The Development of the 'Telislife' Questionnaire for the Evaluation of Telephone Use in Cochlear Implant Users.

Adrien Bolzer, Michel Hoen, Bettina Montaut-Verient, Charles Hoffmann, Marine Ardoint, Ariane Laplante-Lévesque, Nicholas Guevara, Thierry Mom, Chadlia Karoui, Christophe Vincent, et al.

JSLHR

Research Article

The Development of the “Telislife” Questionnaire for the Evaluation of Telephone Use in Cochlear Implant Users

Adrien Bolzer,[a] Michel Hoen,[b] Bettina Montaut-Verient,[a] Charles Hoffmann,[a,c] Marine Ardoint,[b] Ariane Laplante-Lévesque,[b] Nicholas Guevara,[d] Thierry Mom,[e] Chadlia Karoui,[b] Christophe Vincent,[f] and Cécile Parietti-Winkler[a,c]

Purpose: For cochlear implant users, the ability to use the telephone is often seen as an important landmark during rehabilitation and an indicator of cochlear implant benefit. The goal of this study was to develop a short questionnaire exploring the ability to use the telephone in cochlear implant users, named Telislife, and test it in a group of experienced users.
Method: This prospective multicenter study was based on the completion of self-administrated questionnaires. The Telislife includes 20 items using a 5-point Likert scale for answers. Speech recognition scores were obtained with monosyllabic word lists at 70 dB HL. Quality of life was evaluated with the Nijmegen Cochlear Implant Questionnaire. This study included 55 adult patients wearing a cochlear implant for over 1 year.
Results: The Telislife questionnaire showed excellent reliability (Cronbach’s $\alpha = .91$). A significant correlation was found between Telislife scores and Nijmegen Cochlear Implant Questionnaire scores ($r = .69$, $p < .001$) and speech recognition scores ($r = .35$, $p = .007$).
Conclusion: Given significant correlations between Telislife scores and both speech recognition and quality of life and given its short form, the Telislife questionnaire appears to be a reliable tool to evaluate cochlear implant outcomes in clinical practice.
Supplemental Material: https://doi.org/10.23641/asha.13322873

Cochlear implants (CIs) are active hearing implants that revolutionized the management of severe-to-profound hearing loss and total deafness. CIs can restore the perception of the surrounding auditory world and enable speech understanding for the vast majority of patients. Patients report the impact of CIs to extend far beyond auditory perception to also improve social participation and quality of life (QoL). In children, for example, CIs enable the development of oral language and access to education, often in mainstream schools, a key dimension in personal development and social integration (Almeida et al., 2015; Warner-Czyz et al., 2015). In the elderly, CIs have a positive impact on autonomy and stimulate cognitive functioning (Mosnier et al., 2015; Sonnet et al., 2017). Given that the impact of CIs extends beyond auditory aspects, the evaluation of CI benefits must cover a broader range of abilities as well. Researchers and national health agencies increasingly use patient-reported outcome measures to reliably quantify CI benefits (O’Leary et al., 2010).

Measuring QoL

Traditionally, audiometric performance, evaluated with pure-tone audiometry and speech recognition scores, has been the primary CI outcome measure. The assessment of QoL, based on questionnaires, widens the evaluation of CI benefits. The literature describes different patient-reported outcome measures, which can be divided in two categories: generic questionnaires and disease-specific questionnaires. Generic questionnaires (e.g., Glasgow Benefit Inventory, Short Form Health Survey, Health Utilities Index, or World Health

[a]Service d’ORL et CCF, CHU Nancy, France
[b]Scientific and Clinical Research Group Cochlear Implants, Oticon Medical, Vallauris, France
[c]Laboratoire Développement, Adaptation et Handicap (DevAH-EA 3450), Faculty of Medicine and Faculty of Sciences and Sport, University of Lorraine, Vandœuvre-lès-Nancy, France
[d]IUFC GCS CHU Nice–Centre Antoine Lacassagne, France
[e]Service ORL et CCF, CHU Gabriel Montpied, Clermont-Ferrand, France
[f]Service d’Otologie et Oto-neurologie, CHRU Lille, France
Correspondence to Chadlia Karoui: chok@oticonmedical.com
Editor-in-Chief: Frederick (Erick) Gallun
Editor: Christian E. Stilp
Received May 20, 2020
Revision received September 11, 2020
Accepted September 16, 2020
https://doi.org/10.1044/2020_JSLHR-20-00273

__Disclosure:__ Ariane Laplante-Lévesque, Chadlia Karoui, Michel Hoen, and Marine Ardoint are employees of Oticon Medical. All other authors have declared that no competing interests existed at the time of publication.

