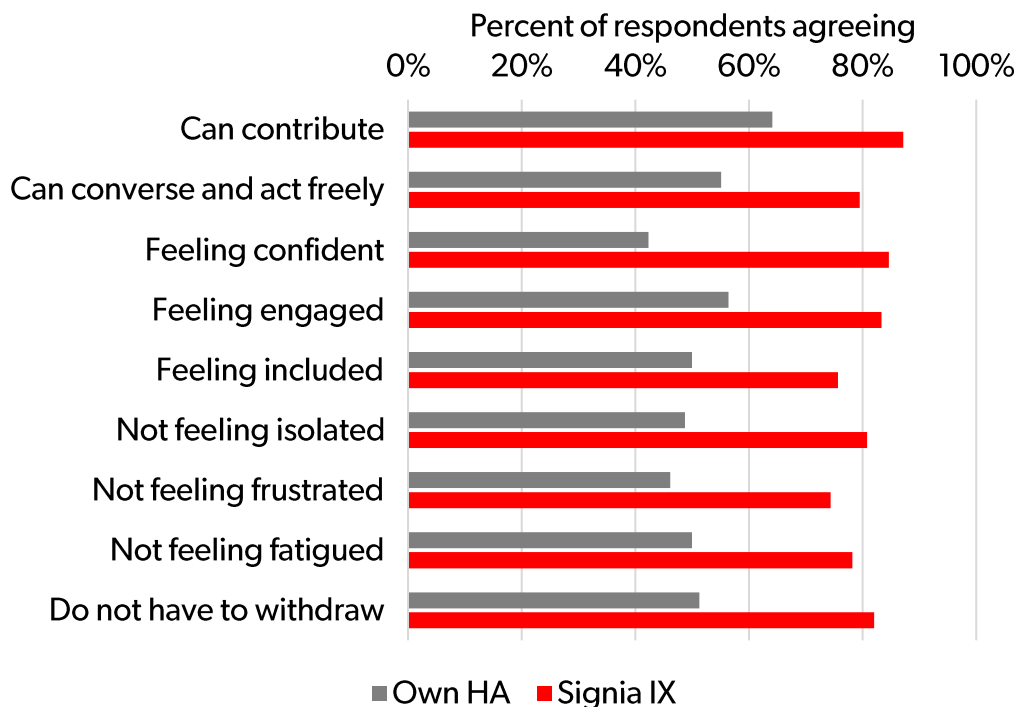


Figure 3. Percentage of respondents agreeing with each of nine different statements related to the experience of being in a conversation, when wearing their own hearing aids and Signia IX.

Several quite striking observations can be made in Figure 3. Overall, we again see a clear positive effect for Signia IX. With Signia IX, the proportion of respondents agreeing with the various statements ranges between 74% and 87%. With their own hearing aids, the corresponding proportions range between 43% and 64%. Thus, for all nine items in Figure 3, the proportion of wearers with a positive conversation experience is substantially increased by Signia IX. This indicates that Signia IX with RTCE can improve, perhaps dramatically, the conversation experience for many wearers.

Going a bit deeper into the individual items, it is interesting to observe the many facets of a conversation where Signia IX can make a difference. With Signia IX, 87% of respondents believed they could contribute to a conversation (compared to 64% with own hearing aids), and 79% believed they could converse and act freely (compared to 55% with own hearing aids). As indicated by the data, these beliefs were often accompanied by feeling confident (85%), feeling engaged (83%), and feeling included (76%), and by the absence of feeling isolated (81%), frustrated (74%), and fatigued (78%). Consequently, 82% of respondents reported that they did not have to withdraw from group conversations when wearing Signia IX, as compared to only 51% with own hearing aids.

The differences in agreement rates between own hearing aids and Signia IX were analyzed in the same way as the satisfaction rates reported above, i.e., using a two-proportion z-test with a Benjamini-Hochberg correction for multiple comparisons. The analysis showed that for all questions, the agreement rate was significantly higher for Signia IX than for own hearing aids (all  $p < .01$ ). That is, a significantly higher proportion of respondents had positive experiences when wearing Signia IX during conversations as compared to when they were wearing their own hearing aids.

