

# A Review of Desirable Features of Children's Hearing Aids

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Questionnaires were sent to 33 manufacturers to determine which of their hearing aids could be used with an FM system via direct-input or a neckloop arrangement. For each of these hearing aids, specific information was requested regarding options for receiving the FM signal, output limiting, microphone type, and warranty period. Of the 65 hearing aids included in the survey, more than two-thirds had 5 or fewer of the 10 desirable features suggested by the authors. Because such information frequently does not appear on hearing aid specification sheets, the results of the authors' survey may be used as a guide in selecting hearing aids for hearing-impaired children.

Most hearing-impaired children will use some type of group amplification system during the course of their educational training. With the increased popularity of the personal FM system, it is very likely that an FM arrangement will include a child's personal hearing aid coupled via direct input or a neckloop. However, Hawkins and Van Tasell (1982), Hawkins (1984), Hawkins and Schum (1985), and Thibodeau (in press) have indicated that not all hearing aids are equally well-suited for these arrangements. In many cases the electroacoustic characteristics of a hearing aid will change when it is coupled to an FM system. In addition, some hearing aids are limited in their signal options when coupled to FM systems. For example, they may be capable of receiving only the FM and the environmental signals combined and not have the option to receive the FM-only signal. Because information regarding signal options and compatibility with FM systems is often not included in manufacturers' specifications, there is a need for a comprehensive summary of the features of FM-compatible hearing aids.

Hawkins (1984) measured speech recognition in noise by mildly-to-moderately hearing-impaired children using a variety of FM arrangements. Based on his findings, the following desirable features of hearing aids for children are proposed:

1. *A hearing aid should be capable of functioning in both a direct-input and a neckloop arrangement.* Hawkins found that either arrangement, compared to the personal hearing aid alone, was equivalent to approximately a 15-dB improvement in signal-to-noise ratio (S/N) and as much as a 32% improvement in speech recognition. Having both options

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(direct-input and neckloop) would provide maximum flexibility to accommodate whatever amplification arrangements may be encountered throughout the school years.

2. *A hearing aid should be capable of receiving an FM signal alone or in combination with environmental signals in both the direct-input and the neckloop arrangement.* Receiving the signal via FM-only resulted in approximately a 17-dB increase in S/N compared to receiving the signal via FM + environmental microphone for Hawkins' subjects. At a +6 dB S/N, there was a 20% increase in speech recognition when using FM-only compared to FM + environmental microphone. However, there may be times, such as class discussions in relatively quiet rooms, when the FM + environmental microphone is needed so that the child can hear the teacher as well as classmates.

3. *A hearing aid should have a directional microphone.* When listening via FM + environmental microphone, Hawkins' subjects tolerated approximately 5 dB more noise when the hearing aids had directional microphones.

Based on our clinical experience, the following additional desirable features for children's hearing aids are proposed:

4. *A hearing aid should have compression.* Compression has been recommended when the dynamic range of a listener – that is, the difference between uncomfortable loudness levels and threshold levels – is less than 40 dB (Hawkins, 1980; Skinner, 1988). However, dynamic range is difficult to determine in young children with limited attention span or language skills which limit comprehension of the concept of uncomfortable loudness. Furthermore, predictions of dynamic range based on data from adults are complicated by the fact that the smaller ear canals of young children result in higher sound pressure levels than for adults (Jirsa & Norris, 1978). A conservative approach would be to fit children with hearing aids which have compression capability so that, when dynamic range cannot be determined, maximum output can be limited with less undesirable distortion of the speech signal.

5. *A hearing aid should have at least a two-year warranty.* In order for children to receive maximum benefit from amplification, they should wear their hearing aids during all waking hours. Consequently, their hearing aids will be exposed to elements such as undue perspiration and playground dirt and will be at a greater risk for repair than a hearing aid worn by an adult.

