Quality of Life for Children With Cochlear Implants: Perceived Benefits and Problems and the Perception of Single Words and Emotional Sounds

Efrat A. Schorr
Froma P. Roth
Nathan A. Fox
University of Maryland, College Park

Purpose: This study examined children's self-reported quality of life with a cochlear implant as related to children's actual perceptions of speech and the emotional information conveyed by sound. Effects of age at amplification with hearing aids and fitting of cochlear implants on perceived quality of life were also investigated.
Method: A self-reported quality of life questionnaire and assessments of speech perception (single words) and emotion identification were administered to a sample of 37 children with cochlear implants who were congenitally deaf, who were 5–14 years of age, and who all used spoken language.
Results: The children reported significant improvement in quality of life because of their cochlear implants, and they also reported low levels of concern about typical problems associated with wearing an implant. The children's perceived quality of life did not significantly predict speech perception performance at the single word level. In contrast, increased quality of life predicted better performance on the emotion identification task. Age at first use of amplification predicted perceived quality of life.
Conclusions: The findings regarding age reinforce the importance of early detection and intervention for children's positive quality of life with cochlear implants later in childhood.

KEY WORDS: quality of life, children, cochlear implants, speech perception, emotion understanding

The literature on children with cochlear implants has demonstrated significant outcomes in many areas. In particular, dramatic progress has been noted in the perception of speech by children with cochlear implants, which has surpassed that of children with comparable hearing loss who used hearing aids (Geers & Moog, 1994; Miyamoto, Svirsky, & Robbins, 1997; Tomblin, Spencer, Flock, Tyler, & Gantz, 1999). Furthermore, many children who received cochlear implants at a young age have developed speech perception skills that allowed them to develop fluent spoken language at a rate resembling that of children with normal hearing (Kirk et al., 2002; Svirsky, Chute, Green, Bollard, & Miyamoto, 2000; Svirsky, Teoh, & Neuberger, 2004). The literature, however, has revealed significant variability in speech perception skills among children with cochlear implants (Geers, Brenner, & Davidson, 2003; Pisoni, Cleary, Geers, & Tobey, 1999).

In light of the general consensus suggesting these devices' effectiveness, researchers have begun investigating the broader effects of cochlear implant use on children's social and emotional development. Such socioemotional outcomes are central to parents' and professionals' support of these children's optimal development. One important type of outcome for children with cochlear implants, as with any individual having a chronic impairment or requiring use of a medical device or surgical procedure, is the measurement of *quality of life* (Haensel, Engelke, Ottenjann, & Westhofen, 2005). In the health literature, quality of life refers to the individual's ability to enjoy normal life activities, including the concepts of functional capacity and well-being (Guyatt, Feeney, & Patrick, 1993). Assessments of quality of life for children have been instrumental in focusing attention on patient health and well-being (Varni, Limbers, & Burwinkle, 2007).

Two general areas of interest characterize the research literature on quality of life for children with cochlear implants. First, quality of life has been examined vis-à-vis the cost utility of the implant device and procedure, evaluating whether the audiological or language benefits justify the financial costs involved (Cheng et al., 2000; O'Neill, O'Donoghue, Archbold, & Normand, 2000). Second, researchers have studied individual subjective attitudes toward relative improvements in various aspects of the pediatric patient's life because of the cochlear implant, most often from the parents' perspective (Nicholas & Geers, 2003; O'Neill, Lutman, Archbold, Gregory, & Nikolopoulos, 2004; Sach & Whynes, 2005; Stacey, Fortnum, Barton, & Summerfield, 2006).

Recently, several researchers have reported on the implant's implications for quality of life among specific pediatric populations, such as those affected by Usher syndrome (Damen, Pennings, Snik, & Mylanus, 2006) or autism spectrum disorder (Donaldson, Heavner, & Zwolan, 2004). Damen et al. (2006) reported that implanted children with Usher syndrome Type I showed improved auditory and social functioning as compared with children with Usher syndrome who did not receive cochlear implants. Donaldson et al. (2004) examined speech and language and speech perception assessments as well as a parent survey targeting behavior and communication outcomes to compare pre- and postimplant performance of 7 children with autism spectrum disorder. After cochlear implantation—in addition to improvements in speech, language, and speech perception—children with autism also made gains in communication, behavior, and family interactions when compared with their preimplant performance.

Relatively few studies have directly observed or questioned children with cochlear implants about the quality of their lives. Chmiel, Sutton, and Jenkins (2000) developed a 5-point scale to assess the quality of life of children with cochlear implants via direct questioning about the implant's relative benefits and problems. The 11 children in their study reported significant improvements in their quality of life and minimal negative effects because of the cochlear implant. In addition, comparison with parents' ratings on the scale revealed that children and parents gave very similar responses. Haensel et al. (2005) also examined the quality of life of 16 children with prelingual deafness who had 10–13 years of implant experience, using a questionnaire format. They found that most children had few complications from surgery and would recommend a cochlear implant to others.