Organization Quality of Life) can be used in patients regardless of health condition to assess the impact of the health condition and the effectiveness of its treatment on general QoL. When considering the evaluation of the impact of CIs, these questionnaires typically lack sensitivity as they assess communication abilities or social aspects of life but rather focus on domains that are unrelated to CIs and their impact. Therefore, these generic questionnaires usually show only moderate improvements after CI and correlations with speech recognition scores only after subset analysis (McRackan et al., 2018). To address the lack of sensitivity of generic questionnaires, disease-specific questionnaires were developed for populations with specific health conditions. For the purpose of CI, these questionnaires can again be divided in two groups, depending on their scope: hearing-specific questionnaires (e.g., Hearing Handicap Inventory, Abbreviated Profile of Hearing Aid Benefit [APHAB]) or CI-specific questionnaires (e.g., Nijmegen Cochlear Implant Questionnaire [NCIQ]). McRackan et al. (2018) recently conducted a meta-analysis of hearing- and CI-specific questionnaires identifying 13 studies eligible for their synthesis, which included papers reporting adult data obtained either with the NCIQ as CI-specific questionnaire or with various hearing-specific questionnaires such as APHAB, Hearing Handicap Inventory, or the Speech, Spatial and Qualities of Hearing Scale (Gatehouse & Noble, 2004, five different questionnaires in total). This analysis demonstrates that CIs have a large significant positive impact on QoL when comparing pre- to postimplantation scores on both types of questionnaires. However, the same meta-analysis reports a weak pooled correlation between CI-specific QoL measures and speech recognition scores (r = .22–.24, depending on the speech recognition test considered). This result highlights that speech perception, as currently evaluated by speech audiometry in clinical settings, only captures one dimension of the impact of CIs on communicative and social abilities as well as QoL. This also suggests that these two measures are complementary and that a complete evaluation of CI benefits must include both the evaluation of auditory abilities and QoL. One potential limitation in this context is that QoL questionnaires are not adapted to everyday clinical practice because of the high number of items they contain. For example, the World Health Organization Quality of Life contains 100 items, and the NCIQ contains 60 items. It is therefore important to develop new QoL assessment tools that are concise enough to be relevant in a clinical environment and that correlate with both comprehensive QoL questionnaires and with speech perception scores.

Measuring Ability to Use the Telephone

One of the benefits of cochlear implantation is, at least for most patients, the development or recovery of speech perception abilities, culminating with notable improvements in difficult communication situations such as in noisy environments or over the telephone, with compressed speech signals and without visual feedback. Around 70% of adult CI recipients with postlingual deafness use the telephone (Anderson et al., 2006; Cray et al., 2004). Telephone use is documented to increase after cochlear implantation, suggesting that ability to use the telephone could be considered as one dimension of CI benefits (Anderson et al., 2006; Cray et al., 2004). Other studies of telephone use in CI users show how communication abilities could be improved, either with videoconferencing (Mantokoudis et al., 2017) or with connection accessories (Rey et al., 2016; Wolfe et al., 2016). It has been shown that speech perception using mobile phones is better than when using landline telephones (Tan et al., 2012). These results suggest that telephone use in CI users can be considered as an important factor pertaining to their general communication abilities and representing a symptomatic dimension of CI rehabilitation, potentially broadly related to postsurgical improvements. Cray et al. (2004) noted that one of the correlates of telephone use was a good level of speech perception without speech reading. This direct link between speech perception outcomes and the ability to use a telephone could make it possible to use a measure of telephone use abilities to indirectly quantify speech perception outcomes in CI users.

We found no questionnaire dedicated to telephone ability in patients with CI, yet it seems that the telephone is a relevant area of CI outcome, with, for example, the Hearing Implant Sound Quality Index containing two items targeting telephone ability (Amann & Anderson, 2014) and the NCIQ containing one item targeting telephone ability (Hinderink et al., 2000).

In a preliminary investigation with 26 CI users, we described ability to use the telephone with four mutually exclusive categories: (a) unable to use the telephone, (b) able to use the telephone with a familiar speaker on a familiar topic, (c) able to use the telephone with a familiar speaker on an unfamiliar topic, and (d) able to use the telephone with an unfamiliar speaker on an unfamiliar topic (Rumeau et al., 2015). We reported a strong relationship between these categories and speech recognition measures. We concluded that the evaluation of the ability to use the telephone could be an effective, fast, and reliable tool to evaluate both speech recognition capacities and QoL in CI users. The goal of this study was to develop a short questionnaire, named Telislife, exploring CI users' ability to use a telephone and to test this questionnaire in a group of experienced CI users.

Materials and Method

Study Design

This prospective multicenter study is based on the completion of self-administrated questionnaires. The data collection occurred in collaboration with four university hospitals in France: Nancy, Lille, Clermont-Ferrand, and Nice. Four types of data were collected: (a) general and demographics, (b) ability to use the telephone (Telislife questionnaire), (c) QoL (NCIQ), and (d) speech audiometric data.

Consecutive patients were recruited during routine audiological, medical, psychological, or speech therapy appointments at one of the four participating University Hospitals. To be included, patients had to be adults (≥ 18 years old), implanted since at least 1 year with a unilateral or bilateral CI, be fluent in French, and follow the standard postimplantation follow-up and rehabilitation program. Speech tests were performed as part of the routine clinical follow-up of the patients, and at the end of one visit, a physician provided information about the questionnaire and obtained written informed consent from each patient. The questionnaires were completed in a pen-and-paper format in the waiting room of the hospital and sent anonymously to the local delegation for research and innovation (Délégation à la recherche clinique et à l'innovation) of the hospital. This observational, noninterventional study was conducted in agreement with the declaration of Helsinki, and the protocol was approved from the hospital's local ethics committee "Comité de Réflexion Ethique Nancéien Hospitalo-Universitaire," who approved the protocol on February 23, 2016.