6. *A hearing aid should have direct-input capability as a standard feature.* Hearing aids which are not compatible with FM systems may be fit on children by some dispensers who are not knowledgeable about special-order procedures. Furthermore, such special ordering or retrofitting for direct-input options often involves additional paperwork by the audiologist/hearing aid dealer and may result in unwanted delays in amplification experience for hearing-impaired children.

The purpose of this paper is to report the results of a survey intended to identify hearing aids capable of functioning in direct-input and neckloop arrangements, and to provide a reference for clinicians to use in selecting hearing aids for children. The options associated with the six desirable features listed above led to the 10 optimal characteristics shown in Table 1, which were assessed for each aid.

## METHOD

A questionnaire was sent to the 15 manufacturers listed in the Buyer's Guide to Assistive Devices (1987) as providers of direct-input systems and to the 18 other manufacturers listed in the 1987 Directories of hearing health care in *The Hearing Journal* or *Hearing*

**Table 1**  
Desirable Features of Behind-the-Ear Hearing Aids for Children

<ol style="list-style-type: none"> <li>1. Capable of receiving the FM-only signal in the direct-input mode.</li> <li>2. Capable of receiving the FM + environmental signal in the direct-input mode.</li> <li>3. Capable of two signal options: the FM-only signal or the FM + environmental signal in the direct-input mode.</li> <li>4. Capable of receiving the FM-only signal in the neckloop mode.</li> <li>5. Capable of receiving the FM + environmental signal in the neckloop mode.</li> <li>6. Capable of two signal options: the FM-only signal or the FM + environmental signal in the neckloop mode.</li> <li>7. Directional microphone.</li> <li>8. Compression.</li> <li>9. Direct-input capability standard.</li> <li>10. Two-year warranty.</li> </ol>
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*Instruments* as producing hearing aids compatible with auditory training systems. The questionnaire was a checklist of features, similar in format to Table 1, with additional questions regarding cost of boots and cords. Information was also taken from the manufacturers' specifications. Of the 17 manufacturers that replied (52% response rate), 12 reported having direct-input hearing aids. The information was verified by phone conversation and through written confirmation from a representative of each manufacturer.

### RESULTS

From the 12 manufacturers, 65 behind-the-ear hearing aids were identified that could be used with direct-input and neckloop arrangements. This is approximately 32% of the total number of behind-the-ear hearing aids available from these manufacturers. The hearing aids and their respective features are provided in Table 2 listed according to high-frequency-average full-on-gain value within manufacturer. Also provided for each hearing aid is telecoil sensitivity. Thus, the list may be used to preselect the hearing aids that have the appropriate gain and the greatest number of desirable features for hearing-impaired children.

The signal options available in each arrangement were difficult to assess because this information was not included in the specifications, and in most cases the manufacturers' representatives needed to consult with their engineers to provide the information. In the direct-input arrangement, 57% of the hearing aids were capable of receiving the FM-only signal while 79% were capable of receiving the FM + environmental signal. In some aids, the FM-only option in the direct-input mode is obtained by setting the aid to the telecoil position such that amplification of any stray electromagnetic energy can occur (e.g., Audiotone A61). Only 35% were capable of both signal options with switch settings that an elementary-age child could accomplish. In contrast, in the neckloop arrangement, all of the aids were capable of receiving the FM-only signal and one-fourth (25%) were capable of both FM-only and FM + environmental microphone options. Although in some cases an aid could be specially ordered to receive a particular signal option, such as the FM-only signal in the direct-input mode, the modification may result in the loss