To date, research has not examined the relationship between children's quality of life with a cochlear implant and other important outcomes, such as speech perception and emotional understanding. Perhaps an increased ability to hear and understand what is going on in one's surroundings, both in terms of linguistic information conveyed by speech and in terms of the emotional valence associated with communicational utterances, may predict higher evaluations of life quality among children with cochlear implants. Children who receive sufficient auditory input from their cochlear implants should not only be able to perceive speech more accurately (Geers et al., 2003) but also should be able to receive emotional information conveyed through sound, independent of speech. These outcomes are especially important in light of the research of Dunn and her colleagues (Cutting & Dunn, 1999; Dunn, Bretherton, & Munn, 1987; Dunn, Brown, & Beardsall, 1991; Dunn, Brown, & Maguire, 1995), which has revealed the importance of both language skill and emotional understanding as significant factors in social development later on in childhood.

The perception of emotion in the vocal expressions of others is considered vital to the accurate understanding of emotional messages (Banse & Scherer, 1996; Frick, 1985; Scherer, 1986). From the youngest age, infants' interpretation of the emotional information conveyed in their caregivers' infant-directed speech facilitates language and emotional development (Papousek, Bornstein, Nuzzo, Papousek, & Symmes, 1990; Walker-Andrews, 1997). Such vocalized expressions of emotion are conveyed in infant-directed speech via linguistic adaptations, such as speaking in simpler language, as well as via nonlinguistic aspects of vocalizations, including prosody, cadence, and intensity (Russell, Bachorowski, & Fernandez Dols, 2003).

Thus, perhaps children for whom cochlear implants provide an opportunity for improved speech perception and vocal emotion recognition would report positive quality of life with their cochlear implant. These two aspects, speech perception and vocal emotion recognition, might be specifically affected by cochlear implant use because ideally the implant provides dramatically increased auditory information to the child. At present, there is insufficient knowledge about the perceptual abilities of young children with cochlear implants to recognize either linguistic or nonlinguistic auditory signals of emotion (Hosie, Russell, Gray, Scott, & Hunter, 1998). The present study aimed to narrow this gap in the literature by assessing speech perception and emotional understanding among children with cochlear implants and investigating how these objective abilities predicted the children's subjective quality of life.

In addition, research has shown that some of the variability in speech and language skills may have its roots in age differences at the time of onset of auditory input with a cochlear implant. Early detection of deafness and early intervention significantly influence the development of spoken language later in childhood (Kennedy et al., 2006; Yoshinaga-Itano, Sedey, Coulter, & Mehl, 1998). Previous research has shown that children with congenital deafness who receive cochlear implants at younger ages demonstrate better cognitive (Sharma, Dorman, & Spahr, 2003), language (Nicholas & Geers, 2006; Tomblin, Barker, Spencer, Zhang, & Gantz, 2005), and speech perception (Nikolopoulos, Gibbin, & Dyar, 2004; Schorr, Fox, vanWassenhove, & Knudsen, 2005; Svirsky et al., 2004) outcomes relative to children who receive cochlear implants at older ages.

Whereas there is little research on the effects of age at implantation on social or emotional outcomes, Schorr (2006) described the feelings of loneliness of school-age children (5–14 years) with cochlear implants. She found that early cochlear implantation was associated with low levels of loneliness during middle and late childhood. Perhaps the children's subjective evaluations of their quality of life with the cochlear implant are related to the age at cochlear implantation in a similar manner. The present study sought to explore this possibility.

The first aim of this descriptive study was to examine children's subjective perceptions of their quality of life with their cochlear implants as measured by their reports on the implant's benefits and problems. The second aim was to investigate how these children's subjective quality of life perceptions may be predicted by their auditory functioning as measured by performance on speech perception and vocal emotion identification tasks. The third aim was to examine whether early auditory experience, specifically the timing of onset of auditory input with hearing aids and later on with cochlear implants, would predict children's perceived quality of life with their cochlear implants.

Four main research questions were posed in this study:

1. To what extent do children perceive positive quality of life with their cochlear implant?
2. Does perceived quality of life with a cochlear implant predict speech perception performance?
3. Does perceived quality of life with a cochlear implant predict vocal emotion identification performance?
4. Does the age at which children first received hearing aids or their cochlear implant predict the extent to which they experience their quality of life with a cochlear implant?