General and Demographics

The following demographic data were collected: age group (18–45, 46–65, 66–85, or > 85 years), gender, hearing status (aided or unaided; type of aid, CI or hearing aid), onset of deafness (pre- or postlingual), duration of deafness (in years), etiology of deafness (11 options and an "other" free field), and CI experience (< 1, 1–2, 2–3, 3–4, or > 4 years). Then, the patients were asked about their CI system's brand and model, time of daily use, and accessories. Finally, patients were asked about their telephone habits: telephone brand(s) and model(s), amount of daily use (< 1, 1–3, 3–6, 6–9, 9–12, or > 12 hr), and modality of usage (giving/receiving calls, sending/receiving text messages or instant messages, using applications, surfing the Internet, and "other" free fields).

Ability to Use the Telephone: Development of the Telislife Questionnaire

To evaluate ability to use the telephone in CI users, we built a questionnaire of 20 items using a 5-point Likert scale for answers (see Supplemental Material S1). Items were inspired by our previous experience with measuring telephone ability (Rumeau et al., 2015), by the literature, and more specifically by two validated questionnaires, one of CI sound quality (Hearing Implant Sound Quality Index; Amann & Anderson, 2014) and one of hearing aid benefit (APHAB; Cox & Alexander, 1995). Items were generated to cover all dimensions of the construct "ability to use the telephone." Therefore, the questionnaire included several items related to speech perception, but also to voice recognition, voicemailusage, speech production, and perception of pitch cues, known to encode emotions.

The 20 items of the questionnaire cover four subdomains: (a) speech recognition in favorable situations (Items 5, 8, 11, 13, and 19; e.g., "On the phone, how difficult is it to have a conversation in a quiet environment?"), (b) speech recognition in complex situations (Items 6, 7, 9, 10, and 14; e.g., "On the phone, how difficult is it to have a conversation in a noisy environment?"), (c) voice perception (Items 1, 2, 3, 4, and 15; e.g., "On the phone, how difficult is it to recognize the voice of a family member?"), and (d) speech production (Items 16, 17, and 18; e.g., "When calling a relative/someone from your family, how difficult is it for him/her to understand you?"). Finally, Items 12 and 20 are general satisfaction items and are not included in any subdomain.

The five first authors, who all have extensive experience interacting with adult CI users in their clinical and research roles, collaboratively generated, reviewed, and revised the 20 items of the questionnaire for good face validity. Response options were placed on scales of ease ("very easy" to "not easy at all"), difficulty ("very difficult" to "not difficult at all"), and satisfaction ("very satisfied" to "not satisfied at all"), as verbal answer options are associated with less confusions than numerical response options (Krosnick & Fabrigar, 1997). For each item, patients could also choose "not applicable" (NA) as answer. Five items (Items 2, 12, 15, 18, and 20) were reverse-coded to ensure that patients remained attentive during questionnaire completion.

QoL: NCIQ

To evaluate CI-specific QoL, we used the French version of the NCIQ (Hinderink et al., 2000). The NCIQ explores QoL in CI users and is made of 60 items that are grouped in three main domains and six subdomains: (a) "physical" domain with three subdomains, "basic sound perception," "advanced sound perception," and "vocal production"; (b) "psychological" domain with the subdomain "self-esteem"; and (c) "Social" domain with two subdomains, "limitation of activities" and "social interaction." Each subdomain contains 10 items. The possible answers for every item appear in the form of a 5-point Likert-type scale varying from "never" to "always" (occurrence questions, 55 statements) or from "no" to "quite well" (ability questions, five statements), and the patient is required to answer which statement best fit their experiences.

Speech Audiometry

Speech recognition performance was evaluated once with and once without speechreading. Patients were tested with their own CI sound processor programmed with their everyday mapping parameters, processing strategy, and electrode configuration, and without hearing aid for bimodal users. Speech identification was measured with one randomly picked Lafon list, including 17 French monosyllabic words containing three phonemes. Speech identification was scored as the percentage of phonemes correctly repeated. Trained audiologists read the Lafon lists in a soundproof booth, with or without visual feedback.

Statistical Analyses

Results from the Telislife questionnaire were expressed as a score from 1 to 5 on the Likert scale; maximal score was thus 100. NA responses were treated as missing values, and all Telislife scores and subscores were calculated as percentages of answers (based on the total of non-NA answers). For the NCIQ, scores were also expressed as a percentage of expressed opinions, and a correlational analysis was run.

