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Oticon Play PX: Supporting Communication, Learning and Inclusion for Children and Teens

ABSTRACT

Children and teens with hearing loss require full access to sound and communication to grow, thrive, and learn. Oticon's Pediatric BrainHearing philosophy and innovative sound processing strategies in the Oticon Play PX hearing technology provide a strong communication network to support the hearing needs of children and teens with hearing loss. With a Deep Neural Network embedded on the new Polaris platform and advanced features, important sounds are delivered with exceptional clarity and resolution.

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life-changing **technology**

Introduction

Today, most children and teens with hearing loss attend their neighborhood school and participate in activities alongside their hearing peers (CRIDE, 2018). Their "Being" or self-identity is constructed based on their own unique set of experiences and relationships and is supported by those around them (Kerby, 1991). Like their peers with normal hearing, children and teens have a desire to feel connected and participate in the world around them. Research on inclusion and children with hearing loss has shown to have positive effects in the areas of academic achievement, social competence, and wellness (Eriks-Brophy & Whittingham, 2013). Hearing aid technology is an integral part of that connection and participation. It is critical to the development of inclusion and their "Belonging." In addition, Gordey (2018) found inclusion and belonging to be important for children and teens with hearing loss in their learning and social environments.

"When they feel comfortable, when they feel safe, and they know that they are going to be heard and have their needs met, they are able to take risks and enjoy grade one." Grade one classroom teacher (Gordey, 2018)

Well-designed hearing aid technology needs to include advanced sound processing, connectivity, discrete design and comfort to support children and teens as they embrace "Becoming" and explore their aspirations for the future. The ability to interact with their hearing peers, have full communication access, and feel confident that they can participate in their important listening environments is crucial (Gordey, 2020).

"I would not be the person I am today without my hearing aids" Janna, grade eleven student (Gordey, 2020)

New Advancements in Hearing Technology for Children and Teens

Incidental learning, inclusion, engagement and participation requires hearing technology with full communication access. In addition, children and teens live in a world that is dynamic, complex, and filled with unpredictable sound scenes (Crukley et al., 2011). Our Pediatric BrainHearing™ philosophy asserts that the brain needs access to high quality sound to help determine where and when to focus. Conventional hearing aid technology may reduce access to the full sound scene as they are limited by a basic set of rules, where sound is analyzed and adjusted based on those rules with intent to improve speech understanding. As a result, the sound scene is restricted in its application of directionality, noise reduction and compression. Oticon pediatric BrainHearing technology ensures a full, precise, balanced sound scene allowing the individual to have full communication access, and have confidence in their important listening environments.

"I was afraid in school that I was going to miss something someone said" James, grade seven student (Gordey, 2020)

Children and teens often express their frustration with trying to hear in situations where speech and noise blend together. Whether it is trying to listen to friends while walking down the school hallway or following a conversation at a busy café, children and teens with hearing loss find these listening environments very challenging (Gordey, 2020). Oticon Play PX includes the new and powerful Polaris platform. Polaris allows the hearing aid to operate all of our advanced features including a highly trained, built in, Deep Neural Network (DNN). The DNN recognizes the complexities of speech and other sounds in the environment. Because the DNN is not bound by conventional hearing technology's "rule based system" , it can analyze complex patterns in various sound scenes with precision, representing the sounds with clarity and better contrast and balance.

"Trying to hear with my hearing aids when I walk in the hallway, that's especially rough." Eva, grade nine student (Gordey, 2020)

Oticon Play PX includes a new feature to offer communication support in complex environments. MoreSound Intelligence (MSI) includes a combination of processing systems that make speech stand out, keep other sounds accessible and effectively manages background noise. MSI in Oticon Play PX 1 may be described as a three step process (Figure 1):

1. Scanning and analysis of the sound scene
MoreSound Intelligence scans the full sound scene 500 times per second, resulting in a precise analysis of all sounds and the complexity of the surroundings. It then applies the optimized child-specific settings to establish a clear target for how to handle all varying sound scenes.

2. Spatial clarity processing
Once the environment is scanned and analysed, Spatial Clarity Processing precisely organizes the sounds around the child. Spatial Clarity Processing includes two main technologies. In easy environments Virtual Outer Ear is active, modelling the filtering of real human pinnae to recreate natural and accurate spatial information. In more complex environments, the more powerful Spatial Balancer takes over. It makes sure meaningful sounds remain accessible and stay precisely balanced against potentially disturbing noises around the user.

