

Latest developments in fitting software for children: The Junior Mode

Everything you need to know to help support your pediatric fittings

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Abstract

It is crucial when fitting children to use appropriate hearing instrument settings and features in order to facilitate speech and language development and to give the child the best opportunities in life. The Junior Mode fitting software (iPFG 2.0 and upwards) was developed with the help of the Phonak Pediatric Advisory Board and the wider pediatric community to provide accurate, efficient and holistic pediatric fittings. The most recent research has been collated in order to provide evidence-based, customizable software defaults specifically tailored to children. Additionally, printable counseling materials, the Junior Reports, aim to empower families, children and teachers by providing individualized information about the child's hearing loss, hearing system settings as well as hints and tips on a wide range of relevant topics.

This article focuses on the following ten questions, drawing upon the most recent research and evidence:

- 1. Why do we need pediatric fitting software?**
 - Hearing loss and children
 - Special fitting considerations for children
 - Matching technology to the needs of each child
- 2. How does the Junior Mode help hearing care professionals?**
 - Overview of the Junior Mode features
- 3. What exactly are the Junior Mode software defaults?**
 - The importance of an evidence based approach
- 4. Help! I'm confused**
 - User cases to demonstrate how the Junior Mode is tailored to each age group: 0-4 years, 5-8 years, 9-18 years
- 5. What if I disagree with the Junior Mode defaults? Can I change them?**
 - Discussion of the customizable defaults
- 6. How are directional microphones fit to children within the Junior Mode? Does the default microphone change depending on the age of the child?**
 - The latest research on the use of directional microphones for each age group
- 7. What are the Junior reports? When do I use them and why are they useful?**
 - Discussion of the Junior printable materials, tailored for children, their families/caregivers and teachers
- 8. Will the Junior Mode help in my busy clinic?**
 - Results from market research
- 9. How does the Junior Mode take into account the future of pediatric fittings?**
- 10. Where can I get more information?**

1. Why do we need pediatric fitting software?

Hearing loss and children

Hearing loss affects 1-3 infants per 1000 births (Fortnum and Davis, 1997). This statistic increases when we include acquired or progressive hearing losses. Hearing loss can affect communication, cognition, behavior, social-emotional development and academic potential. With the introduction of newborn hearing screening (NHS) and rapid advances in technology, the opportunity for improved long term outcomes for hearing impaired children has increased dramatically. Several studies have indicated that early diagnosis and intervention provides more positive outcomes for hearing impaired children and their families (e.g. Robinsshaw, 1995; Apuzzo and Yoshinaga-Itano, 1995; Yoshinaga-Itano, Sedey, Coulter and Mehl, 1998). These positive outcomes can only be achieved through early intervention, which ideally includes the use of high quality hearing systems fit with pediatric-friendly software.

Special fitting considerations for children

There are several considerations that need to be taken into account when fitting children:

- Children rely heavily on well fit hearing instruments in order to hear their own speech as well as the speech of others, so that they can develop speech and language themselves (Seewald, Ross and Spiro, 1985; Scollie, 2004). Speech and language is also heavily tied to social and emotional development, social integration and educational development. In this context, fitting children with hearing instruments becomes a considerable responsibility for all those working with the child.
- Children's needs are very different from adults. Among other things, children are exposed to diverse, often noisier, listening environments and are unable to control their acoustic environment. Moreover, the needs of children also vary widely depending on their age. For example, the needs of a six

month old infant will differ from those of a school aged child, and contrast even more to a teenager. For this reason, Phonak developed three Junior Modes: 0-4 years, 5-8 years and 9-18 years. The differences between the three Junior Modes are discussed in more detail in the User Case section (Page 9).

- Just like adults, fitting of appropriate hearing instruments for children requires knowledge of the degree and shape of the child's hearing loss (including which sounds are uncomfortable for the child), ear specific data and knowledge of a conductive component, such as middle ear fluid. Unlike adults however, for infants at least, clinicians must sometimes begin a fitting with incomplete data which is then built up over several test sessions. In addition, very young children can not actively take part in the fitting process.
- Children with normal hearing perform more poorly than normally hearing adults on many auditory tasks and are at a disadvantage in many listening environments. For example, children need higher signal-to-noise-ratios (Hall, Grose, Buss and Dev, 2002), lower reverberation times (Neuman and Hochberg, 1983) and are less able to make use of context (Nittrouer and Boothroyd, 1990). Hearing impaired children have a 'double disadvantage' and therefore need a well designed and highly accurate fitting and regular follow up in order to be given the best chances in life.
- Pediatric fittings require a holistic, multi-disciplinary approach. The team of professionals working with a child with hearing loss is often more comprehensive compared to adults. These pediatric specialists include pediatric hearing care professionals; ear, nose and throat doctors; speech and language therapists/pathologists; teachers of the deaf; pediatricians; health visitors; educational audiologists/psychologists and most importantly the parents & care-givers.