Descriptive statistics established the construct validity of the Telislife questionnaire. The normality of the distribution of Telislife scores was verified with a Shapiro–Wilk test. Reliability of Telislife scores was assessed with Cronbach's alpha coefficient and split-half reliability. Construct validity was assessed by comparing Telislife and NCIQ scores. We used a Pearson test for parametric data correlation between Telislife and NCIQ scores and between questionnaire and individual speech recognition scores. A p value of $< .05$ was considered statistically significant. When performing multiple tests on the same nonindependent factors, a Bonferroni correction for multiple corrections was applied by dividing the alpha value by the number of tests performed. For analyses of variance (ANOVAs), the Tukey's honestly significant difference (HSD) test was chosen for post hoc assessment of specific effects, as it includes a correction for multiple comparisons.

Results

Participants and Sample Demographics

Sixty-eight patients were initially included into the study. From these 68 participants, 13 (19.1%) were not included for further analyses: 11 (16.2%) because they had more than five out of 20 of NA answers, one (1.5%) because of a severe multihandicap (could not complete the questionnaire), and one (1.5%) because answers were obviously incoherent (oppositions between positively and negatively rated items). Further analyses are based on 55 respondents. Table 1 describes the 55 respondents.

Phone Usage Habits in CI Users

Most participants (59.6%) used smartphones, and 38.5% of participants used feature mobile phones. The majority of respondents (72.2%) used their phone for audio conversations and other use (e.g., texting, applications, access to the Internet), while 16.7% reported using their phone exclusively for audio conversations. Conversely, 27.8% of the respondents reported using a mobile phone without using the audio output (e.g., texting, applications, access to the Internet). Most respondents (74.5%) reported using their mobile phone mainly without a dedicated accessory. The primary usage reported was sending/receiving text messages (58.6%), while audio conversations were the primary use in 36.2% of users. When giving or receiving audio calls, 75.5% of patients with CI used direct audio access, either through the traditional sound output of their phone (40.8%) or using the loudspeaker option of their phone (34.7%). The majority of patients (53.5%) used their phone for less than 1 hr a day, and 27.6% used their phone for 1–3 hr a day.

Table 1. Demographic characteristics of the 55 respondents.

Characteristic		*n*	Proportion (%)
Gender	Female	29	52.7
	Male	26	47.3
Age groups	18–45 years	9	16.4
	45–65 years	25	45.4
	65–85 years	21	38.2
Implantation type	Unilateral	42	76.4
	Bilateral	13	23.6
CI brands	Oticon Medical	35	63.6
	Med-El	11	20.0
	Cochlear	7	12.7
	Unknown	2	3.6
CI experience	1–2 years	14	25.5
	2–4 years	10	18.2
	> 4 years	30	54.5
	Unknown	1	1.8
Deafness onset	Pre- or paralingual	10	18.2
	Postlingual	41	74.5
	Unknown	4	7.3

Note. CI = cochlear implant.

Telislife Questionnaire Analysis

Item analysis: The proportion of NA responses ranged from a minimum of 0% (0/55) for four items (Items 3, 5, 8, and 19) to a maximum of 16.4% (9/55) for Item 1: "On the phone, is it difficult to differentiate a female voice from a child's voice?" The overall proportion of NA responses over the 1,100 responses was 4.9%. All response options were used, the different ratios for the Likert scores being 214 (20.5%) for 1, 190 (18.2%) for 2, 208 (19.9%) for 3, 224 (21.4%) for 4, and 210 (20.1%) for 5. These scores were not significantly different from the theoretical distribution of 20% for each possible response as evaluated by a chi-square test: $\chi^2(4, N = 55) = 0.28$, $p = .99$. Moreover, the full range of answers (min = 1, max = 5) was used for 18 out of 20 items, and only two items (Items 6 and 7) were never attributed the maximal score. These two items (i.e., "On the phone, how difficult is it to have a conversation when in a noisy environment?" or "On the phone, how difficult is it to have a conversation when other people are speaking around you?") are challenging listening situations for CI users. This is also mirrored in the lowest average scores and lowest standard deviation on these two items (1.7 ± 0.9 and 1.8 ± 0.9, respectively), suggesting that most users experience these situations as difficult, and this explains the narrow range in response compared to other items.

Internal Consistency

The internal consistency (reliability) of the Telislife questionnaire was evaluated using Cronbach's alpha coefficient. For the questionnaire, globally, it was $\alpha = .91$, corresponding to excellent reliability (Saris & Gallhofer, 2014). Running a split-half reliability measure comparing odd and even items, the correlation between the two halves was $r = .87$, and the Guttman split-half reliability was .93. Looking into the four subcategories, the two subcategories evaluating speech perception showed very good reliability levels, with .90 for the subdomain speech perception "favorable situations" and .91 for the subdomain speech perception “complex situations,” when the two other subcategories showed lower reliability levels of α = .68 and .71 for voice perception and speech production, respectively.

Distribution of Total Scores and Subdomain Scores

Telislife total scores (see Figure 1A) were, on average, 60.3 ± 17.8 points out of a maximum of 100 points, ranging from 25.3 to 94.0. Total scores followed a normal distribution (Kolmogorov–Smirnov $d = 0.08$, $p > .20$ and Shapiro–Wilk $W = 0.97$, $p = .25$). The median value of 62.1% was very close to the average value of 60.3% and the skewness at −0.17 suggests a rather symmetric distribution with a slight left skew (see Figures 1A and 1B). The kurtosis value of −0.87 suggests a relatively light-tailed distribution with slightly more scores around the mean value than expected from a normal distribution.