Method

Participants

The present sample of 37 children, 16 boys and 21 girls who were 5–14 years of age (M = 9 years), all met the following criteria: (a) were deaf from birth, (b) demonstrated no additional significant disability (such as blindness or autism), (c) used spoken English as their native language, (d) used spoken English as their primary mode of communication at the time of testing, (e) had nonverbal IQ scores in the average or above-average range (a minimum score of 85 on Matrices subtest of the Kaufman Brief Intelligence Test; Kaufman & Kaufman, 1990), (f) had a minimum of 1 year of cochlear implant experience, and (g) had a minimum general language proficiency level of 5 years (i.e., met the age cutoff on both the Peabody Picture Vocabulary Test–III [Dunn & Dunn, 1997] and the age-appropriate Grammatic Understanding subtest of the Test of Language Development–Primary, Third Edition [Newcomer & Hammill, 1997], Test of Language Development–Intermediate, Third Edition [Hammill & Newcomer, 1997], or Test of Adolescent and Adult Language–Third Edition [Hammill, Brown, Larsen, & Wiederholt, 1994]). Details of the 37 children are presented in Table 1.

The age at which the children received their cochlear implant ranged from 0;16 to 8;3 ([years;months]; M = 3;2). Duration of use for the cochlear implant ranged from 0;19 to 10;6 (M = 5;9). The children were from the mid-Atlantic United States. With respect to the ethnicity of the participants, a majority of children were White (n = 32), and the remainder were African American (n = 1), Asian (n = 3), and Latin American (n = 1).

Assessments

Quality of life. The children's quality of life questionnaire (Chmiel et al., 2000) assessed particular aspects of self-reported quality of life affected by cochlear implant use. The version for younger children, administered here to participants who were 5–8 years of age, consisted of 7 benefit items (e.g., "The cochlear implant helps you understand what people are saying"; "The cochlear implant helps you make new friends") and 6 problem items (e.g., "It's big and sometimes hard to wear"; "You are embarrassed by how it looks") to be rated on a 5-point Likert scale ranging from 1 (*no benefit/no problem*) to 5 (*great benefit/great problem*). The version for older children, administered here to children who were 9–14 years of age, consisted of 15 benefit items and 7 problem items to be rated on the same 5-point scale. The items that appeared only in the older children's version were excluded from the current analysis so that the responses of both groups to the same items could be analyzed together.

Table 1. Participants with cochlear implants (*n* = 37): Demographic data, language level, and scores on study variables.

	Demographic data					Language proficiency		Speech perception		Emotion identification			
ID	Age	Age at implant	Implant duration	Gender	Etiology	PPVT	Grammar	LNT	MLNT	Positive	Neutral	Negative	Total sounds
1	5;4	1;9	3;7	M	Unknown	120	14	84	83	50	67	42	53
2	5;8	1;8	4;0	M	Unknown	107	9	68	75	58	67	25	50
3	5;10	1;3	4;7	F	Genetic	104	12	68	54	67	83	75	75
4	6;3	1;4	4;11	M	CMV	115	13	84	86	83	25	75	61
5	6;5	1;6	4;11	F	Unknown	80	8	60	71	64	92	33	63
6	6;6	1;5	5;1	F	Unknown	80	5	50	75	100	33	83	72
7	6;7	1;4	5;3	F	Unknown	92	9	54	67	92	67	17	58
8	6;10	1;6	5;4	F	Unknown	97	10	68	75	100	100	33	78
9	7;0	3;2	3;10	M	Unknown	116	10	80	92	100	83	50	78
10	7;0	1;11	5;1	M	Unknown	86	6	80	88	58	58	67	61
11	7;4	2;9	4;7	M	Unknown	70	3	74	67	50	50	33	44
12	7;4	2;0	5;4	F	Unknown	85	10	58	58	83	50	67	67
13	7;5	2;0	5;5	M	Unknown	97	8	74	71	50	58	83	64
14	7;8	1;11	5;9	F	Unknown	91	9	60	71	67	75	33	58
15	7;11	2;6	5;5	F	Unknown	99	9	80	96	67	75	50	64
16	8;2	1;9	6;5	F	Unknown	115	9	64	75	83	75	83	81
17	8;3	3;7	4;8	F	Unknown	76	8	70	67	42	92	67	67
18	8;5	1;4	7;1	F	Unknown	80	7	74	71	58	58	75	64
19	8;10	2;6	6;4	M	Unknown	85	8	70	75	92	67	75	78
20	8;11	5;1	3;10	M	CMV	79	8	78	88	58	83	50	64
21	8;11	7;3	1;8	F	Unknown	93	12	74	88	50	83	33	56
22	9;5	3;0	6;5	M	Genetic	98	12	62	54	67	100	58	75
23	9;8	2;6	7;2	M	Unknown	73	7	34	63	75	58	25	53
24	9;8	1;4	8;4	F	Conn.26	68	7	70	62	75	33	50	53
25	9;11	3;6	6;5	F	Unknown	82	9	88	75	25	100	100	75
26	9;11	2;4	7;7	M	Waardenburg syndrome	54	7	62	75	58	42	58	53
27	10;3	2;1	8;2	F	Unknown	81	7	70	83	83	92	100	92
28	10;4	4;6	5;10	F	Unknown	68	7	64	92	75	58	42	58
29	10;4	3;10	6;6	F	Unknown	59	7	60	79	100	75	42	72
30	10;4	2;1	8;3	M	Unknown	64	6	52	63	100	36	17	51
31	10;5	7;6	2;11	F	Hyperbilirubinemia	72	6	68	88	75	100	75	83
32	10;10	4;4	6;6	M	Unknown	69	10	58	79	100	73	58	77
33	11;3	4;10	6;5	F	Unknown	70	6	62	67	83	100	100	94
34	11;10	3;1	8;9	F	Unknown	64	5	52	46	83	82	67	77
35	13;0	8;2	4;10	F	Unknown	110	11	78	96	83	83	100	89
36	13;9	3;3	10;6	M	Unknown	84	9	58	79	75	42	8	42
37	14;11	4;2	10;9	M	Genetic	104	6	88	88	92	92	75	86
M	8;11	3;2	5;9			86.1	8.4	67.5	75.1	73.6	70.5	57.4	67.2
SD						17.4	2.4	11.9	12.4	18.9	21.4	25.4	13.4
Range	5;4–14;11	1;4–8;3	1;7–10;6			54–120	3–14	34–88	46–96	25%–100%	25%–100%	8%–100%	42%–94%