Matching technology to the needs of each child

"The general goal of any hearing aid fitting is to provide a signal that makes soft, moderate and loud sounds audible but not uncomfortable and provides excellent sound quality in a variety of listening environments."

(Pediatric Amplification Protocol, American Academy of Audiology, 2003)

This can be achieved using a recognized prescription formula such as the Desired Sensation Level (DSL) or the National Acoustic Laboratories (NAL) fitting formula and verifying that prescription targets are met across a variety of input levels in an external test box. However, as well as meeting prescription targets, the needs of each child must be assessed individually so that appropriate hearing instrument features can be chosen. Prescription formulae are a starting point but there are many other questions hearing care professionals need to consider when fitting a child. For example:

- Which features should I activate and which should be disabled to provide optimal audibility?
- How many programs should I give the child?
- When should I introduce a directional microphone?
- How does programming change as the child gets older?
- How and when should I provide access to the telephone?
- When should I introduce an FM system?
- What printed information should I give to the child, parents/caregivers and teachers?

These questions can be challenging for both new and experienced pediatric hearing care professionals. The hearing instrument technology, including features, programs and manual controls, must be matched to the needs of the child and their family. The Junior Mode was developed in order to help answer these questions and to provide efficient, accurate and tailored pediatric fittings, taking into account the latest research and developments.

2. How does the Junior Mode help hearing care professionals?

The Junior Mode:

- uses research based evidence for the use of technology
- takes a holistic approach
- takes into account the changing needs of children as they grow with three easy-to-access Junior Modes (0-4 years, 5-8 years and 9-18 years)
- allows more accurate and efficient pediatric fittings as the defaults are tailored to children
- keeps members of the team up-to-date with Junior reports, counseling materials tailored to the needs of each child and their family
- enables more time for counseling and testing

Overview of the Junior Mode Features

The Junior Mode includes:

- **Separate software defaults** tailored for infants and toddlers (age 0-4 years), school children (age 5-8 years) and teens (age 9-18 years)
- **FM + M** as the start-up program
- **DSL v5** as the default fitting formula (NAL-NL1 and proprietary formulae are also easily available as defaults)
- **Useful, time-saving pediatric defaults** for the most important listening programs
- Individual fitting philosophies are supported with customizable defaults
- **Printable, tailored materials** for parents, caregivers and teachers
- **Extensive Help** section, providing references and resources
- **New features** are available with each new software release

3. What exactly are the Junior Mode defaults? Show me the evidence.

The need for evidence-based practice has grown over the past decade (McCreery, 2008). The Junior mode defaults were developed based on inputs from the international pediatric community, the Phonak Pediatric Advisory Board

(please see p.16 for a list of members) and available research evidence. The appropriate Junior Mode is automatically selected based on the child's date of birth. If the developmental age of the child differs, the Junior Mode most suited to that child can easily be selected. All defaults can be clearly viewed in the software and can be customized depending on need. For example, some clinicians may prefer to change the default fitting formula from DSL v5 to NAL-NL1. Junior defaults are applied depending on the features available within the selected hearing instrument model.

For ease of understanding, defaults common across all Junior Modes will be discussed, and then user cases will be examined to show the differences between defaults for Junior 0-4, 5-8 and 9-18 years.

Junior Mode defaults for all Junior Modes (0-4, 5-8, 9-18 years)

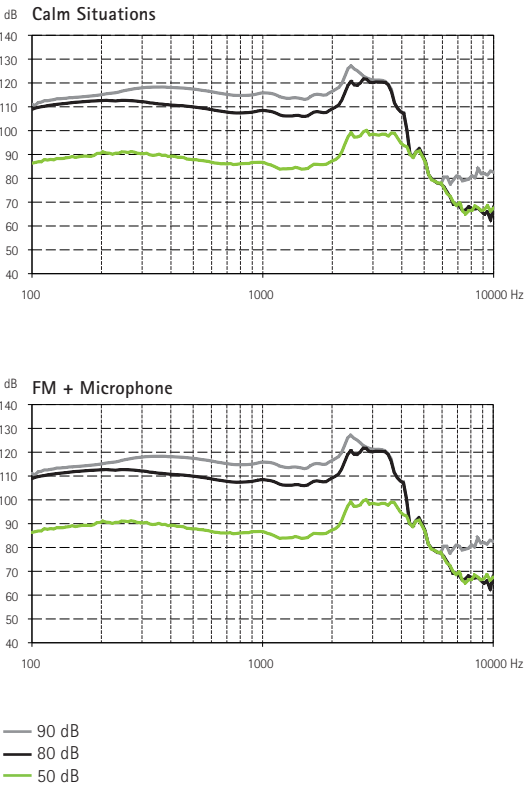
a. Start-up program: FM+M (FM+Calm Situations)

Communication development in children with hearing loss is challenged by noise, reverberation and distance, even with binaural amplification. With noise and reverberation, children may experience a 50% reduction in speech recognition (Thibodeau, 2008). The start-up program within the Junior Mode is FM+M by default, as long as the hearing instrument supports FM. This allows easy access to FM solutions as the child's instruments are always 'FM Ready'.