### Willingness to recommend and keep the hearing aids

Respondents were also asked the following two simple questions, with the response options being “yes” and “no”:

- Would you recommend the hearing aids to friends or family?
- Would you like to keep the hearing aids?

The percentage of respondents who would recommend or keep their own hearing aids and Signia IX (as indicated in the third and fourth questionnaire, respectively), is shown in Figure 4.

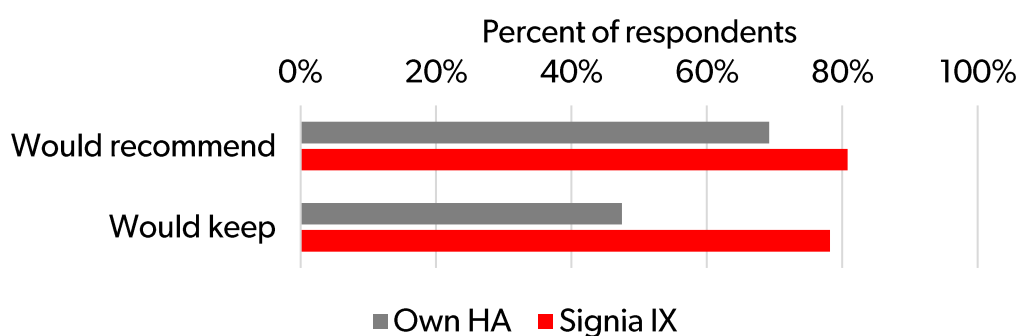


Figure 4. Percentage of respondents being willing to recommend and being willing to keep their own hearing aids and Signia IX, respectively.

On the question of willingness to recommend hearing aids to others, 81% stated they would recommend Signia IX, while 69% stated they would recommend their own hearing aids. While there was a difference in recommendation rates, it was not as clear as some of the previous results, as a two-proportion z-test showed no significant difference between the recommendation rates for own hearing aids and Signia IX ( $p = .096$ ). However, when asked about whether they would like to keep the hearing aids, the difference between own hearing aids and Signia IX became more substantial. Overall,

78% stated they would like to keep Signia IX, whereas only 48% would keep their own hearing aids after having worn Signia IX, and this was a clearly significant difference ( $p < .0001$ ).

The fact that the proportion of respondents willing to both recommend and keep, respectively, Signia IX are almost identical (around 80%), whereas a substantial difference in the two proportions (69% vs. 48%) is observed for own hearing aids. This finding could suggest that the experience of wearing Signia IX had an impact on many respondents' perception of their own hearing aids. While the performance of their own hearing aids for many respondents was perceived as good enough for them to be willing to recommend them, the willingness to keep them was likely affected by the better performance experienced with Signia IX.

## Preference

At the end of the survey period, in the fourth and final questionnaire, respondents were asked to state their preference between their own hearing aids and Signia IX – across different perceptual and emotional domains – by answering the following questions. For each question, they were asked to pick either their own hearing aids or Signia IX:

- In your experience, which hearing aids provide the best speech understanding across all listening situations?
- In your experience, which hearing aids provide the best experience in conversations with other people?
- In your experience, which hearing aids require the least listening effort in daily life?
- In your experience, which hearing aids provide the most exciting listening experience in your daily life?
- In your experience, which hearing aids make you feel more energized (less tired/less strained) in your daily life?
- In your experience, which hearing aids make you feel more confident in your daily life?
- Overall, which hearing aids do you prefer?

Figure 5 shows the percentage of respondents choosing their own hearing aids and Signia IX, respectively, for each of the seven questions. The figure shows almost the same pattern across the seven questions. In broad terms, and in alignment with the results presented above, Signia IX is preferred by around 80% of respondents, while 20% prefer their own hearing aids. Based on the results already reported, it is not surprising that the highest preference is observed on the question about conversation experience, for which 82% of respondents stated that Signia IX performed best. However, almost the same preference rates were observed for Signia IX on the other questions about best speech understanding (79%), least listening effort (77%), most exciting listening experience (81%), feeling more energized (81%), feeling more confident (79%) and overall preference (77%). In all seven cases, the preference for Signia IX is highly statistically significant according to a binomial test (all  $p < .00001$ ).

