KNOWLEDGE BRIEF – 2014

VoicePriority *i* ™ – Oticon's Adaptive FM

EDITOR OF ISSUE

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ABSTRACT

Noise levels in classrooms are unpredictable and often high. It is important for the student with hearing loss to hear and understand both the teacher and classmates, as both provide opportunities for learning. VoicePriority *i* ™ (VP*i*) - recently validated in independent research - is an adaptive FM strategy in the Oticon Sensei hearing instrument family. In an adaptive manner, VP*i* adds gain to the traditional FM signal as the noise level around the hearing instrument increases. This means that it works individually for each student, to optimize the clarity of the signal in each listening position.

VP*i* activates/deactivates almost immediately, depending on the noise levels around the student. This helps students shift their attention between different speakers to ensure that both the primary speaker (teacher) and the secondary speakers (classmates) are audible in class. Since VP*i* is also highly compatible with most remote microphones on the market, it provides a flexible, personalized and unique connectivity solution for students, teachers and hearing care professionals.

Children's hearing needs

Picture a computer class where a group of children are waiting for the teacher to announce and explain the day's activities. In the background, keyboard typing sounds, computer fan noise, laughter and conversations from excited students are present. Some students are watching YouTube videos together. The ability to take part in peer conversations and then quickly switch our attention to hear a teacher's instructions is something that most of us would take for granted. However, this represents one of the many difficult listening situations a child with hearing loss experiences during a typical school day (Crukley et al, 2011; Madell & Flexer, 2008).

It is well known that young children have different listening needs than adults. While children are developing language, they do not have a stored "library" of words, nor do they have the same degree of auditory experience with the world that adults possess. As a consequence, a disrupted signal with some lost syllables is a bigger problem for children than adults. This is because it is more difficult for children to fill in the missing pieces and understand the received message (Ching et al, 2001).

Adults also have fully developed selective attention. This means that they have the ability to take advantage of where people are situated in a room and differ-

ent characteristics of talkers, such as tonal quality and fundamental frequency (Shinn-Cunningham & Best, 2008). With this information, the brain is better equipped to "decide" which conversations to pay attention to and which to ignore (Alain, 2007). Even a mild hearing loss can cause problems with selective attention, making listening very difficult in noisy environments. A shift in a classroom discussion between a teacher asking a question and a student responding can be very problematic for the hearing impaired child. For this reason, children with hearing impairment need help to separate voices in competitive speech, as they have immature selective listening capacity while also having a reduced ability to hear in noisy environments compared to normal hearing peers (Leibold et al, 2013).

Oticon VoicePriority *i*™

Although children have a reduced ability to hear in competitive speech and noise, they spend most of their time in environments that are much noisier and more diverse than those in which adults spend their time (Crukley et al, 2011). Remote microphone systems, such as FM, have been developed to give additional help to students with hearing loss in classroom environments. With traditional FM, it is recommended that the transmitter have the same output as the hearing instrument microphone when both are introduced to the same input signal (usually 65 dB SPL). This scenario is known as FM transparency. When FM transparency is achieved, it will provide an improved signal-to-noise ratio (SNR) of approximately 10-15 dB under normal sound conditions (AAA, 2011). However, as the noise levels increase above these normal sound conditions, fixed traditional FM gain is not enough to preserve a 10-15 dB SNR and the teacher may quickly become inaudible. In this situation, a more advanced strategy is needed.

To respond to this requirement, Oticon has introduced the adaptive FM strategy VoicePriority *i*™ (VP*i*) which is available in the latest Sensei pediatric hearing instrument family. In an adaptive manner, VP*i* adds gain to the FM signal as the noise level at the hearing instrument increases. This helps maintain an appropriate SNR for intelligibility of the teacher's voice, even when noise levels around the student are high. VP*i* activates when the sound pressure level (SPL) around the student reaches approximately 58 dBA. When noise levels increase, gain is linearly added to the FM signal. For example, at 60 dBA, 2 dB FM gain is added; at 65 dBA, 7 dB FM gain is added, and so on. VP*i* provides up to 13 dB of added gain. For noise levels above 71 dBA, VP*i* maintains the addition of 13 dB (graph in Fig 1).