It is clear that FM systems are not only useful at school but also in other situations such as at day care, at home and during outdoor activities (Gabbard, 2005). For infants, FM systems allow increased audibility for language input, provide full access to the speaker, allow increased communication in difficult situations such as in the car or buggy and provide access to important and enjoyable activities such as reading stories. The use of FM systems also allows the parent/caregiver to feel more connected to the child (Thibodeau, 2008). Benoit

(1989) found that when wearing FM, parents facilitated conversation more and children would imitate sounds more often. Moeller, Donaghy, Beauchaine, Lewis and Stelmachowicz (1996) found that several of the children using FM systems regularly in the home made significant progress in language development. For older children and teens, FM systems provide access to the teacher's voice in the less than optimal school listening environment, as well as allowing access to a broad range of important social activities such as family gatherings, going to the shopping mall or having lunch with friends. In addition, FM systems allow older children to stay connected with the world around them through the use of devices such as mobile phones, ipods and computers.

Figure 1
2cc test box measurements showing the hearing instrument output at 50, 80 and 90 dB from 200-5 kHz for Calm Situations and FM+Microphone (noise cancellation and features off).



Microphone settings of Calm Situations and FM+M are now identical

In the past, clinicians have been concerned that the microphone ('M') in the 'FM+M' program was different from the microphone in the 'Calm Situations' base program, especially for verification. However, the settings are now identical as can be seen in the figure 1. This means that optimized performance to prescription targets can be maintained regardless of which of these programs is used.

b. Default fitting formula: Desired Sensation Level (DSL v5)

The default fitting formula for the Junior Mode is DSL v5, which is the most recent version released in 2006. The DSL prescription formula was originally validated to ensure that children, even those too young to respond to test signals, are given appropriate amplification. However, NAL-NL1 or proprietary formulae can also be easily chosen as a default. As long as the prescription formula has an evidence base, it is not important which formula is used. The new advances in DSL v5 were designed to allow a 'seamless interface' between diagnostic data collected in neonatal hearing screening and hearing instrument prescription and fitting (Seewald, 2008). DSL v5 includes:

- Updated real-ear-to-coupler-difference (RECD) data. This includes foam tip and earmold coupling and RECD predictions based on the nearest month.
- Application of an automatic correction factor to Auditory Brainstem Response (ABR) thresholds, measured in nHL, to obtain an estimated hearing level (eHL), required to program the hearing instruments accurately.
- Targets for multiple input levels.
- Maximum output limiting based on broadband (speech) inputs.

The recent advances still reflect the aims of the DSL method developed in the 1980s (Seewald, 2008):

- Audibility, comfort and safety
- Systematic, clinically feasible
- Infant/child friendly

A complete review of the Desired Sensation Level method is beyond the scope of this article. However there is a comprehensive discussion in Scollie et. al. (2005) or Moodie et. al. (2007).

c. SoundRecover (Non-linear frequency compression) default: on

The aim of SoundRecover (non-linear frequency compression) is to take the high frequency sounds that the child is unable to hear, and compress them to a lower frequency region where the child can hear better. SoundRecover also seeks to give greater audibility of high frequency everyday sounds such as birdsong or warning beeps. Importantly, SoundRecover uses a multichannel approach and incorporates a separate control for frequency compression only in the higher channel. This allows the lower frequencies to remain uncompressed as much as possible to avoid vowel artefacts (Bagatto, 2008).

Stelmachowicz, Pittman, Hoover and Lewis (2002) demonstrated that children with mild to moderately severe hearing loss experience significantly greater difficulty with perception of the high frequency phonemes /s/ and /z/ while wearing their hearing instruments compared to the performance of children with normal hearing. In addition, they showed that discrimination of /s/ and /z/ was dependent upon adequate aided audibility up to at least 8000 Hz. The provision of sufficient audibility for high-frequency phonemes such as /s/ and /z/ is critical for the development of speech and language (for example /s/ is one of the most frequently occurring sounds in the English language). For this reason, SoundRecover is enabled by default, in the Junior Mode, in order to provide children with access to high frequency speech and environmental sounds.

What research evidence is available to use SoundRecover with children?