The scores observed for the four subdomains were respectively 67.6 ± 22.0 points for the subdomain speech “favorable situations,” 43.1 ± 19.4 for the speech “complex situations subdomain,” 62.1 ± 17.8 for voice perception, and 75.8 ± 20.8 for speech production. A one-way repeated-measures ANOVA performed on the total score and four subdomains reveals a significant principal effect, $F(4, 216) = 70.01$, $p < .05$, and post hoc paired evaluations corrected for multiple comparisons (Tukey’s HSD) revealed that all scores were significantly different from another (all ps < .05), except for the subdomain voice perception, which was not significantly different from the total score ($p = .91$) and the subdomain score speech “favorable situations” ($p = .06$).

Internal consistency was further evaluated by correlating all subdomains of the Telislife questionnaire with the total score. All observed correlations were significant with corrected alpha values (see Table 2).

Construct Validity

To test the construct validity of the Telislife, total scores and subdomain scores were compared with NCIQ scores and speech audiometry scores using correlation analyses. We expected that Telislife scores would converge with NCIQ scores and speech audiometry scores.

Associations Between Telislife Scores and NCIQ Scores

A significant correlation between the total score of the Telislife questionnaire and all scores, global and subdomains, from the NCIQ was observed (see Table 3). The correlation between the two total scores was significant: $r(53) = .69$, $p < .001$ (see Figure 2). Furthermore, the Telislife “speech production” subdomain appears more selective, and the strongest relation was found with the speech production dimension of the NCIQ, $r(53) = .59$, $p < .001$, and with two other subdomains from the NCIQ, advanced speech perception, $r(53) = .47$, $p < .001$, and the physical composite score, $r = .53$, $p < .001$.

Associations Between Telislife Scores and Speech Audiometry Scores

To test the potential association between measures of QoL by the Telislife questionnaire or the NCIQ and audiometric outcomes, we computed correlation coefficients between the Telislife and NCIQ scores and scores obtained during the speech audiometry tests. Telislife score is positively correlated with speech recognition score without speechreading ($r = .33$, $p = .015$). Figure 3 presents these results.

Figure 1. (A) Histogram distribution of total Telislife scores and comparison to the theoretical normal distribution (dotted line). (B) Scatter plots of the individual scores showing the distribution of the individual total scores and scores for each Telislife subdomain. The cross represents the mean and standard error of mean.

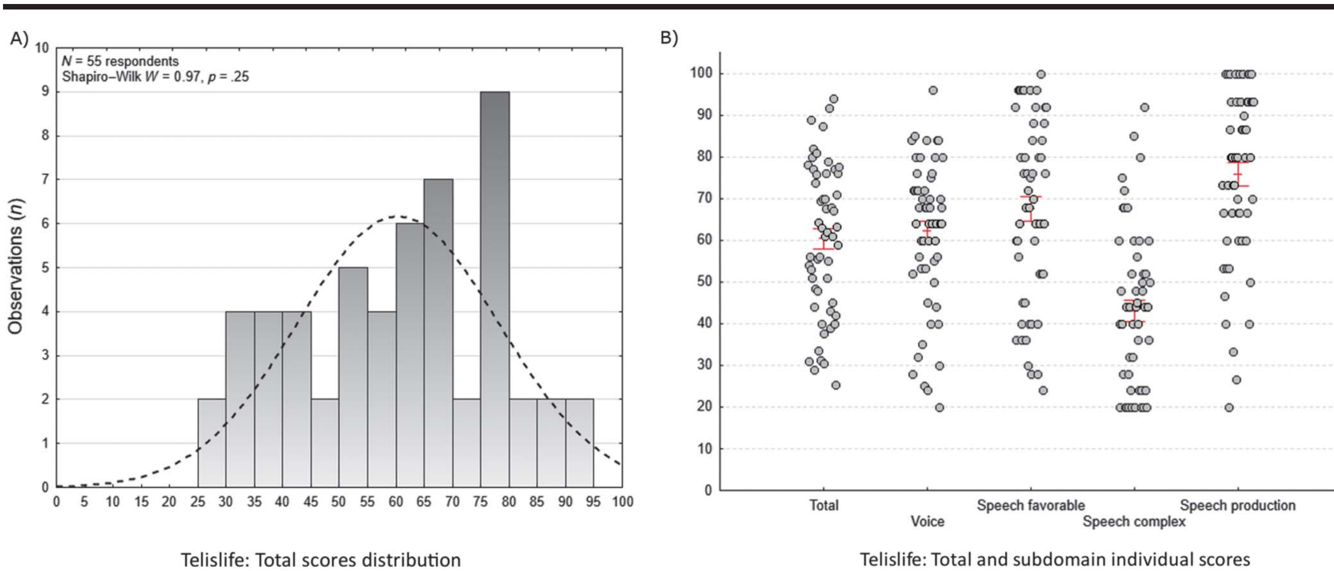


Table 2. Summary of correlations between the total score and the four subdomains of the Telislife.