Y = Added FM input gain of VoicePriority *i*™(dB)
X = Noise level around student (dB SPL (A))

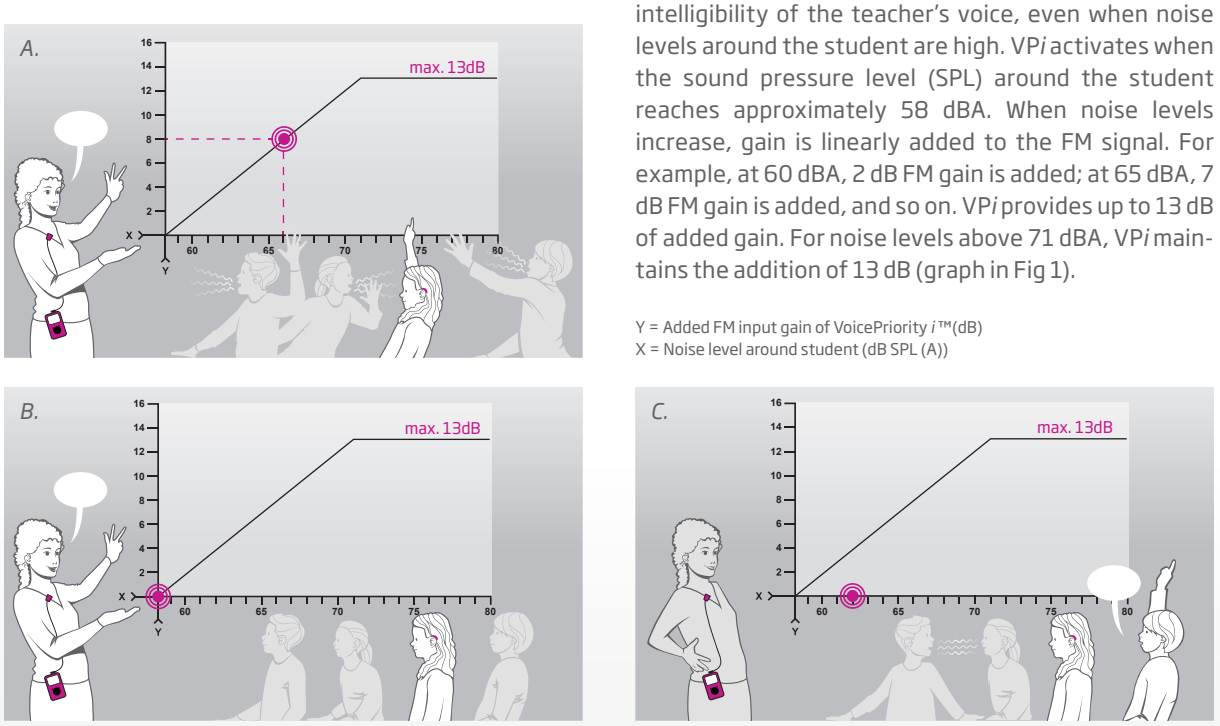


Figure 1. Examples showing listening conditions where VPi is active or not active:

A. *VPi is active and gives 8 dB additional gain. This is because the noise level is 66 dBA around the child with hearing aids (displayed by a pink dot on the graph) and the teacher is the primary talker in this situation.*

B. *VPi is not active since the noise level around the child with hearing aids is below 58 dBA (pink dot). Only traditional FM gain is needed to maintain an appropriate SNR.*