Several studies have shown benefits of using SoundRecover for both adults and older children. For example, Glista, Scollie, Bagatto, Seewald, Parsa and Johnson (2009) evaluated prototype multichannel nonlinear frequency compression (SoundRecover) with 13 adults (aged 50-81 years) and 11 children (aged 6-17 years) with sloping high frequency hearing loss (ranging from moderately severe to profound). Several outcome measures were used, including speech sound detection, speech recognition and self reported preference measures. Results indicated that when SoundRecover was enabled, there was significant improvement of consonant and plural recognition (high frequency speech sounds). Importantly, vowel recognition did not change significantly, indicating that SoundRecover did not provide artefacts in the low frequencies. Glista et. al. attribute these benefits to the 'increased audibility of additional high frequency energy, albeit presented in a lower frequency range, compared to the conventional hearing aid fittings.' (page 10).

An automatic pediatric fitting of SoundRecover, based on data collected from Glista et. al's study, has been developed and implemented in all Junior Modes in iPFG 2.0 (and above).

Is SoundRecover beneficial for children of all ages?

Yes. SoundRecover 'on' is the default for all three Junior Modes, for those hearing instruments that support SoundRecover. As with many features, it is difficult to test SoundRecover on very young children due to a lack of test methods. However, the aim of SoundRecover is to provide access to important high frequency sounds for speech development, vital for infants. The Phonak Pediatric Advisory Board suggests using SoundRecover for infants as well as older children, with the usual monitoring and follow-up.

"We were pleased to see interest in the development of hearing aids that have the capability to provide high frequency audibility for children. We are fitting it on children of all ages now and our experiences have generally been positive."

Dr Patricia Roush, Department of Otolaryngology,
University of North Carolina at Chaper Hill, USA

"I have no reservations about using SoundRecover in newborns and children under one year of age...With SoundRecover we expand the audible range and provide more information. I consider it problematic to reduce information for very young children, e.g. with a noise reduction algorithm. However, I have no problem with providing more information and we are ultimately able to do that with SoundRecover."

Andrea Bohnert, MTA-F Senior Pediatric Audiologist,
University Mainz, Germany

Is SoundRecover beneficial for all levels of hearing loss?

There is now research evidence showing the benefits of SoundRecover not only for those with moderately severe-profound hearing loss, but also preliminary results show the benefits of SoundRecover for children with mild-moderate hearing losses. For example, Wolfe, Caraway, Andrew, Schafer and Nyffeler (Submitted), evaluated the benefits of SoundRecover for 16 children aged 5-13 years with mild-moderately severe sensorineural hearing losses. Results showed that none of the children objected to SoundRecover and many immediately reported that they could understand speech better. These subjective findings were also supported by the UWO plural test scores, which showed a significant increase in speech scores with SoundRecover. Wolfe et. al. concluded that, due to the benefits, SoundRecover should be considered for children with mild-moderately severe hearing loss. A similar recommendation has been made by Prof. Richard Seewald:

"At this point, there is no indication that the benefits of SoundRecover are limited to any particular configuration or degree of hearing loss. What we're trying to do, whether it be a mild, moderate or profound hearing loss, is to bring sound into the audible range of the child."

Prof. Richard Seewald, University of Western Ontario, Canada

A guide to verifying hearing instruments with SoundRecover can be found on:
www.phonak.com/pediatric_fitting

d. Default DataLogging: enabled

DataLogging is always enabled by default in the Junior Mode, similar to the Standard Mode. DataLogging is an excellent tool for pediatric hearing care professionals as it helps to interpret reports from the child or parent and increases the efficiency of the fitting process. For example, the child/parent may give unclear information or may not be able to verbalise the problem. DataLogging provides useful and objective information for individualized counseling and problem solving.

e. Default Mute: off

The mute function of the hearing instrument is off by default to avoid inadvertently turning the hearing instruments off.

f. Default: matching prescription targets

The Junior Mode aims to match prescription targets from first fit, making verification in an external test box more efficient. Thus the defaults are occlusion control 'off' (i.e. no reduction of low frequency gain), acclimatisation level 'maximum' (to allow enough gain to reach targets) and default to the pediatric version of DSL v5 (rather than the adult version).