Note. Current age, age at implant, and duration of implant use are presented as years;months. ID = identification; PPVT = Peabody Picture Vocabulary Test–III; Grammar = age-appropriate Grammatic Understanding subtest of the Test of Language Development–Primary, Third Edition (TOLD-P:3), Test of Language Development–Intermediate, Third Edition (TOLD-I:3), or Test of Adolescent and Adult Language–Third Edition (TOAL-3); LNT = Lexical Neighborhood Test; MLNT = Multisyllabic Lexical Neighborhood Test; Positive, Neutral, and Negative = the valence of emotional sounds; M = male; F = female; CMV = cytomegalovirus; Conn.26 = Connexin 26 (gene causing autosomal recessive nonsyndromic hearing loss).

For younger children, 5–8 years of age, the examiner read the questionnaire items to the children. Some of the children were able to read the questions independently and completed the questionnaire in writing. The examiner remained seated nearby in case the child had difficulty with an item or had any questions. Alternatively, children responded verbally by indicating the relative helpfulness or hindrance of the cochlear implant on the 5-point scale. If needed, the examiner presented a visual aid (designed by Chmiel et al., 2000)—a picture of a set of five glasses ranging from empty to completely full—and the child could select the appropriate glass representing the relative benefit or hindrance of the cochlear implant for that item. The examiner noted cases in which the child did not seem to understand the items or the Likert-scale responses, and these cases were omitted from the present analysis ($n = 3$). The older children, 9–14 years of age, were given a written version of the questionnaire and completed it independently. Again, the examiner remained seated nearby in case the child had difficulty with an item or had any questions.

On the Quality of Life Scale, problem items were reverse coded. Then, benefit and problem items were summed, such that higher sum scores indicated either greater benefit or greater problems.

Chmiel et al. (2000) did not provide information on reliability and validity of the quality of life questionnaire in their original description of the instrument. Calculation of reliability for the present study revealed a Chronbach's alpha statistic of .857.

Speech perception. A pair of tests—comprising the Lexical Neighborhood Test (LNT) and the Multisyllabic Lexical Neighborhood Test (MLNT)—was designed by Kirk, Pisoni, and Osberger (1995) specifically for children with hearing loss who use cochlear implants, to assess their ability to recognize spoken single words of different lengths and difficulty levels. Good test–retest reliability (>.83 for lists; both easy and hard components) and interlist equivalency have been demonstrated previously on these tests (Kirk, Eisenberg, Martinez, & Hay-McCutcheon, 1999). Both the LNT and MLNT measure speech perception through assessment of open-set word recognition. The LNT contains two 50-item lists of monosyllabic words, and the MLNT consists of two 24-item lists of two- and three-syllable words. Two sets of items were designed to enable test and retest of children. We used the set of items on List 1. In each test, half of the words are considered lexically *easy,* meaning that they are common and have few phonologically similar words (e.g., juice and good in the LNT, children and animal in the MLNT). Half are considered lexically *hard* words, meaning that they occur infrequently and have many phonologically similar words (e.g., thumb and pie in the LNT, butter and lion in the MLNT).

The LNT and MLNT test word lists were presented using prerecorded speech stimuli in a standard order. The speech stimuli were presented via loud speakers in a quiet room to each participant at approximately 75 dB SPL. The children were seated 75 cm from the speaker at 0° azimuth. The percentage of correct words for the easy and hard word lists of both the LNT and MLNT were scored, and for the purpose of simplification, an average of the four subtests was calculated. Higher scores indicate better speech perception.