3. Neural clarity processing
Neural Clarity Processing utilizes the DNN's training from 12 million real-life sound scenes to analyse the intricate details of virtually all sounds to create contrast between the identified sounds. The result is a more natural representation of all sounds in a clear, and balanced sound scene, enabling children to more easily make sense of surroundings.

MoreSound Amplifier (MSA) is an additional feature in Play PX that is uniquely equipped to optimally place the rebalanced signal within the patient's dynamic range. While compression systems are an essential component of today's hearing aid technology, we understood the need to improve upon it. MSA in Oticon Play PX 1 follows MSI in our sound processing pathway to ensure there is a clear, balanced and high quality sound input to work with. Sounds are constantly processed through two different pathways – a 4-channel path and a 24-channel path. The system identifies which type of information is present and what resolution, or pathway, should be prioritized when amplifying. The systems wants to be in a 24/slow path as much as possible as it preserves the most details in the speech signal. It reverts to 4/fast when needed and then returns back into the higher resolution, gradual response 24/slow mode. MSA takes the cleaned up rebalanced signal and places it within the dynamic range of the patient. It can quickly choose between being accurate, to preserve the details of stable speech, or fast, to manage sudden changes in loudness level. We believe that the increased resolution capability of MSA supports children and teens in their communication access and opportunities to participate; conversations will be better preserved within their dynamic range and provide their brain more speech detail in their important listening environments.

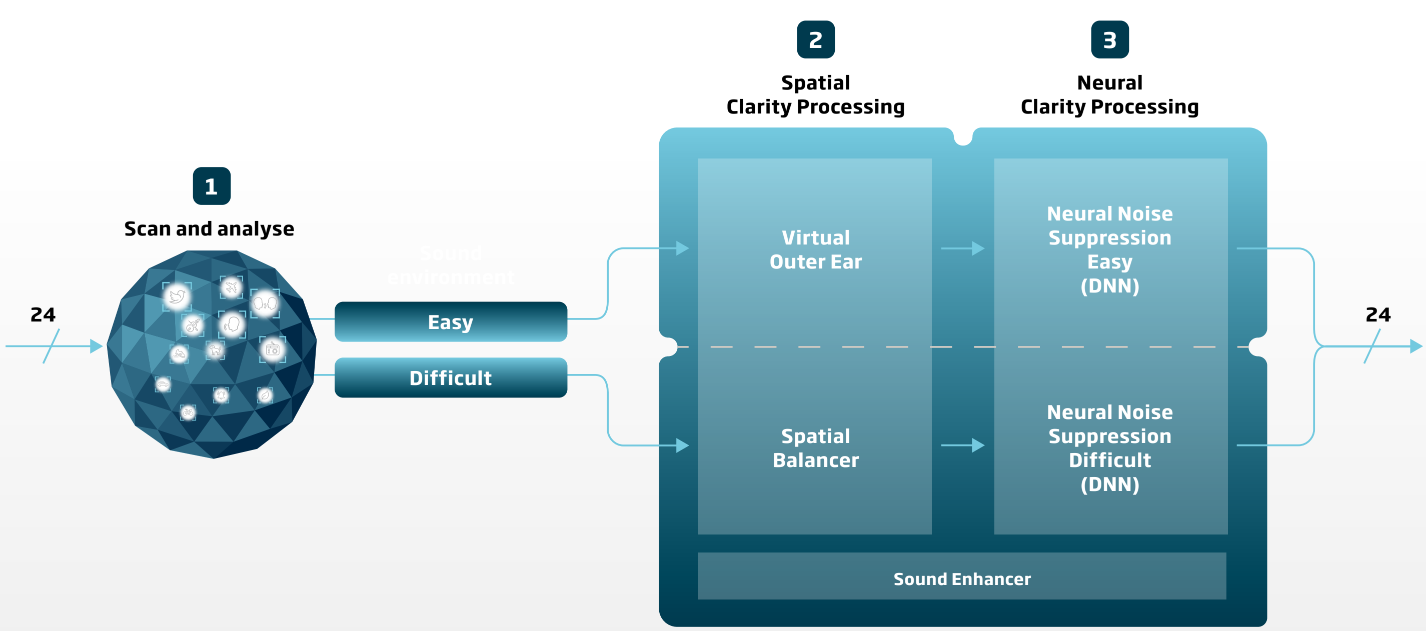

Figure 1. The three step process of MSI in Oticon Play PX 1

The last new feature in Oticon Play PX is MoreSound Optimizer (MSO). MSO is an advanced feedback manager that utilizes an exclusive strategy called Spectro Temporal Modulation (STM) to prevent feedback. MSO offers pediatric hearing care professionals hearing aid fittings to provide optimal gain while managing unwanted feedback. For children and teens with hearing loss, we believe this may promote increased confidence in using their hearing aid technology.