4. Help! I'm confused

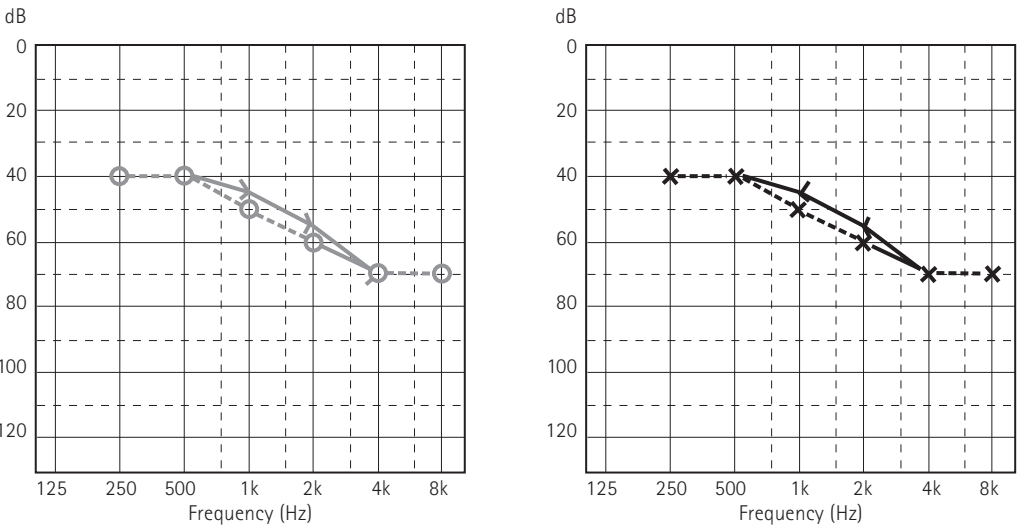
User cases to demonstrate how the Junior Mode is tailored for each age group: 0-4 years, 5-8 years, 9-18 years.

Three children, three fittings, three Junior Mode applications:

- Jessica
Age 6 months, Junior Mode 0-4
- David
Age 5 years, Junior Mode 5-8
- Simon
Age 16 years, Junior Mode 9-18

In order to highlight the differences between the three Junior Modes, Jessica, David and Simon have exactly the same hearing loss and use the same hearing system (Figure 2).

Figure 2
Audiogram of Jessica, David and Simon. All have the same hearing loss and use Nios micro hearing instruments and dynamic FM binaurally.





Jessica: 6 months

History

- Hearing loss detected after neonatal hearing screening
- Diagnosed with a mild-moderate hearing loss at 8 weeks
- Fitted with hearing instruments by 12 weeks
- Good parental acceptance of Jessica's hearing loss
- Jessica attends nursery 2 days/week

Useful Junior Reports

For Jessica's family:

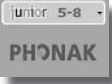
- Hearing system passport for parents
- SoundRecover information for parents
- Speech, language and listening development (0-6 months)
- Diary of observations (0-4 years)
- Care and maintenance of the hearing system for parents
- General information for parents

For Jessica's nursery teachers:

- Hearing system passport for teachers
- SoundRecover information for teachers
- Care and maintenance of the hearing system for teachers

Junior Mode Defaults

Feature	Default	Why?	Evidence Base/Comments
Start-up program	FM+M	■ Easy access to FM solutions ■ Increased audibility for language input ■ Increased incidental learning ■ Increased access to communication situations (e.g. baby stroller, story time, car, meal times, nursery, family gatherings) ■ Allows parents to feel more connected with Jessica	■ Gabbard (2005) ■ Thibodeau (2008)
Additional available programs	Calm Situations manual program (Speech in Quiet)	Can be programmed for special situations, such as periods of middle ear effusion (MEE)	MEE is very common in young children. 90% of children have MEE before school age (Rovers et al., 2004)
Manual controls (volume control and program switch)	Disabled	Avoids Jessica inadvertently changing the volume or switching between programs	If necessary, parents can have access to the program switch/volume control via a remote control
Automatic program	If the hearing instrument supports an automatic program, it is not placed in the manual toggle sequence by default.	The Phonak Pediatric Advisory Board advises not to use automatic programs with young children as there is little published research to support this at present	If required, an automatic program can easily be added. Go to [Configuration] > [Junior Settings] and click on "Enabled" for "Include automatic programs in toggle sequence".
Microphone mode	Omni-directional	■ Infants and young children need omni directional listening to maximize acoustic and linguistic input and to learn localisation ■ The Phonak Pediatric Advisory Board recommends not to use directional microphones under 5 years of age, as there is limited published research examining the effect of directional microphones on speech understanding in very young children. ■ FM systems are the solution of choice for improving the signal to noise ratio in noise	■ Akhtar (2005) ■ Directional microphones are a controversial issue for young children. Recent findings by Ching et. al. (2008) concluded that directional microphone technology does not significantly disadvantage children of any age. ■ A directional microphone can easily be added by changing the default in [Configuration] > [Junior Settings]



David: 5 years

History

- Late diagnosis
- Hearing loss diagnosed at 12 months after parental concerns prompted testing
- Hearing instruments fit within 2 weeks
- Parents keen for as much information as possible
- Both David and his parents accept the hearing loss and are open to hearing instruments
- Speech and language therapist and teacher of the deaf are involved
- Attends local mainstream school

Useful Junior Reports

For David's family:

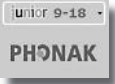
- Hearing system passport for parents
- SoundRecover information for parents
- Diary of observations (5-8 years)
- Care and maintenance of the hearing system for parents
- General information for parents

For David's school teachers:

- Hearing system passport for teachers
- SoundRecover information for teachers
- Care and maintenance of the hearing system for teachers