Telislife scores and subdomains	Voice	Speech favorable	Speech complex	Speech production
Total score	.89	.95	.90	.63
$r(53)$ =	**$p < .0125$**	**$p < .0125$**	**$p < .0125$**	**$p < .0125$**

Note. To correct for multiple comparisons, the alpha value was corrected to $p = .0125$. Significant correlations at corrected p threshold are indicated in bold.

No significant correlation was found between Telislife and speech recognition scores with speechreading ($r = .21$, $p = .13$) as well as between the NCIQ score and speech recognition score with or without speechreading ($r = .12$, $p = .39$, and $r = .26$, $p = .059$, respectively).

Exploratory Analyses of Telislife Scores in Relationship to Demographics

To further investigate Telislife scores regarding our CI population demographics, we performed a one-way ANOVA for all Telislife scores subcategories on the patients gender ($F = 0.65$, $p = .65$), CI experience ($F = 1.09$, $p = .38$), CI brand ($F = 0.85$, $p = .6$), and phone usage time ($F = 1.39$, $p = .14$), all nonsignificant. However, the analysis was significant for both age ($F = 4.31$, $p = .02$) and deafness onset ($F = 5.42$, $p = .002$) variables. Post hoc analyses (Tukey's HSD) for these latter two variables were found to be with significant effects for the Telislife "speech production" subdomain with age category of 45–65 years being significantly higher in comparison to age category of 65–85 years (mean scores = 84.27 and 68.89, respectively, $p = .03$) and pre- or paralingual deafness onset being significantly lower compared to postlingual deafness ($F = 4.71$, $p = .035$). Similarly, the Telislife "speech recognition in favorable situations" subdomain significantly varied depending on the deafness onset subcategory with subjects with pre- or paralingual deafness presenting lower scores than the ones with postlingual deafness ($F = 8.78$, $p = .004$). Finally, no significant correlation was to be found between the continuous variable "deafness duration" with any of the Telislife subdomains scores (Telislife total score, $r = -.0894$, $p = .541$), Telislife "voice perception" subdomain ($r = .1183$, $p = .418$), Telislife "speech recognition in favorable situations" subdomain ($r = -.15$, $p = .31$), Telislife "speech recognition in complex situations" subdomain ($r = -.03$, $p = .81$), and Telislife "speech production" subdomain ($r = -.26$, $p = .08$).

Discussion

The purpose of the study was to develop and test a new clinical tool that assesses both audiometric performance and QoL in CI users. We developed the Telislife, a 20-item questionnaire evaluating the ability of CI users to use the telephone. We found a significant correlation between Telislife scores and both speech recognition scores without speechreading and scores on the 60-item NCIQ.

Telephone Use in CI Users

CI recipients from our sample use a telephone, mostly to have audio conversations (72.2%), much in line with what was reported in former studies (Anderson et al., 2006; Cray et al., 2004; Sousa et al., 2015). Most (74.5%) use audio communication over the telephone without a dedicated accessory, directly through the audio output or loudspeaker of their telephone (75.5%). It therefore makes sense to evaluate telephone use in patients with CI as they do use their telephone and use it for speech communication in most cases, even if 27.8% of the respondents in our study used their phone almost exclusively for visual applications such as surfing the Internet, texting/messaging, or using apps. These results could be influenced by sampling bias in our study: The sample of respondents was relatively aged, with 38% of the participants being over 65 years and only 16% being below 45 years. This bias was also reflected in the types of phones used, with 59.6% of respondents using smartphones and 38.5% of respondents using feature phones. The Telislife questionnaire therefore captures a relevant dimension of CI outcomes, namely, telephone usage, and can be used over a broad range of users. Undoubtedly, a whole dimension of economic cost would have to be taken account, as nowadays, the prices of mobile phones are extremely increasing, especially mobile Internet telephony considered with better intelligibility and quality (Guignard et al., 2019) in comparison to GSM mobiles—along with all associated CI communication accessories such as audio cables.

The Telislife Questionnaire

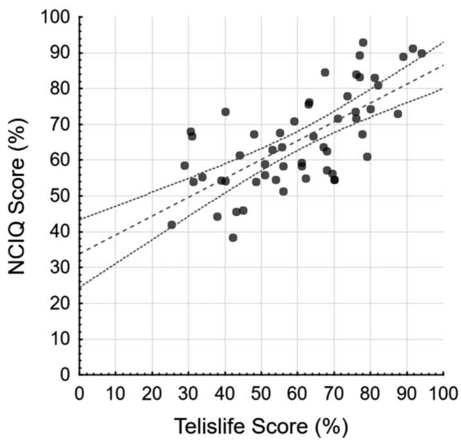
The Telislife questionnaire was first evaluated by analyzing response patterns across all participants. Responses were in general valid, with 80.9% of valid questionnaires and a global proportion of NA responses below 5%. This suggests that most respondents could understand and rate the different items and that chosen items actually matched with realistic situations that respondents understand and experience. The fact that all possible Likert ratings over the selected 5-point scales were used for almost all items (only the max score of 5 was not used for two items) also suggests that the rating scales are appropriate and do capture the variety of experiences and opinions about the depicted telephone use situations. Along the same lines, the total scores

Table 3. Correlations between the total scores and main subdomains evaluated by the Telislife questionnaire and the Nijmegen Cochlear Implant Questionnaire (NCIQ).