Vocal emotion identification. The children's ability to identify the emotional valence of nonlinguistic sounds was assessed using stimuli developed by Pollak, Holt, Wismer Fries (2004). These sounds, produced by a female actor, were recorded using a Computerized Speech Laboratory (Kay Elemetrics, Lincoln Park, NJ) and a high-quality XLR microphone with balanced input (Shure, Niles, IL). The sounds were recorded at a sampling rate of 10 kHz with 16-bit resolution. Each of the sounds contained no linguistic information but expressed affective information. For the purpose of the present study, 12 sound stimuli were selected from the original set designed by Pollak et al.: 4 negative stimuli ("uch," "oww," and two samples crying), 4 positive stimuli ("mmm," "ooohh," "woohoo," and giggle), and 4 neutral stimuli ("um," "hmm," "ahh," and "mhm"). These 12 stimuli were presented three times each, for a total of 36 trials, delivered via loudspeakers in a quiet room to each participant at approximately 75 dB SPL. The children were seated 75 cm from the speaker at 0° azimuth. Informal training was provided by the examiner who presented two sample stimuli and offered an opportunity for the child to ask questions or clarification about the desired response.

After each stimulus was presented, the participants were asked to report or imitate what sound they heard, and this response was recorded verbatim. Next, they were asked to classify the sound as either a positive, negative, or neutral sound. Responses were accepted verbally or by pointing to a positive, neutral, or negative icon. The results were scored as either correct or incorrect. The performance on the trials was summed separately for each condition (positive, negative, or neutral) and reported as percentage correct for each condition. The children with normal hearing, as a group, accurately identified the emotional valence of the positive sound stimuli 86% of the time, of the neutral sound stimuli 82% of the time, and of the negative sound stimuli 79% of the time; furthermore, they accurately identified the total identification of the stimuli 82% of the time (Schorr, 2005). These stimuli were selected, as opposed to spoken language with linguistic cues removed, to provide as broad a view as possible of the ability of children with cochlear implants to recognize the emotional valence of sounds without the confound of language proficiency.

Recruitment and Assessment Procedures

Recruitment of participants took place with the assistance of hospital-based cochlear implant centers, local educational programs for children with hearing loss, the Alexander Graham Bell Association for the Deaf and Hard of Hearing (Washington, DC), and private speech-language pathologists and audiologists throughout the mid-Atlantic United States. Several families contacted us through a Web site set up to advertise the study. Families were contacted by mail or phone and invited to participate in the study.

Each participant took part in a 1-day assessment at the Child Development Laboratory at the University of Maryland (College Park) or a different site, including a school for children with hearing loss and a private speech therapy office. Several participants were assessed at a different site to permit the participation of children who lived a significant distance from the Child Development Laboratory. Conditions in all testing locations were kept as similar as possible. Assessments were administered in two sessions, morning and afternoon, with breaks for lunch at the campus cafeteria and throughout the testing to prevent fatigue. Informed consent was obtained from the accompanying parent before testing began. The accompanying parent completed a questionnaire providing information about the child's audiological, educational, and family background. All four of the assessments (quality of life, LNT, MLNT, and emotional identification tests) were administered to each participant individually.

Results

Descriptive Findings on Quality of Life Because of Cochlear Implant Use

As a group, the children reported a high benefit rating from their cochlear implant (see Table 2). Overall, the scores were quite high, with a total mean of 26.59 out of a possible maximum of 35. The highest scores emerged for the item "it helps you hear sounds in the environment" ($M = 4.59$). The lowest scores emerged for the item "getting less mad/frustrated or upset when others do not understand you" ($M = 3.00$). Thus, substantial variance was evidenced across items; yet, even for the lowest scoring items, the cochlear implant was generally seen to provide at least moderate benefit.

The children reported a relatively low severity of problems arising from use of their cochlear implant (see Table 3). The mean overall problem score for children was 12.73, whereas the lowest possible score was 6. The two items that posed the least problem for the children (both with a mean score of 1.92) were "your friends make fun of you because of it" and "it's big and sometimes hard to wear." The item that posed the greatest problem for the children ($M = 2.32$) was "sometimes you don't want to wear it and your mother and father say you have to." That is, even for the most problematic item, the mean score was rated closest to *some problem* and less than *a moderate problem*.

Background/Audiological Variables and Quality of Life

As a preliminary analysis of the data, correlations between criterion variables were examined. Zero-order correlations were generated to determine the correlation of overall quality of life score with the following child background variables: gender, socioeconomic status, nonverbal IQ, language proficiency, age at time of study, age at first hearing aid amplification, age at implant, and duration of cochlear implant use. The resulting correlations are presented in Table 4. As seen in Table 4, only two significant correlations with quality of life emerged, negatively with age at first use of hearing aid and positively with duration of cochlear implant use. Thus, the child's higher overall quality of life correlated with lower age at first amplification ($r = -.36, p < .05$) and with longer

Table 2. Implant benefit scores for children.