Junior Mode Defaults

Feature	Default	Why?	Evidence Base/Comments
Start-up program	FM+M	■ Easy access to FM solutions at school and at home ■ Allows for an increased signal-to-noise ratio for speech understanding (to hear both the teacher and the children around him) ■ Allows access to many communication situations (e.g. TV, car, meal times, cinema, children's parties, family gatherings)	■ Flexer, Wray and Ireland (1989) ■ Crandell and Smaldino (2000) ■ Gabbard (2005) ■ Thibodeau (2008)
Additional available programs	Calm Situations manual program (Speech in Quiet) Speech in Noise manual program	■ Calm Situations allows an additional program for special circumstances, such as middle ear effusion (MEE) ■ Speech in Noise manual program allows access to a directional microphone, increasing signal to noise ratio when the child is facing the speaker	■ Gravel et. al. (1999) ■ Rovers et. al. (2004) ■ Ricketts et. al. (2007) ■ Ching et. al. (2008)
Manual controls (volume control and program switch)	Enabled	Gives David ownership of his hearing loss	Empowering older children is an important goal for pediatric fittings
Automatic program	If the hearing instrument supports an automatic program, it is not placed in the manual toggle sequence by default.	The Phonak Pediatric Advisory Board advises not to use automatic programs with young children as there is little published research to support this at present.	If required, an automatic program can easily be added. Go to [Configuration] > [Junior Settings] and click on "Enabled" for "Include automatic programs in toggle sequence"
Microphone mode	Real Ear Sound (RES) in the Calm Situations manual program Fixed Directional (in the Speech in Noise manual program)	■ Results from adults have shown RES can restore front-back localisation abilities otherwise lost due to the microphone location effect of BTE instruments ■ Research with older children has found directional microphones to be effective when listening in background noise ■ It is important that children receive counseling regarding the correct use of directional microphones. There will only be significant benefit when the head is pointed at the sound source of interest and away from the noise	■ Gravel et. al. (1999) ■ Field Study News (2005). Real Ear Sound, Savia. ■ Ricketts et. al. (2007) ■ Ching et. al. (2008)



Simon: 16 years

History

- Hearing loss detected at 9 months
- Fitted with hearing instruments by 14 months
- Attends college, plans to go to university.
- Enjoys listening to his iPod, going to the cinema and going out with friends

Useful Junior Reports

For Simon:

- Hearing system passport for children
- SoundRecover information for children
- Diary of observations (9–18 years)
- Care and maintenance of the hearing system for children

For Simon's family:

- Hearing system passport for parents
- SoundRecover information for parents
- Care and maintenance of the hearing system for parents
- General information for parents

For Simon's college teachers:

- Hearing system passport for teachers
- SoundRecover information for teachers
- Care and maintenance of the hearing system for teachers

Junior Mode Defaults

Feature	Default	Why?	Evidence Base/Comments
Start-up program	FM+M	■ Easy access to FM solutions. ■ increased signal-to-noise ratio for speech perception ■ Increased access to communication situations (e.g. family gatherings, parties, sports, restaurants, shopping malls and school/college) ■ Bluetooth technology provides easy access to cell phone and iPod	■ Flexer, Wray and Ireland (1989) ■ Crandell and Smaldino (2000) ■ Gabbard (2005) ■ Thibodeau (2008)
Additional available programs	Calm Situations Speech in Noise Comfort in noise	■ Allows an additional program for special circumstances (e.g. colds) ■ A directional microphone is available to help increase signal to noise ratio (SNR)	■ Gravel et. al. (1999) ■ Ricketts et. al. (2007) ■ Ching et. al. (2008)
Manual controls (volume control and program switch)	Enabled	Gives Simon ownership of his hearing loss	Empowering older children and teenagers with regards to their hearing loss is an important goal.
Automatic program	Enabled (if the hearing instrument supports an automatic program)	To provide easy access to the correct program depending on the environment	The automatic program can easily be removed from the toggle sequence if required. Go to [Configuration] > [Junior Settings] and click on "Disabled" for "Include automatic programs in toggle sequence".
Microphone mode	Real Ear Sound (RES) in the Calm Situations manual program Fixed Directional (in the Speech in Noise manual program)	■ Results from adults have shown RES can restore front-back localisation abilities otherwise lost due to the microphone location effect of BTE instruments ■ Research with older children has found directional microphones to be effective when listening in background noise ■ It is important that children receive counselling regarding the correct use of directional microphones. There will only be significant benefit when the head is pointed at the sound source of interest and away from the noise	■ Gravel et. al. (1999) ■ Field Study News (2005). Real Ear Sound, Savia. ■ Ricketts et. al. (2007) ■ Ching et. al. (2008)

5. What if I disagree with the Junior Mode defaults? Can I change them?

Yes. All Junior defaults can be customized by the hearing care professional to match their fitting needs. Dollaghan (2007) points out that evidence based practice should encompass not only external resources, such as peer-reviewed research published in respected journals, but should also be based on the clinician's experience and expertise and the preferences of an informed parent or family member. In addition McCreery (2008), in his article on pediatric hearing aid verification, states that sometimes there is limited availability of research evidence due to the heterogeneity of hearing impaired children who use hearing instruments, and the fast pace of technological development. For this reason, all of the Junior Mode defaults are customizable so that defaults can easily be changed to match the needs of both the fitter and the child.