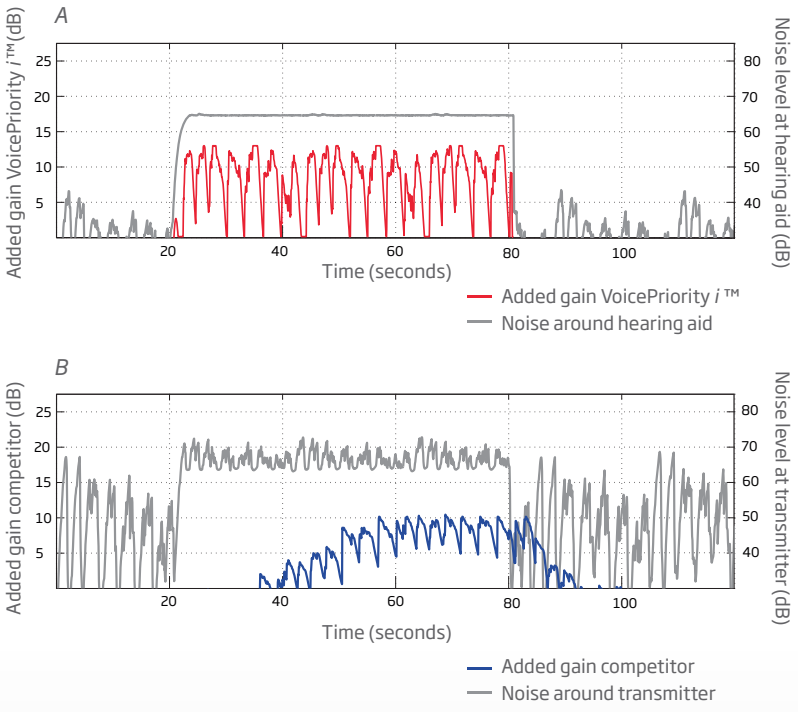
C. *The teacher has just asked a question and is listening to an answer from a classmate of the child with hearing aids. VPi has quickly deactivated since the teacher is not the primary talker. Even if the classroom noise is measured to 62 dBA (pink dot), VPi is not active when the teacher is not speaking, to facilitate the child's attention shift to the new talker.*

Two conditions need to be met in order for VP*i* to be active: the noise level needs to be above 58 dBA and the teacher needs to be talking through the remote microphone (Fig 1). VP*i* reacts almost immediately, with attack and release times of 30 and 600 ms respectively. This is important because fellow students also make valuable contributions during class. If the adaptive FM strategy were to activate and deactivate in a slow manner, there would be a greater risk of missing out on words when shifting the attention between teacher and peers in a noisy classroom environment. Just missing out on one syllable can make the student very isolated in noisy environments. Since VP*i* responds rapidly, it supports the student's ability to separate different sound sources and optimally - not miss out on classroom communication.

Hearing impaired students who perceive classroom participation as satisfying have higher scores for quality of life in school, social contact with peers and better mental health (Hintermair, 2011). Children also learn in an indirect manner from conversations around them, an ability often referred to as "incidental learning" (Saffran et al, 2011). Therefore, being able to accurately follow classroom conversations is an important factor for social interaction, health and learning.

Box 1: VP*i* attack and release times - much faster than a competitor's adaptive strategy

An advanced feature does not help if it is not available when needed. Oticon's VP*i* was designed to follow the fast conversation changes in the classroom - without degrading sound quality by reacting too fast.
Test setup: Attack and release times of the adaptive FM signal were measured in a Verifit box. The hearing aid was connected via an audio shoe to a computer measuring the FM signal coming into the hearing aid. A standard speech signal with a mix of a female and male voice (ITU-T P.501, 2014) was presented in English at approximately 84 dB SPL at the transmitter microphone in both scenarios representing the teacher's voice). Due to compression in the transmitters, this value is closer to 72 dB SPL when delivered to the hearing aid. The Verifit speakers played a 60-second fixed pink noise at approximately 66 dB SPL, starting after 20 seconds (light grey curves in graphs). The pink noise was presented at the noise detector of the adaptive FM system in both scenarios, i.e. with VP*i* this was at the hearing aid microphone and with the competitor's strategy it was presented to the microphone at the transmitter.



Result: Scenario A: *VPi (red curve) reacted almost instantaneously (within milliseconds) when the noise increased above or fell below the activation threshold, which can be seen in the graph as a fast activation when the noise kicked in at 20 seconds and fast deactivation after almost exactly 80 seconds.* ***Scenario B:*** *The competitor's FM strategy (blue curve) reacted slower with an attack time of 17 seconds and a release time of 12 seconds. Note that the speech at the transmitter (teacher's voice) is also added to the noise level with the competitor's strategy, since both are detected at the same position by the transmitter microphone. This is why the light grey curve varies more in scenario B in comparison to in scenario A.*

Because VP*i* uses a noise detector placed in the hearing instrument, FM gain is also adjusted individually for each student. For example, a student sitting next to a loud air conditioner would receive additional FM gain with VP*i*, whereas a student at a distance from the air conditioner would not. VP*i* is designed to meet the specific needs of each child by improving the SNR on an individual basis. This is different from another adaptive FM strategy in the market which places the noise detector in the transmitter microphone. With the transmitter placement, the same gain change is provided to all students in the classroom, based on what is happening around the teacher. Schafer et al (2013) notes:

"One potential disadvantage of measuring the noise level at the location of the transmitter is that the noise levels located at the teacher and child may differ to some degree."