The cochlear implant helps you:	Minimum	Maximum	*M*	*SD*
Get less mad/frustrated or upset when others do not understand you.	1	5	3.00	1.45
Use the telephone.	1	5	3.69	1.41
Say words more clearly so people can understand you.	1	5	3.78	1.38
Be part of more activities like sports, piano lessons, or dancing.	1	5	3.78	1.48
Understand what other people are saying.	1	5	3.95	1.27
Make new friends.	1	5	3.97	1.46
Hear sounds in the environment (baby crying, doorbell, horns).	1	5	4.59	0.95
Total score	13	35	26.59	6.23

Note. These items on the Quality of Life Scale were rated as follows: 1 = *no help*, 2 = *some help*, 3 = *moderate help*, 4 = *quite a bit of help*, 5 = *great help.*

Table 3. Implant problem scores for children.

Item	Minimum	Maximum	*M*	*SD*
It's big and sometimes hard to wear.	1	5	1.92	1.36
Your friends make fun of you because of it.	1	5	1.92	1.40
Embarrassed about how it looks.	1	5	2.08	1.41
You need to be extra careful wearing it so it doesn't break.	1	5	2.19	1.53
Sometimes you don't want to wear it and your mother and father say you have to.	1	5	2.30	1.51
Some sounds are too loud like a lawn mower or a baby crying.	1	5	2.32	1.62
Total score	6	27	12.73	5.39

Note. These items on the Quality of Life Scale were rated (before reverse coding) as follows: 1 = *no problem*, 2 = *some problem*, 3 = *moderate problem*, 4 = *quite a problem*, 5 = *great problem.*

duration of cochlear implant use ($r = .34, p < .05$). These two variables were, somewhat surprisingly, not significantly intercorrelated in the sample ($r = -.17$, *ns*), though the correlation was in the expected direction (earlier age at first amplification correlated with longer duration of implant use). On the basis of the above, these two variables (age at first amplification and duration of cochlear implant use) were entered into the subsequent regressions.

Speech Perception and Quality of Life

As seen in Table 4, a nonsignificant negative correlation emerged between children's speech perception ability and their subjective quality of life ($r = -.16$, *ns*). However, to eliminate the possibility of complex intercorrelations, a multiple regression analysis was conducted for the total sample (see top of Table 5), with quality of life as the dependent variable and with speech perception and the two significant audiological variables identified earlier (age at amplification and duration of implant use) as the independent variables. This model including three predictors did have predictive value for quality of life, $R^2 = .243$, $F(3, 30) = 3.21$, $p < .05$; however, the only specific variable that was significant was age at amplification.

Emotion Identification in Sounds and Quality of Life

Table 4 shows a significant positive correlation between the ability to perceive the emotional valence of nonlinguistic sounds and children's subjective quality of life ($r = .35, p < .05$). That is, children's better perception of sounds' emotional valence was associated with their reports of higher life quality. A multiple regression analysis was conducted for the total sample (see bottom of Table 5), with quality of life as the dependent variable and with emotion identification in sounds and the two significant audiological variables identified earlier (age at amplification and duration of implant use) as the independent variables. This model including three predictors had predictive value for quality of life, $R^2 = .267$, $F(3, 31) = 3.76$, $p < .05$; however, no single variable had significant predictive value.

A slightly different pattern emerged for the subgroup of older children who were 9–14 years of age. A stronger

Table 4. Correlations between total quality of life scores and background/audiological variables.

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Quality of life score	—	−.16	−.03	−.09	−.03	.22	**−.36***	−.03	**.33***	−.16	**.35***
2. Gender		—	.29	−.08	.24	.01	.09	−.05	.07	**.39***	**−.35***
3. SES			—	−.02	**.35***	.05	−.02	.14	−.10	.20	.15
4. Nonverbal IQ				—	.17	.07	−.25	.09	−.02	.14	.09
5. Language proficiency					—	**−.37***	−.20	−.16	−.32	**.48****	.125
6. Age at time of study visit						—	.17	**.69****	**.55***	−.02	.30
7. Age at amplification with hearing aids							—	.34	−.17	−.14	−.31
8. Age at implant								—	−.23	.15	.25
9. Duration of cochlear implant use									—	−.20	.12
10. Speech perception										—	.16
11. Emotion identification of sounds											—

Note. Values in bold indicate statistically significant correlation. SES = socioeconomic status.

*$p < .05$. **$p < .01$.

Table 5. Two regressions predicting quality of life scores (by speech perception and by emotion identification in sounds) for the total sample.