6. How are directional microphones fit to children within the Junior Mode?

Does the default microphone change depending on the age of the child?

Yes. Directional microphones are a controversial issue with differing expert opinions. Based on research, the default microphone mode for Junior Mode 0-4 is omni directional. The Phonak Pediatric Advisory Board recommends not using directional microphones for children under 5 years of age in order to maximise acoustic linguistic input and to aid localisation. For example, Akhtar (2005) suggests that children as young as two years of age access language through overhearing in addition to direct communication. Directional microphones, in this context, may hinder access to speech, particularly if the child is not facing the speaker. FM is the solution of choice for optimal hearing in noise for infants and young children.

However, important new research from Ching et. al. (2008) has shed new light on the topic. They

tested 27 children (hearing impaired and normal hearing; 10 months - 6 years) and found that if the child looks ahead, the signal-to-noise ratio (SNR) increases with directional microphones. There was a directional advantage of up to 3dB in different scenarios. Interestingly, they found that age does not affect the amount of time the child looks at the talker. Additionally, both normally hearing and hearing impaired children look at the talker more than 50% of the time with child-directed speech. Ching et. al. concluded that directional microphone technology does not significantly disadvantage children of any age. It is however important to counsel caregivers and professionals on making the most of the directional advantage, by facing the child when talking and by teaching the child to look at the talker.

It is clear that the use of directional microphones for infants and young children is controversial. As long as the discussion is still open, the Junior Mode default remains omni directional for Junior 0-4 based on the general consensus of the Phonak Pediatric Advisory Board. However, the default can be changed easily in the fitting software for those fitters who wish to take on board Ching et. al's findings.

In Junior Mode 5-8 and 9-18, the default microphone mode is Real Ear Sound in the Calm Situations program. Real Ear Sound restores pinna cues lost due to the microphone location effect of Behind-the-Ear (BTE) hearing instruments by utilizing advanced signal processing schemes. Results from adult studies have shown that Real Ear Sound can improve localization abilities, particularly reducing front-back confusions (Field Study News, 2005). In the Speech in Noise program the default microphone is directional as research with older children has found directional microphones to be effective when listening in background noise. For example, Gravel, Fausel, Liskow and Chobot (1999) found improved listening performance in noise with fixed directional microphones for two groups of children with hearing loss who

were 4–6 years and 7–11 years. Directional microphones resulted in better performance at more difficult signal-to-noise ratios (SNRs) when compared to the omni directional condition. Ricketts et. al. (2007) evaluated speech recognition in school age children (aged 10–17 years) using directional microphones in a variety of simulated classroom environments. Directional microphones resulted in better speech recognition in noise when the desired speaker was in front of the child. Importantly, directional benefit in settings where the speaker was on the side or behind the student, depended on the child's ability to turn their head to the sound source of interest. It is therefore important for hearing care professionals to explain to the child and their care-givers, in which situations a directional microphone is useful.

In summary, based on the available evidence, the Junior Mode recommends that children above 5 years can benefit from directional microphone technology in similar settings to adults. This is when:

- the target is relatively close and to the front
- the noise is primarily to the sides and back
- reverberation is not excessive (Lindley, Schum and Fughholt, 2009).

7. What are the Junior reports? When do I use them and why are they useful?

The purpose of the Junior reports is to empower families and children by providing individualized information about the child's hearing loss, hearing system settings as well as in depth information on a wide range of relevant topics. They also aim to facilitate good multidisciplinary team working in order to provide ongoing habilitation and support. Separate reports are available for parents, teachers and children, tailored to their different needs.