The other manufacturer's adaptive remote microphone strategy also activates/deactivates much more slowly than VP*i*, making it potentially not as appropriate as VP*i* for the fast attention shifts in dynamic classroom environments (Box 1).

Validated by independent research

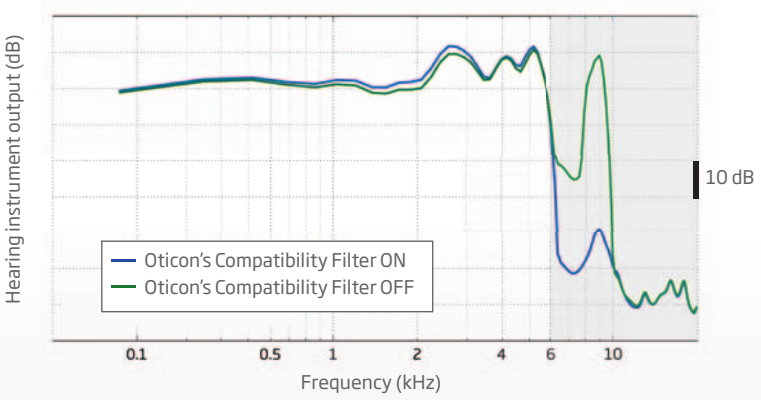
VP*i* has been evaluated by Erin Schafer, Ph.D., a well-known researcher of FM technology, at the University of North Texas. Twenty school-aged children evaluated the equipment during a 4-week-trial and were tested in several conditions measuring remote microphone benefit. Dr. Schafer's research team found that VP*i* provided superior behavioral performance and subjective ratings relative to both a traditional fixed-gain FM system and a hearing instrument alone. In addition, when asked in a questionnaire whether they would recommend Amigo FM and Oticon Sensei with VP*i* to other students, 94% of the responding children (18/20) said that they would (Schafer et al, 2013). An online presentation of these results by Dr. Schafer can also be viewed at AudiologyOnline (www.audiologyonline.com).

Compatibility

VP*i* is standard in all instruments in the Oticon Sensei product family. The feature is implemented in the DAI/FM + M program, and can be enabled/disabled in Genie under End fitting/More Tools/Phone and DAI/FM.

Box 2: Oticon's Compatibility Filter – removing unwanted tones

Oticon's Compatibility Filter. Oticon's Amigo FM system uses its full bandwidth of 7.5 kHz to transmit the high frequencies of speech to the hearing instrument for the best possible speech intelligibility. Another manufacturer's FM system uses the higher frequencies for data transmission, rather than speech signal transmission. Sensei's Compatibility Filter option prevents the potential reception of these disturbing non-speech transmission inputs (DTMF tones) when another manufacturer's FM transmitter is combined with an Amigo receiver and Sensei. This increases compatibility, which is especially convenient if several children with different receivers share the same transmitter in a classroom.



Test setup: *The above graph was measured with an ITU-T P.501 speech signal in a HATS (Head and Torso Simulator) with a closed earmold. An Oticon Sensei hearing aid and an Amigo receiver was combined with a competitor's remote FM microphone (which uses DTMF tones for data transmission).*
Result: *At 8-9 kHz the DTMF tone was attenuated by approx. 45 dB when the Compatibility Filter was ON (blue curve) - makin g the disturbing tone inaudible -compared to OFF (green curve). When the Filter is used in this specific mixed-manufacturer situation, the bandwidth of the FM signal is, by necessity, reduced to approx. 6 kHz (light grey area) instead of the 7.5 kHz bandwidth that can be obtained using a complete Amigo FM solution.*

VP*i* works with all Oticon Amigo transmitters and receivers that can be used with the FM + M program, also with the Streamer Pro when an FM receiver is attached to it (Oticon, 2013). In addition, VPi functions well in combination with most other manufacturers' FM transmitters, thanks to Sensei's Compatibility Filter option. When enabled, the Compatibility Filter allows for the combined use of another manufacturer's remote mic/transmitter (that uses data transmission in the higher frequencies) with the broader-bandwidth (7.5 kHz) Amigo receiver. In this scenario, the bandwidth of the FM input to Sensei is, by necessity, reduced to approximately 6 kHz via the Filter; this is done to maintain good sound quality to the child. Without the Compatibility Filter, the other manufacturer's transmitter can introduce unwanted high frequency tones in the FM signal to the broader-bandwidth Amigo receiver (Box 2). When using Sensei and VP*i* with another manufacturer's complete FM solution (same manufacturer's mic/transmitter and receiver) the Compatibility Filter is not required. Furthermore, the use of the Compatibility Filter has no effect on the performance of the VP*i* function.