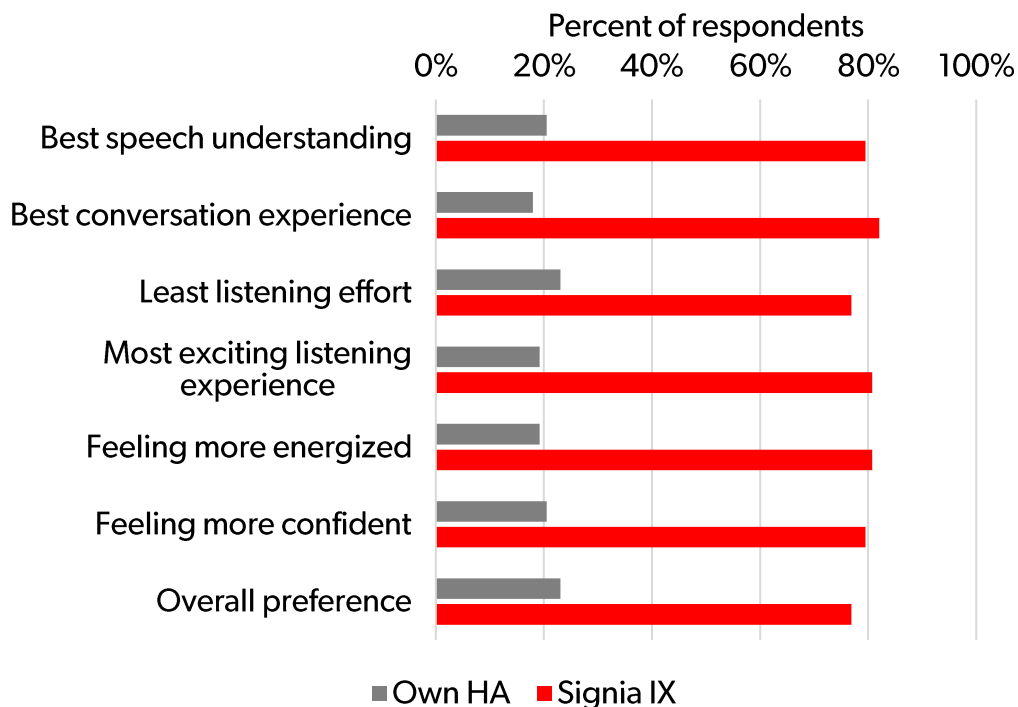


Figure 5. Percentage of respondents picking own hearing aids and Signia IX, respectively, when asked about which hearing aids provide the best performance in seven different perceptual and emotional domains.

## Signia Assistant

In the questionnaires administered at the end of the two trial periods with Signia IX, respondents were asked a few simple questions about their use of the Signia Assistant (SA). The questions asked and the response categories were:

- Did you use the Signia Assistant in the past [three/two] weeks while wearing the Signia IX hearing aids? (Yes; No)
  - If yes: Did you find the Signia Assistant useful? (Yes; No)
  - If no: Why did you not use the Signia Assistant? (I did not feel the need; I have the Signia app, but I was not aware of the Signia Assistant; I do not have the Signia app)

Thus, each respondent answered two questions, for which the second question depended on their answer to the first (i.e., whether they had used SA during the trial period they had just completed).

In Figure 6, the answers from both questionnaires have been pooled. The left bar in the plot shows the proportion of respondents who indicated they had used SA at least once (by answering yes to the opening question), and the right bar shows the proportion who stated that they never used SA during the two trial periods. The figure shows that 59% indicated they had used SA, while 41% indicated that had not used it. The figure also shows that among those who used SA, 89% indicated they found it useful, while the remaining 11% stated they did not find it useful. This means that 53% of the total sample of respondents reported they had used SA and found it useful.