**Table 2**  
Features of Direct-Input Hearing Aids from Manufacturers Responding to Survey

Model	Direct Input Signal Options			Neckloop Signal Options			Directional Mic	Compression	Direct Input Standard	2-year Warranty	T-coil Sensitivity <sup>c</sup>	HFA <sup>d</sup>	Total No. of Features
	FM Only <sup>a</sup>	FM + Env <sup>b</sup>	Both	FM Only	FM + Env	Both							
AUDIOTONE													
A61	✓	✓	✓	✓				✓	✓		120	71	6
A72	✓	✓	✓	✓				✓			88	59	5
BELTONE													
Avanti		✓		✓	✓	✓	•	✓	✓		121	71	5
Suprimo		✓		✓	✓	✓	•	✓	✓		125	68	6
DAHLBERG													
HV	✓	•	•	✓				✓	✓	✓	120	69	5
DANAVOX													
135PPAGCI		✓		✓	✓	✓		✓	•	✓	108	70	6
1251PPAGCI								✓	✓	✓	110	64	5
OTICON													
E28P	•	✓	•	✓				✓	✓		125	71	6
E38P	✓	✓	✓	✓	✓	✓		✓	✓		125	70	8
E39PL	✓	✓	✓	✓	✓	✓		✓	✓		123	66	8
E27P	•	✓	•	✓	•	•	✓	✓	✓		120	65	5
E25P	•	✓	•	✓	•	•		✓	•		120	62	4
E30P	•	✓	•	✓	•	•			•		115	61	2
E31V	•	✓	•	✓	•	•	✓		•		111	54	3

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Table 2 Continued

Model	Direct Input Signal Options			Neckloop Signal Options			Directional Mic	Compression	Direct Input Standard	2-year Warranty	T-coil Sensitivity *	HFA FOG *	Total No. of Features
	FM Only *	FM + Env *	Both	FM Only	FM + Env	Both							
E30V	•	✓	•	✓	•	•			•		111	52	2
E37F	✓	•	•	✓	•	•	✓	✓	✓		100	49	5
E35F	✓	•	•	✓	•	•		✓	✓		100	47	4
PHILLIPS													
S45G		✓		✓					✓		123	73	3
S45O		✓		✓				✓	✓		123	63	4
S45I		✓		✓				✓	✓		123	63	4
PHONICEAR *													
845PPC	✓	+	+	✓	•				✓		126	70	3
600PPCL	✓	+	+	✓	•				✓		117	68	3
600PPC	✓	+	+	✓	•				✓		119	67	3
845PPCD	✓	+	+	✓	•		✓		✓		127	66	4
860PPCL	•	✓	•	✓	✓	✓			✓		114	66	5
602PPCS	✓	+	+	✓	•				✓		112	65	3
860PPC	•	✓	•	✓	✓	✓			✓		115	64	5
600PPCH	✓	+	+	✓	•				✓		107	63	3
805SCD2	✓	+	+	✓	•		✓	✓	✓		100	52	5
860C	•	✓	•	✓	✓	✓			✓		102	52	5
600CD	✓	+	+	✓	•		✓		✓		98	51	4
805CD2	✓	+	+	✓	•		✓	✓	✓		100	50	5
600CHD	✓	+	+	✓	•		✓	✓	✓		89	46	4

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Table 2 Continued

Model	Direct Input Signal Options			Neckloop Signal Options			Directional Mic	Compression	Direct Input Standard	2-year Warranty	T-coil Sensitivity <sup>c</sup>	HFA <sup>d</sup>	Total No. of Features
	EM Only <sup>a</sup>	EM + Env <sup>b</sup>	Both	EM Only	EM + Env	Both							
602CS	Y	+	+	Y	•				Y		92	45	3
811CST		Y	•	Y	•			Y	Y		89	43	4
REXTON													
Selectra PP6		Y		Y	Y	Y		Y	Y	Y	120	71	7
Selectra PP4		Y		Y	Y	Y		Y	Y	Y	115	63	7
Selecta PP6DM		Y		Y	Y	Y	Y	Y	Y	Y	115	63	8
Mini Primo PLUS OGC		Y		Y				Y	Y	Y	98	55	5
Mini Primo PLUS IGC		Y		Y				Y	Y	Y	98	55	5
Mini Primo PLUS IHC		Y		Y				Y	Y	Y	92	48	5
Mini Primo PLUS OHC		Y		Y				Y	Y	Y	92	48	5
TELEX													
372LAI	Y	Y	Y	Y					Y	•	120	72	5
363CAI	Y	Y	Y	Y				Y	Y	•	117	63	6
353CAI	Y	Y	Y	Y				Y	Y	•	107	53	6
UNITRON													
EIP	Y	Y	Y	Y	•					Y	120	69	5
EIPL	Y	Y	Y	Y	•					Y	120	69	5
UE12PP	Y	Y	Y	Y	•					Y	120	69	5
UE12PPL	Y	Y	Y	Y	•					Y	120	69	5
UE10	Y	Y	Y	Y	•			Y		Y	117	62	6
UM60PP	Y	Y	Y	Y	•					Y	110	60	5