Running back and forth to a charging station for remote microphone equipment in class can take up valuable time from the student's social life and can make children with hearing loss avoid using FM technology. Another problem with remote microphone technologies is that they also can drain the hearing aid battery, leading to both additional costs and more time spent on changing batteries. VP*i* in Oticon Sensei uses very little processing power, making battery consumption insignificant. With the lowest power consumption ear-level receivers available on the market, the Amigo FM technology also functions well with hearing instruments running on a 312 battery.

Conclusion

With the release of VP*i*, children, audiologists and teachers have been provided with a new, evidence-based adaptive FM strategy. This strategy was specifically developed to help hearing impaired children tackle the challenges experienced in noisy environments every day. Among other benefits, VP*i* adjusts the gain of the FM signal individually for each student, since classroom noise is often higher in some parts of the classroom than others. It has been shown in independent research that VP*i* provides significant benefit compared to traditional FM or a hearing instrument alone (Schafer et al, 2013). Furthermore, VP*i* activates/deactivates almost immediately, so that no words are missed when the child's attention shifts between the teacher and peers. Since VP*i* is standard in all Oticon Sensei instruments, it is easily accessible and enabled by default, in order to provide the best possible benefit for every child with hearing loss.

References

AAA (2011) American Academy of Audiology, Clinical Practice Guidelines, Remote Microphone Hearing Assistance Technologies for Children and Youth from Birth to 21 Years. Retrieved from: http://www.audiology.org/resources/documentlibrary/Documents/HAT_Guidelines_Supplement_A.pdf

Alain C (2007) Breaking the wave: effects of attention and learning on concurrent sound perception. Hearing Research 229: 225-36.

AudiologyOnline (2014) Effects of Voice Priority in FM Systems for Children with Hearing Aids. Retrieved from http://www.audiologyonline.com/

Brown DK, Cameron S, Martin JS, Watson C & Dillon H (2010) The North American Listening in Spatialized Noise-Sentences test (NA LiSN-S): normative data and test-retest reliability studies for adolescents and young adults. Journal of American Academy of Audiology 21: 629-41.

Ching TY, Dillon H & Byrne D (2001) Children's amplification needs-same or different from adults? Scandinavian Audiology 53: 54-60.

Crukley J, Scollie SD & Parsa V (2011) An exploration of non-quiet listening at school. Journal of Educational Audiology 17: 23-35.

Hintermair M (2011) Health-related quality of life and classroom participation of deaf and hard-of-hearing students in general schools. Journal of Deaf Studies and Deaf Education 16: 254-71.

ITU-T P.501 (2014) ITU-T Test Signals for Telecommunication Systems. Available for preview at: http://www.itu.int/net/itu-t/sigdb/genaudio/AudioForm-g.aspx?val=10000501

Leibold LJ, Hillock-Dunn A, Duncan N, Roush PA & Buss E (2013) Influence of hearing loss on children's identification of spondee words in a speech-shaped noise or a two-talker masker. Ear & Hearing 34: 575-84.

Madell, JR & Flexer CA (2008) Pediatric Audiology: Diagnosis, Technology, and Management. NY: Thieme.

Oticon (2013) Increasing the feasibility for teenagers to use FM [White paper]. Kongebakken, Denmark: Fuglholt, M. L. Saffran JR Newport EL, Aslin RN, Tunick RA & Barrueco S (1997) Incidental Language Learning: Listening (and Learning) Out of the Corner of Your Ear. Psychological Science 8: 101-105.

Schafer EC, Sanders K, Bryant D, Keeney K & Baldus N (2013) Effects of Voice Priority in FM Systems for Children with Hearing Aids. Journal of Educational Audiology 19: 12-24.

Shinn-Cunningham BG & Best V (2008) Selective attention in normal and impaired hearing. Trends in Amplification 12: 283-99.

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