	NCIQ									
Telislife	**Global score**	**Basic sound perception**	**Advanced sound perception**	**Speech production**	**Self-esteem**	**Activity**	**Social interaction**	**Physical**	**Psychological**	**Social**
Total score	$r = .69$, **$p < .001$**	$r = .50$, **$p < .001$**	$r = .70$, **$p < .001$**	$r = .49$, **$p < .001$**	$r = .45$, **$p < .001$**	$r = .54$, **$p < .001$**	$r = .53$, **$p < .001$**	$r = .65$, **$p < .001$**	$r = .45$, **$p < .001$**	$r = .55$, **$p < .001$**
Voice recognition	$r = .62$, **$p < .001$**	$r = .43$, **$p < .001$**	$r = .58$, **$p < .001$**	$r = .37$, $p = .006$	$r = .41$, $p = .002$	$r = .55$, **$p < .001$**	$r = .51$, **$p < .001$**	$r = .53$, **$p < .001$**	$r = .41$, $p = .002$	$r = .55$, **$p < .001$**
Speech favorable	$r = .64$, **$p < .001$**	$r = .45$, **$p < .001$**	$r = .64$, **$p < .001$**	$r = .42$, $p = .001$	$r = .44$, **$p < .001$**	$r = .51$, **$p < .001$**	$r = .50$, **$p < .001$**	$r = .59$, **$p < .001$**	$r = .44$, **$p < .001$**	$r = .52$, **$p < .001$**
Speech complex	$r = .67$, **$p < .001$**	$r = .47$, **$p < .001$**	$r = .66$, **$p < .001$**	$r = .34$, $p = .012$	$r = .52$, **$p < .001$**	$r = .58$, **$p < .001$**	$r = .56$, **$p < .001$**	$r = .56$, **$p < .001$**	$r = .52$, **$p < .001$**	$r = .59$, **$p < .001$**
Speech production	$r = .37$, $p = .006$	$r = .29$, $p = .032$	$r = .47$, **$p < .001$**	$r = .59$, **$p < .001$**	$r = .06$, $p = .665$	$r = .09$, $p = .519$	$r = .12$, $p = .393$	$r = .53$, **$p < .001$**	$r = .06$, $p = .665$	$r = .10$, $p = .448$

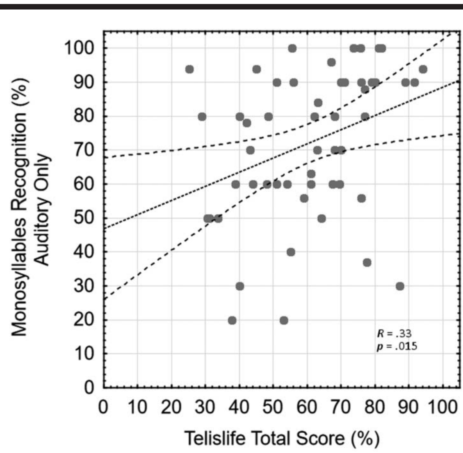
Note. To correct for multiple comparisons, the alpha value was corrected to $p = .001$. Significant correlations at corrected p threshold are indicated in bold.

Figure 2. Correlation between Telislife and Nijmegen Cochlear Implant Questionnaire (NCIQ) scores. Black lines show linear regression and 95% confidence interval.



followed a normal distribution, with an average and median values quite close to each other and not too far from the center of the distribution at 50%, showing a good variability of the total score allowing to differentiate between CI users who have both low and high ability with telephone usage. Reliability was rather high with a Cronbach's α of .91, and split-half reliability at r = .87, suggesting that the questionnaire showed a high internal consistency overall (Slattery et al., 2011). The subdomains also showed some relevance with a high reliability for the subdomains speech "favorable situations" and speech "complex situations," with the three other subdomains showing, however, lower reliability levels. All subdomains participated to the global score, with significant correlations to the global score without being equivalent to it (except for the subdomain speech "favorable situations," which was nonsignificantly different from the global score).

Figure 3. Correlation between Telislife scores and speech perception scores (Lafon monosyllabic words) obtained in the auditory-only condition, without speechreading. Dotted lines show linear regression and 95% confidence interval.