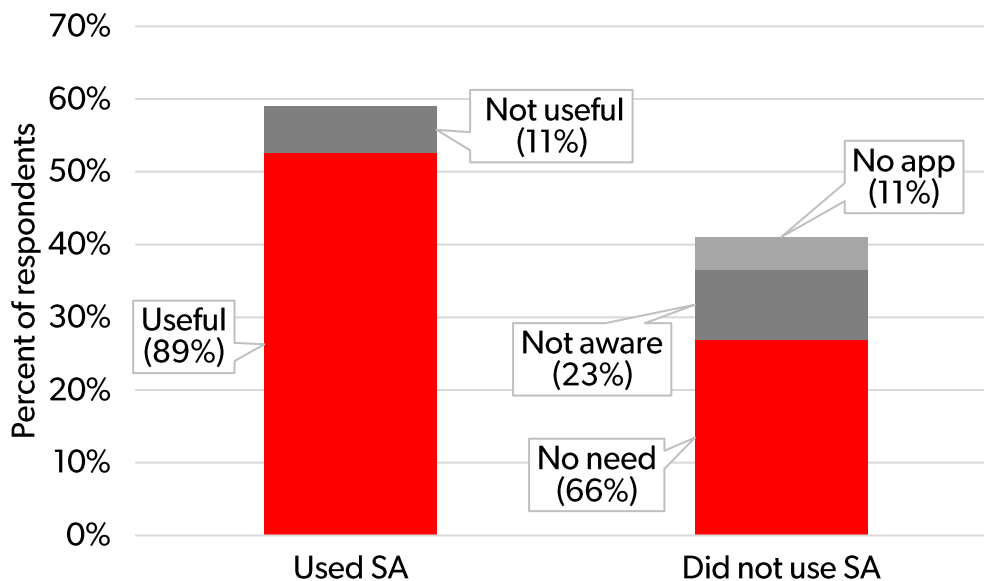


Figure 6. The left bar shows the percentage of respondents using Signia Assistant (SA) at least once during the two Signia IX trial periods, and the right bar shows the percentage of respondents not using SA. The left bar is color-coded to indicate the proportions of SA users who reported SA to be either useful or not useful. The right bar is color-coded to indicate the proportions of non-SA users who indicated the reason for no use to be “I did not feel the need,” “I was not aware of SA” or “I do not have the app,” respectively.

Figure 6 also shows the distribution of reasons for non-use indicated by the 41% of respondents who did not use SA during the trials. In 66% of the cases, “I did not feel the need” was indicated as the reason, whereas “I have the Signia app, but I was not aware of the Signia Assistant” and “I do not have the Signia App” were indicated as the reason in 23% and 11% of the ‘did not use SA’ cases.

In summary, the data from the questions on respondents’ use of SA indicate that the vast majority of respondents who used SA perceived it to be useful, while the majority of respondents who did not use Signia Assistant found no reason to use it.

## Discussion

The results from the international wearer survey presented in this paper paint a very clear picture. Across all the different perceptual, emotional and behavioral domains, which were investigated in the survey, Signia IX provided considerably high levels of wearer satisfaction – with 86% of respondents indicating being overall satisfied – and Signia IX was strongly preferred in comparison with respondents’ own hearing aids.

Based on its advanced multi-stream technology, Signia IX offers RealTime Conversation Enhancement, which enables detection and enhancement of individual talkers when the wearer engages in conversations in background noise. Accordingly, the survey focused on communication in general and respondents’ conversational experiences in particular. The results clearly demonstrate that Signia IX can provide substantial benefits for the wearer in conversational situations in two important ways:

- 1) The questions related to speech understanding and other aspects of the perceptual listening experience showed favorable outcomes for Signia IX.

- 2) The questions that addressed some of the more emotional and behavioral aspects of conversations revealed similar outstanding results that favored Signia IX processing.

With Signia IX, specifically, an impressive 87% of respondents reported they could contribute to conversations, and the other survey data showed this was often accompanied by feelings of confidence, engagement and inclusion – and feelings of not being isolated, frustrated or fatigued – when participating in a conversation.

The availability of RealTime Conversation Enhancement in Signia IX likely plays a significant role in respondents' extremely positive ratings within these conversation-related domains and the finding that wearers had a strong preference for Signia IX over their own hearing aids (which had different types of signal processing). The results can be explained by the real-time direct adaptation to the conversation, based on an analysis of the dynamic conversation scenario, which traditional hearing aids with slower and less direct adaptive systems do not offer.