"Sometimes I am not even aware that my hearing aids are whistling. My friend tells me, and that is sort of embarrassing." Matt, grade twelve student

The Evidence Behind Oticon Play PX 1

Advancements in Oticon hearing aid technology offers new opportunities for communication access for children and teens with hearing loss. Research studies on new, advanced features in pediatric hearing aids are crucial for hearing care professionals. Evidence is an essential component to assist in their evaluation and selection of hearing technology. Oticon Play PX provides a package of research studies to support our hearing aid technology and its use with children and teens.

Parent Perspectives on Rechargeable Hearing Aids for their Children

Oticon Play PX offers a state-of-the-art rechargeable solution for children and teens in a mini-BTE and mini-RITE style. It provides a full day's power on a fast 3-hour charge. To inform the development of our rechargeable hearing aid, we wanted to understand if parents would consider using this technology. In December 2019, survey research was completed with parents of children who wore hearing aids and attended a hearing resource program in Vancouver, British Columbia, Canada. Twenty-four families responded to the survey where they were invited to share their opinions on rechargeable hearing aids (Gordey, 2020). Results showed a strong desire by parents to use rechargeable hearing aids, with 67% reporting they would use this solution with their pre-school-aged children (Figure 2). When parents were asked about their confidence in a rechargeable hearing aid, 88% of the participants stated they felt certain that this technology was reliable. Parents in this study also described the reasons for wanting a rechargeable hearing aid. This included saving money on buying batteries, being better for the environment, and that charging the hearing aid battery every night meant they could trust the hearing aid would work well for the following day (Gordey, 2020).

Oticon RemoteCare: Opportunities for Self-Determination

Remote hearing care has been shown to provide benefits for healthcare professionals, their patients, and their families (Swanepoel et al., 2010). In addition, remote care has been evaluated for use in pediatrics as a facilitator to increasing hearing aid use time for newly fit children (Muñoz et al., 2020). As part of Oticon's connectivity package, remote hearing care is available to hearing care professionals. While the Oticon RemoteCare provides technical support between patients and their audiologist, we were interested to know if it might also

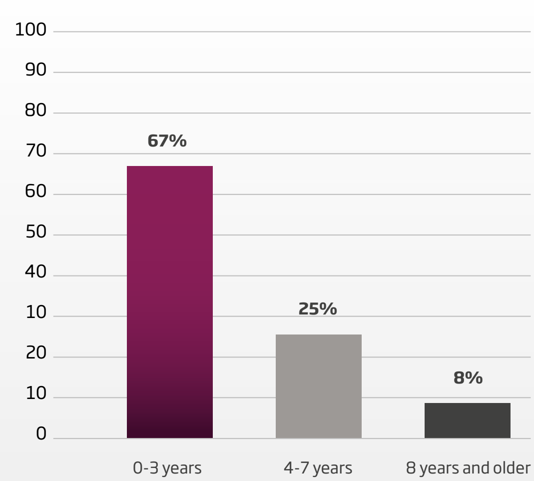

Figure 2. Age parents would select a rechargeable hearing aid for their child

have a role in promoting parent self-determination. A qualitative study was developed in collaboration with the audiologists at Rady Children's Hospital. The objective of this study was to look at parent perspectives on using the Oticon RemoteCare and other remote applications for their children's audiology appointments and investigate the benefits and challenges they experienced. Ten parents of preschool-aged children who wore Oticon hearing aids participated in remote hearing care appointments with their audiologist. Parents were interviewed on their experiences with remote hearing care and its use with their audiologist. Results from this study identified five main themes from the parent interviews: Relatedness (parent-audiologist relationship), autonomy (choice), competency (understanding their child's hearing and hearing technology), communication, and support (Figure 3).

Parent competency and their understanding of hearing loss is crucial. Research has shown that understanding their child's hearing loss and confidence in working with their hearing technology were strongly correlated with adherence to care and their child's frequency of hearing device use (Ambrose et al., 2020). In our study, we found that remote hearing care helped facilitate the development of competency by providing a dedicated appointment for parents to communicate and engage with their audiologist. A parent of two-year old child stated:

"I think sometimes you have questions, especially when you have no experience with hearing aids, so just having someone to bring up those questions face-to-face is much better than sending an email." It almost feels a little bit more intimate sometimes over video chat with the remote hearing care, because you are talking from your own home." (Gordey, 2021)

Research has also shown that parents have a desire to build a relationship with their audiologist where decision-making is shared and their voice is valued (Gordey, 2021). Parents in this study described using the remote hearing care application as being easy to use and a very convenient alternative to a typical audiology appointment. In addition, parents reported that using the remote hearing care application provided a new opportunity to connect with their audiologist because the virtual appointment was dedicated to talking specifically about their children's experiences.