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Table 2 Continued

Model	Direct Input Signal Options			Neckloop Signal Options			Directional Mic	Compression	Direct Input Standard	2-year Warranty	T-coil Sensitivity <sup>e</sup>	HFA FOG <sup>d</sup>	Total No. of Features
	FM Only <sup>a</sup>	FM + Env <sup>b</sup>	Both	FM Only	FM + Env	Both							
UE7	✓	✓	✓	✓	•					✓	105	54	5
UE10H	✓	✓	✓	✓	•					✓	105	52	6
UE7D	✓	✓	✓	✓	•		✓			✓	105	51	6
UM60AGC	✓	✓	✓	✓				✓		✓	100	50	6
UM60	✓	✓	✓	✓						✓	102	50	5
UE8D	✓	✓	✓	✓			✓			✓	104	47	7
UE8	✓	✓	✓	✓						✓	105	47	6
UM60H	✓	✓	✓	✓						✓	97	44	6
UM60D	✓	✓	✓	✓						✓	97	42	7
UE4H	✓	✓	✓	✓						✓	86	40	5
WIDEX													
ES2T		✓		✓						•	109	61	5
ES6T		✓		✓						•	101	53	5
ES1T		✓		✓						•	100	49	5
ES8T		✓		✓						•	93	44	5
Total 65	37	51	23	65	16	16	12	38	40	26			

Note. The signal options were credited as present if an elementary-age child could manipulate the necessary switches. If the signal option required modification of a control by the teacher/audiologist (e.g., Phonic Ear aids), this was noted in the table with a "+" rather than a "✓." Signal options that were available by special order were noted with a "•." "Can receive FM-transmitted signal as sole input." "Can receive FM-transmitted signal combined with input from environmental microphone." "Sensitivity of telecoil in decibels." "High frequency average full on gain in decibels." "Phonic Ear aids now distributed by Phonak."

of another option, such as FM + environmental microphone in the neckloop mode (e.g., Phonic Ear 860 PPC).

Very few of the hearing aids had directional microphones (19%). Just over half of the hearing aids had compression (59%) or came with direct-input as a standard feature (62%). The two-year warranty was available for 40% of the hearing aids. Regarding cost of direct-input arrangements, respondents indicated the wholesale cost ranged from \$11 to \$60 for the boot and from \$5 to \$20 for the cord.

In order to compare the hearing aids according to the desirable features, each aid was assigned a point for each of the 10 features listed in Table 1. The points were summed for each aid. None of the 65 hearing aids had all of the desirable features. While only 7 of the hearing aids had 7 or more of the characteristics, more than two-thirds ( $n = 46$ ) had 5 or fewer. Regarding signal options, only two aids allowed receipt of FM-only and FM + environmental signals in both the direct-input and neckloop modes without any special modifications (Opticon E38P and E39PL).

### CONCLUSIONS

Based on the results of this survey of manufacturers who provide hearing aids with direct-input/telecoil capability, there are very few BTE hearing aids on the market that include the features identified by Hawkins (1984) and the authors as desirable for hearing-impaired children. Audiologists/hearing aid dealers must carefully consider a hearing aid's features, such as options for selecting signal source, compression, directional microphone, and warranty when conducting hearing aid evaluations with children. It is recommended that they stock only those hearing aids that have these desirable features. They should be alert to special ordering requirements for certain options, and limitations associated with modifications that might add one option but remove another. It is also strongly suggested that manufacturers include more information regarding signal options on the specification sheets for each hearing aid with direct-input/telecoil capability.

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