The positive ratings of the conversational experience are clear indications that the superior performance of RealTime Conversation Enhancement already demonstrated in the lab through technical measurements (Jensen et al., 2023d) and perceptual speech-in-noise tests (Jensen et al., 2023a) transfers to the conversational scenarios encountered by actual hearing aid wearers in the real world.

While conversations are an essential part of people's everyday lives, respondents obviously found themselves in many other types of listening situations during the trial. In these situations, respondents likely benefitted from some of the other features offered by Signia IX, such as, for example, advanced noise reduction, Own Voice Processing 2.0 and motion sensor technology. In combination, all the features available on the Signia IX platform contribute to an effective adaptation to a wide variety of listening situations, as well as an effective and smooth transition when the wearer moves from one type of situation to another. In the survey, the ability of Signia IX to provide support to the wearer in a wide range of situations is reflected by the high overall satisfaction rate and by the high ratings in more specific perceptual domains like, for example, sound quality and listening effort.

The high levels of wearer satisfaction with Signia IX – observed in both perceptual, emotional and behavioral outcome domains – tap directly into many of the factors that Nicoras et al. (2023) list as being important for conversational success, most importantly 'being able to listen easily,' but also 'being engaged and accepted' and 'sharing information as desired.' It is well established that hearing aids have a positive effect on the quality of life experienced by the wearer (e.g., Ferguson et al., 2017), and by making conversations more successful, Signia IX can make an important contribution to further improving the wearer's quality of life.

The Signia Assistant is an easy-to-use, AI-based tool that allows Signia IX wearers to get their hearing aids fine-tuned instantaneously when they face a listening problem in their own everyday lives. While the survey included a few questions related to respondents' use of SA, it was not a main focus point in the survey. Thus, it was not mandatory for HCPs to train respondents in the use of SA, and it was not mandatory for respondents to use it. This means the survey does not serve as a systematic and controlled evaluation of SA. However, on the other hand, the survey results may reflect 'rather normal' use of SA.

An interesting finding, which illustrates the potential of SA to offer improvements to the wearers who use it, is that 89% of respondents who used SA during the survey trial found it useful. This rather high rate is consistent with the overall acceptance rate of the fine-tuning suggestion made by the SA exceeds 80% (Jensen, et al., 2023c), meaning that the

there is a high likelihood that the SA will suggest an improved setting that benefits the wearer. Another interesting finding was that in two-thirds of the cases in which respondents did not use SA during the Signia IX trial, 'no need' was indicated as the reason for not using SA. In the remaining cases, respondents reported not to be aware of the SA, or not to have the Signia app installed on their smartphone. These findings may indicate that work needs to be done to make HCPs and wearers more aware of the options and potential benefits available to them via Signia Assistant.

## Summary

In this paper, we presented the results of an international survey in which 78 hearing aid wearers in six different countries across four continents trialed Signia IX in their everyday lives and compared that experience to the use of their own hearing aids.

Across the perceptual, emotional and behavioral domains, a vast majority of respondents were highly satisfied with Signia IX. The satisfaction rates with Signia IX were significantly higher than what was observed for respondents' own hearing aids, and, consequently, Signia IX was strongly preferred over respondents' own hearing aids.

Some of the main findings of the survey were that 86% of respondents were satisfied with Signia IX, 87% of respondents believed they could contribute to conversations with Signia IX and 82% of respondents did not have to withdraw from group conversations with Signia IX. In a direct comparison with their own hearing aids, 82% of respondents stated that Signia provided the best conversational experience, and 79% felt more confident with Signia IX than with their own hearing aids.

The positive ratings of Signia IX – especially those related to the performance in conversations – are likely to be driven by the multi-stream processing offered by RealTime Conversation Enhancement. The results indicate the benefits of the real-time direct adaption to dynamic conversation scenarios, which separates RealTime Conversation Enhancement from the slower and more indirect systems used by most traditional hearing aids.

The survey findings indicate that the benefits of Signia IX previously demonstrated in controlled lab studies transfer to the real world and provide benefits to wearers when engaging in conversations in their normal everyday lives.

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