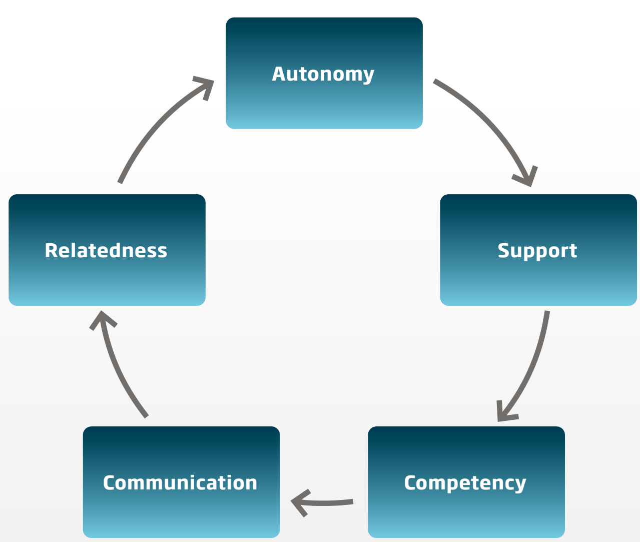

Figure 3. Parent themes from using remote hearing care

This was highlighted by a parent of a one-year old child who said:

"It felt like we were getting an added layer of care from the audiologist, something extra, where we talked about my son's day to day experiences. You don't always get that chance to have that type of a discussion when you attend a busy clinic appointment." (Gordey, 2021)

MoreSound Intelligence enhances communication access

According to research, conventional hearing aid technology may restrict access to 360° listening and access to overhearing, important for incidental learning (Pittman, 2021). Limiting access to the entire auditory environment also limits communication access. Therefore, it is important to provide children with auditory access to all meaningful sounds as well as communication access that is similar to their peers, so that they are able to learn, participate, interact and develop social relationships.

To assess whether MSI would improve auditory and communication access, Pittman (2021) conducted a study to assess children's ability to recognize and recall speech coming from different directions. Recognition and memory for words was examined with lists of 12 words from the Auditory Verbal Learning test (AVLT, Schmidt, 1996). The words in each list were evenly distributed across six locations (see Figure 4) and presented randomly with a one second, inter-word interval. All words were presented at 70 dB SPL. To simulate a typical listening environment, diffused cafeteria noise was presented at 67 dB SPL from three equally spaced loudspeakers within the array. The children listened to all 12 words before repeating aloud as many of the words they could remember. This required the children to retain words in memory for approximately 20 seconds following the start of each list. Performance was calculated as the proportion of words recalled correctly from each direction. Two groups of children were recruited.

The first group of participants consisted of 19 children with normal hearing (pure tone average < 20 dB HL) aged between 10 and 15 years. The aim was to understand children's ability to recognize and recall words in noise when words came from different directions. Overall, the recognition and recall performance from different source locations ranges from 56% to 82%. Normal hearing participants were not able to recognize and recall all words in the complex listening environment, suggesting that the task was difficult. We

Figure 4. Words in the Auditory Verbal Learning test were presented from six different source locations: front and off-axis (±30°), side (±90°) and rear (±150°) on the left and the right.

expected that children with hearing loss, who are more vulnerable to noise, would also find this task challenging even with help of well-fit hearing technology. In addition, we observed that the average performance for words coming from the source locations on the right (74%) were slightly better than from the left (70%).