The comprehensive range of 19 Junior reports cover a wide range of topics. The Junior reports for teachers are designed to help understanding of hearing loss and hearing systems to allow

effective teaching, particularly as the majority of hearing impaired children attend mainstream schools. The Junior reports for children aim to give children ownership of their hearing loss, and are designed for the 9-18 age range. The reports developed for parents aim to provide understanding and practical tips for communicating with their hearing impaired child. To see a sample of all the Junior reports, please visit our website: www.phonak.com/pediatric_fitting

The benefits of the Junior reports include:

- pediatric hearing care professionals can easily provide individualized information to parents, caregivers and teachers
- keeps the multidisciplinary team up-to-date with the child's latest hearing test results and hearing instrument/FM settings
- child's name, date of birth, hearing instruments and serial numbers are visible on each report
- easily accessible in the Junior Mode iPFG 2.1 software and upwards) via the print icon in the top toolbar
- broad range of topics are covered

The Junior Reports:

- **Hearing System Passport for parents/teachers/children:** provides personalized information on the child's hearing loss, inserting the hearing instruments, child-specific hearing instrument/remote control instructions, FM systems and communication tips.
- **Communication tips and strategies for parents/children:** provides advice on communicating effectively and ways to help improve speech and language.
- **SoundRecover information (non-linear frequency compression) for parents/teachers/children:** written by Danielle Glista at the University of Western Ontario, this report provides a clear explanation of SoundRecover, tips on listening checks and some frequently asked questions.

- **FM System information for parents/teachers/children:** explains the benefits of FM technology, the use of FM systems at different ages and gives details of the child's specific FM system.
- **Speech, language and listening development for parents:** provides parents and caregivers with a guide to listening and language development as well as practical tips to help their child's development. The easy-to-read informational sheets provide separate guides for children aged between 0–6 months, 6–12 months, 1–2 years, 2–3 years and 3–4 years. Further references and resources are also available.
- **Diary of observations for parents/children:** provides a journal to help track progress, including any challenges experienced with the hearing instruments or FM system. It allows parents/children to get the most out of their audiology appointments and to monitor progress in a structured way.
- **Care and maintenance for parents/teachers/children:** provides an easy to read flow chart explaining how to care for the hearing system and FM system. It covers earmolds, hearing instruments and listening checks and contains a trouble shooting guide.
- **A guide to hearing loss and amplification technology for parents:** provides highly relevant general information for parents and covers topics such as hearing impairment, possible challenges/needs associated with different degrees of hearing loss, choosing the most suitable technology, FM systems and Cochlear Implants.

8. Will the Junior Mode help in my busy clinic? Qualitative results from market research.

The Junior Mode is designed to make fittings more efficient and accurate, and to improve understanding in order to provide more time for counseling. So what do clinicians who have used the Junior Mode think?

"The Junior Mode is wonderful to work with. It is important to recognize that adults and children require a different fitting approach."

Andrea Bohnert, MTA-F Senior Pediatric Audiologist, University Mainz, Germany

"The programming is fast and efficient. I really liked the separate software defaults for the different age groups and the FM+M as the start up program. I love that the software is so user friendly and really takes into consideration the needs of the pediatric audiologist"

Pediatric Hearing Care Professional, US

On the Junior reports:

"I love this feature. Really visual and helpful for parents during the fitting session"

Pediatric Hearing Care Professional, US

"Like the extra print outs for teacher and family"

Pediatric Hearing Care Professional, Germany

9. How does the Junior Mode take into account the future of pediatric fittings?

The Junior Mode was first available in October 2006 with iPFG 2.0. New features have been added with each iPFG release since then to respond to new research and clinicians' needs. The Junior Mode continues to be modular software and with each new release new features are added. We are already working on future developments to make the software even more user-friendly and valuable. Clinicians can also contact us with comments, suggestions or questions.

10. Where can I get more information?

Two key benefits of the Junior Mode are the evidence-based defaults and the Junior reports. It is important that hearing care professionals are able to find out why certain defaults have been chosen. As a result, there are several sources of further information to better understand pediatric fitting issues and the Junior Mode:

- The **Junior Mode desk top fitting guide** provides a step-by-step guide to using the Junior Mode. Available on: www.phonak.com/pediatric_fitting
- The **Junior Mode iLearn presentation** provides an easy to follow, comprehensive background to the Junior Mode as well as a live demonstration: (www.phonak.com/pediatric_fitting)
- More information is available in the **Junior Help menu** within the Junior Mode.
- **References and resources** for further reading are accessible via the Junior Mode.
- Contact your **local Phonak representative** if you have further questions.

Summary

It is vital when fitting children, to use suitable hearing instrument settings and features in order to provide access to speech and language and to give the child the best opportunities in life. The Junior Mode was developed with the help of the Phonak Pediatric Advisory Board and the wider pediatric community to provide accurate, efficient and holistic pediatric fittings. The most recent research has been collated in order to provide evidence-based, customizable software defaults specifically tailored to children. Additionally, the Junior Reports, printable via the Junior Mode, aim to empower families, children and teachers by providing individualized information about the child's hearing loss, hearing system settings as well as

in depth information on a wide range of relevant topics. These tailor-made informational materials aim to facilitate good multidisciplinary team working in order to provide ongoing habilitation and support for children. In order to take into account changing opinions and needs in the light of new research and feedback, additional features are added to the Junior Mode with each new software release. We are already working on the next releases in order to further maximise the outcomes for hearing impaired children.

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