Variable	B	SE (B)	β	t	p
Predicting quality of life by speech perception					
Age at first amplification	−0.468	0.223	−.345	−2.104	.04
Duration of implant	0.135	0.086	.261	1.568	.13
Speech perception	−0.150	0.167	−.150	−0.901	.38
Predicting quality of life by emotion identification in sounds					
Age at first amplification	−0.337	0.224	−.246	−1.505	.14
Duration of implant	0.148	0.081	.285	1.818	.08
Emotion identification	0.178	0.129	.224	1.380	.18

correlation emerged between emotional identification of nonlinguistic sounds and quality of life ($r = .71, p < .05$). Although this n was small ($n = 16$), a multiple regression analysis was conducted for the older subgroup only (see Table 6), and the model including three predictors had predictive value for quality of life, $R^2 = .787$, $F(3, 31) = 14.75$, $p < .01$. In this case, emotion identification in sounds had strong predictive value, $t(4, 16) = 6.405, p < .01$. Therefore, this is an area that merits further study.

Discussion

The purpose of this exploratory study was to describe children's perceptions of their quality of life resulting from use of cochlear implants. We sought to examine whether the benefits and problems reported by children with cochlear implants were associated with actual auditory functioning as measured by performance in both perception of single words and in identification of vocalized emotions. Furthermore, we explored whether early auditory experience, specifically the timing of onset of auditory input with hearing aids and later on with cochlear implants, would predict children's perceived quality of life with a cochlear implant.

Improved Quality of Life With a Cochlear Implant

These reports of children with congenital deafness indicated that they resoundingly perceived significant benefits from their cochlear implant. This finding is important in and of itself because it reflects *consumer satisfaction* on the part of pediatric cochlear implant recipients. Moreover, these self-reports about the implants' benefits raised several pertinent issues from the children's perspective. Not surprisingly, the most significant reported benefit from the cochlear implant was the children's ability to hear sounds and communicate with others. They also reported that the cochlear implant was quite helpful to them in social and academic areas, such as making friends and succeeding in the classroom. They gave the lowest rating to the item that asked whether the cochlear implant affected their frustration or anger at not being understood. These self-reports suggest that the children are placing the cochlear implant within an appropriate context. They seem to appreciate its assistance in hearing and in other arenas but do not consider it a "magic wand" that can fix everything that is frustrating about living with hearing loss.

Modest Severity of Problems With a Cochlear Implant

The children reported a low level of problems arising from the use of their cochlear implant. They reported the lowest severity of problems about teasing by friends about the implant and about the implant's large size and discomfort to wear. This finding can be interpreted as presenting an overall positive view of the device's potentially negative social consequences and inconvenience.

The children reported being most affected by the problem of conflict with parents over whether and when

Table 6. Regression predicting quality of life scores for the older subgroup (9–14 years of age) by emotion identification in sounds.

Variable	B	SE (B)	β	t	p
Age at first amplification	0.132	0.061	.328	2.149	.05
Duration of implant	0.037	0.023	.215	1.615	.13
Emotion identification	0.207	0.032	.978	6.405	.00

to use the implant. This finding could indicate that the cochlear implant is not helpful to them and that they therefore prefer not to use it, as suggested by some critics of cochlear implantation (Vernon, Rose, & Pool, 1996). However, the children in the present sample reported significant improvement in hearing and communication, as well as other aspects of quality of life, as a result of their cochlear implant. An alternative possibility might be that disagreements with parents over cochlear implant use may arise as a result of typical conflicts with parents rather than representing a global judgment regarding the helpfulness of the cochlear implant. Further qualitative inquiry could provide more information on the specific situations in which such conflicts arise.

Quality of Life as Related to Speech Perception Performance

The subjective reports by children about their quality of life with a cochlear implant were not significantly associated with their objective speech perception performance at the single-word level. On the one hand, this seems surprising in light of our assumption that the children's ability to understand speech is a primary benefit of cochlear implant use and, therefore, that these two variables would be significantly related to one another. On the other hand, this result can be understood in light of the nature of the problems considered in the questionnaire. The benefits tapped in the current Quality of Life Scale addressed only two items directly linked to basic auditory perception (what people are saying, sounds in the environment), whereas the remaining items addressed a much broader scope of functioning. Perhaps the lack of significant intercorrelations here suggests that children's subjective perceptions of the benefits derived from the device extended well beyond the basic level of speech perception, and the children appreciated the implant's more global effects. Similarly, children perceived what is problematic about the implant regardless of the good speech perception they enjoy with the device.

Implant Benefits and Problems as Related to Emotion Identification

In contrast to the absence of evidence for a significant relationship between perceived benefit from the cochlear implant and speech perception ability, the current results suggest that benefits and problems associated with the cochlear implant were tied to vocal emotion perception. Specifically, we found that greater quality of life as reported by children with cochlear implants was linked with more accurate identification of emotional sounds.