The second group of participants consisted of 12 children with bilateral, symmetrical mild to moderately severe hearing loss aged between 11 and 15 years. To evaluate whether MSI improves communication access for children with hearing loss, we compared the performance between the two participant groups of children. We compared the performance with and without MSI enabled with the normal hearing participant data. Hearing aids were fitted according to the DSL v5 rationale, and default settings were used when MSI was enabled. Statistical analyses were performed (multivariate ANOVA, with a statistical significance level of 0.008 for multiple comparisons). When MSI was disabled (i.e., in the omni-directional microphone setting), children with hearing loss perceived and remembered significantly fewer words than children with normal hearing for multiple source locations: from the front and off-axis (left), from the side (left, right) and from the rear (left) except from the front and off-axis (right) and from the rear (right). When MSI was enabled, performance for the children with hearing loss differed from the normal hearing participants only for those words presented from the side (left) and from the rear (left). In other words, when speech was presented from the front and off-axis (left) and from the side (right), children with hearing loss had improved communication access using MSI compared to the omni-directional microphone setting. Figure 5 illustrates the performance from these two source locations. Children with hearing loss recognized and recalled fewer words in noise from the side (left) and from the rear (left) when compared to their normal hearing peers, regardless of the activation of MSI. The reason for such pattern of results remains speculative, but it may be related to an observation in the current study that children with normal hearing also performed poorer in recognizing and recalling words from the left. This could have limited how much children with hearing loss can benefit from the technology. Indeed, this group had a greater disadvantage to recognize and recall words from the left (41%) than the right (64%).

Recognizing and recalling speech coming from different directions is essential to speech and language acquisition as well as social and communication skill development (Oticon whitepaper, Gordey & Ng, 2021). The results of this study suggest improved opportunities

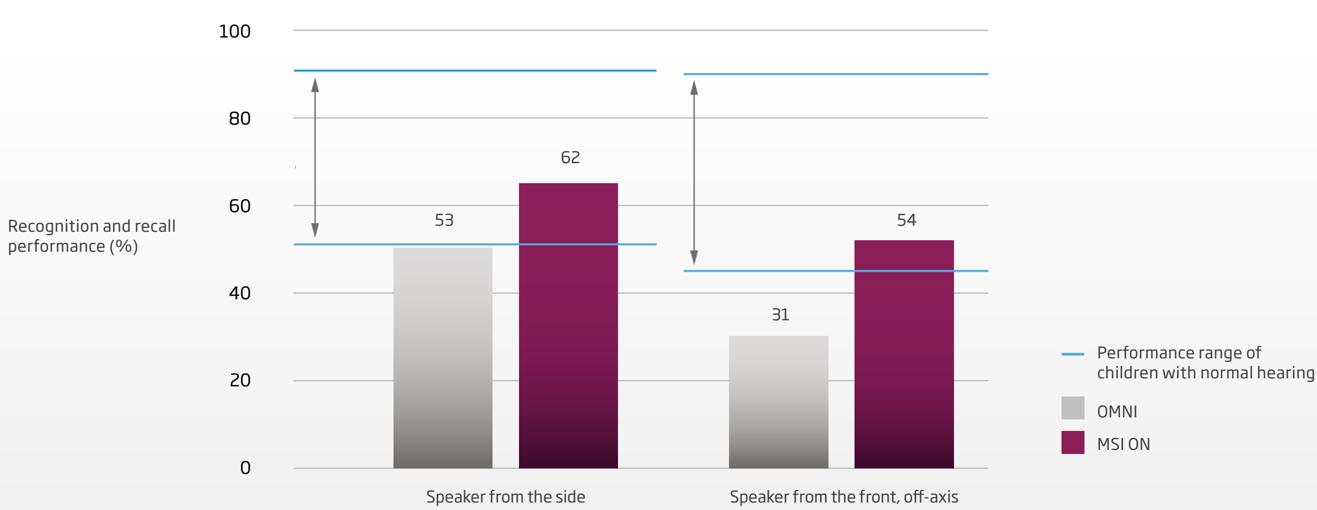

Figure 5. Recognition and recall performance when words are presented from the front and off-axis (left) and from the side (right) with and without MSI enabled for children with hearing loss. Blue lines indicate the performance range (one standard deviation above and below the mean) of children with normal hearing in the respective conditions.

for communication access when MSI is enabled. This confirms and extends the benefits of our BrainHearing technology for children. We have previously showed that OpenSound Navigator™ (OSN) improved speech understanding in noise for children even when the target speech source was off axis and preserved non-target speech coming from different directions (Oticon whitepaper, Ng, 2017). Building on the success of OSN, MSI is our next innovation where we have demonstrated improved recognition and recall when speech is presented from different directions.

Conclusion

To participate, interact, and develop social relationships, children and teens with hearing loss require communication access similar to their peers. While conventional hearing aid technology may not fully support these opportunities, research has shown that the new features in Oticon Play PX promotes full access. We believe this latest innovation in hearing technology from Oticon will provide a life-changing experience for children and teens with hearing loss to learn, engage, thrive, and participate in all their important listening environments.

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