We can suggest several possible interpretations of these results. First, higher perceived quality of life with the cochlear implant predicted better performance on the vocal emotion identification task. Perhaps children who perceived that they hear better are more confident in their ability to accurately hear and interpret sounds, among them sounds delivering emotional information. Likewise, children who perceived a lower quality of life were less accurate at identifying emotional sounds. The problem items do not refer to hearing difficulties but rather focus on restrictions of activities and feelings of self-consciousness toward the device. In other words, perhaps children who felt more troubled by the difficulties of using a cochlear implant demonstrated poorer understanding of emotional sounds. This finding might indicate that when children feel more hampered by their cochlear implant they have less opportunity to interact with others successfully and to gain practice in identifying emotions in sounds and in other channels. Alternatively, it is possible that children with a more pessimistic or negative outlook in general were both more troubled by the challenges of using a cochlear implant and were less accurate in interpreting the emotions of others. These initial speculations also merit considerable further exploration in future research.

Positive Perceived Quality of Life Regardless of Age at Implant

On the basis of inferences from other aspects of children's development, such as speech perception and language skills, we assumed that the age at which children received a cochlear implant would predict perceived quality of life. However, in the present sample, age at time of implant did not prove to be predictive of quality of life measures. Perhaps this stems from the very basic nature of those aspects of functioning presented in the questionnaire. It could be also that the vast improvement provided by the implant is positively experienced by recipients, regardless of how young they were at the time of implantation. In other words, perhaps children are able to enjoy the benefits provided by a cochlear implant even if they receive the implant at a later age. Alternatively, it is possible that age at first amplification and other aspects of early detection and early intervention are more significant in predicting quality of life issues than age at the time of implant.

Indeed, children's age at first amplification was an important predictor of quality of life in the current study. This emphasizes the importance of early detection of hearing loss as well as prompt intervention. It appears that the younger children are at the time of their initial use of hearing aids, the more likely they will be to perceive at a later stage that they are benefiting from their cochlear implant. This finding implies that children will perceive that they are gaining more benefit from their cochlear implant when their hearing loss was detected at a young age, when they received hearing aids early, and when they were able to focus on listening from the time they were young children. This appears to be true despite the presumably limited benefits of hearing aids for children with severe to profound hearing loss, as in the present sample. This finding can be understood in the broader context of the importance of early detection and intervention for children with hearing loss. Yoshinaga-Itano and her colleagues (Yoshinaga-Itano, 2003; Yoshinaga-Itano et al., 1998) have demonstrated the importance of early detection and intervention and have shown that detection of hearing loss and intervention during the first 6 months of life leads to the best speech and language outcomes. Future research would do well to expand on the socioemotional outcomes of implantation as linked to age at diagnosis and onset of intervention.

Limitations of the Study

The small size of the present sample limits interpretations of this study's findings. In particular, with regard to age at implantation, a larger or more homogeneous sample would facilitate measurement of this background variable's predictive ability for future benefits or problems. The small sample size of the present study raises the likelihood of Type I error because mistaken rejection of the null hypothesis is a concern in studies with small samples. On the other hand, there is justification (see, e.g., Grissom & Kim, 2005; Lipsey, 1990) for using more relaxed criteria in judging meaningful effects in studies, such as ours, in which the results are both clinically and educationally important. As well, it is possible that the sample used in the current study represents a self-selected group of children who are satisfied with the benefits provided by their cochlear implants. Perhaps children with poor performance and low satisfaction with a cochlear implant are less likely to volunteer for research projects.

An additional limitation of this study was its cross-sectional nature that evaluated the quality of life for children at only one time interval. It would be very beneficial to assess the quality of life longitudinally, following these children at several intervals over the course of development, to better elucidate the interactions between the unique experiences of children with cochlear implants and the typical developmental issues facing all children as they mature and reach adolescence.

Finally, the present study represents a first description of the relationships between children's perceptions of quality of life with a cochlear implant and their perception of auditory information in speech and emotional sounds. Also, the quality of life measure does not provide documentation of validity. Therefore, further investigation is needed.

Conclusions

The overall picture presented by the children in this study is that they enjoy significant benefits as a result of their cochlear implants. They report considerable benefits from the cochlear implant both in terms of improved ability to hear and to communicate and in areas such as social interactions and academic performance. The children experience a low to moderate level of problems with their cochlear implants, specifically from a conflict with parents over when to use the cochlear implant. Although age at implant did not predict level of benefits or problems, age at first use of amplification did predict the quality of life score for these children. This implies that the early confirmation of hearing loss and the use of hearing aids contribute to positive outcomes in quality of life for children with cochlear implants later on in childhood. This also suggests that children perceive the positive impact of cochlear implant on their quality of life even if they do not receive the cochlear implant at a very young age.

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Contact author: Efrat A. Schorr, who is now at The Dr. Maurine Kessler Auditory Verbal Education Center, A.V. Israel, Beit Turkiz 33 Pierre Koenig Street, Suite 502, Jerusalem 93469, Israel. E-mail: cistudy@yahoo.com.