Construct Validity

Associations Between Telephone Ability and QoL

Global Telislife and NCIQ scores were highly positively correlated. The Telislife global score was significantly correlated to all subdomains of the NCIQ, with r values ranging from .48 to .70, respectively, for subdomains Self-Esteem on the one hand and Advanced Speech Perception and Speech Production of the NCIQ on the other hand. Even if it showed a weaker correlation, it is interesting to note that telephone use is associated with self-esteem. This is suggesting again that telephone use is an important ability for CI users, contributing to their QoL beyond speech recognition. This observation is important as some authors have shown that psychological aspects associated with CI rehabilitation and, in particular, positive self-esteem were an important factor for patients' satisfaction toward CIs (Kobosko et al., 2015). It is thus important that this dimension can also be, at least partially, tackled with our short questionnaire. From these observations, we can consider that the Telislife shows good construct validity and constitutes a reliable tool to assess CI outcomes.

Association Between Telephone Ability and Speech Perception

Telislife scores show a significant positive correlation with speech recognition score without speechreading but not with speech recognition with speechreading. In a previous study, we found a relationship between the ability of CI users to use the telephone and speech perception (Rumeau et al., 2015)—in particular, between CI users' ability to have a telephone discussion with an unknown person and QoL as evaluated with the NCIQ as well as speech perception without speechreading. This discrepancy between the two speech perception tests, with or without speechreading, can be explained by at least two aspects. First, speech interactions over the telephone are still mostly done in an auditory-only mode, that is, without seeing the interlocutor's face, and therefore, it seems logical that speech perception scores without speechreading better describe the telephone communication experience of CI users. Second, speech scores with speechreading tend to show ceiling effects, with some patients scoring close to 100% leading to less interindividual variability in the scores, compared with the scores without speechreading. This suggests that the Telislife has a relatively good construct validity and would capture speech recognition information better than the NCIQ in telephone-listening situations.

Clinical Implications

Our results indicate that measuring telephone ability in CI users with the Telislife is clinically relevant, as it is correlated with QoL and speech identification yet captures broader aspects of functioning. The Telislife contains 20 items and is therefore an efficient patient-reported outcomes measure of the impact of CIs. From a practical point, with the raise of awareness of training session using telephones (Borel et al., 2020), Telislife scores could be used as tool to assess subjects' progress on a long-term period. Hence, with the current direction toward telerehabilitation, the questionnaire could be a practical tool to indicate which subjects could be able to participate in telephone therapy or trainings. Finally, having clinical feedback on the ability of CI users to use the phone is crucial to improve the current CI features and their usability in CI users' daily life. Further analyses of Telislife scores regarding demographics would allow to establish more distinct profiles of patient.

Limitations and Future Research

This article presents the Telislife questionnaire and the first steps of its validation. It would have been interesting to pilot test the items with the target population, for example, using the think-aloud method (cognitive validation). We would have liked to validate the four intended subdomains and conduct a confirmatory factor analysis: This was, however, not possible given the limited sample size. This will be performed in a larger sample of respondents. Similarly, the test–retest reliability of the Telislife, documenting whether scores are stable over time, must be documented. Moreover, it would be intersting to test the subjects in phone-listening situations instead of Lafon measures in the booth because of lack of compression and limited bandwidth in the latter situation, despite sharing the common component of lacking visual cues. Besides, another set of stimuli, including context-related sentences, would have been advantegeous to include in our design as these would give more insights in comparable phone-listening situations of daily life. Finally, as age difference and deafness onset were found to be significant on Telislife subdomain scores, it could be interesting to assess the possibility to refine the understanding of how these scores vary in different subpopulations of CI users (with age, with experience, with type of solution; i.e., unilateral/bilateral/bimodal) for further research projects on wider CI user populations.

Conclusions

The current study confirmed the central role of the ability to telephone for patients with CI in their daily communication ability despite the need of further investigations. We found a significant correlation between Telislife scores and both speech recognition and QoL scores. This questionnaire is a reliable tool to evaluate CI outcomes in clinical practice.

Acknowledgments

The authors express their gratitude to the 68 patients who contributed to this study by completing the questionnaires.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee (committee "Comité de Réflexion Ethique Nancéien Hospitalo-Universitaire"), who approved the protocol on February 23, 2016, and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

References

Almeida, R. P., Matas, C. G., Couto, M. I., & Carvalho, A. C. (2015). Quality of life evaluation in children with cochlear implants. *CoDAS, 27*(1), 29–36. https://doi.org/10.1590/2317-1782/20152014129

Amann, E., & Anderson, I. (2014). Development and validation of a questionnaire for hearing implant users to self-assess their auditory abilities in everyday communication situations: The Hearing Implant Sound Quality Index (HISQUI19). *Acta Oto-Laryngologica, 134*(9), 915–923. https://doi.org/10.3109/00016489.2014.909604

Anderson, I., Baumgartner, W. D., Böheim, K., Nahler, A., Arnoldner, C., & D'Haese, P. (2006). Telephone use: What benefit do cochlear implant users receive? *International Journal of Audiology, 45*(8), 446–453. https://doi.org/10.1080/14992020600690969

Borel, S., Dupré, S., de Bergh, M., Sterkers, O., Mosnier, I., & Ferrary, E. (2020). Rehabilitation of telephone communication in cochlear-implanted adults. *European Annals of Otorhinolaryngology, Head and Neck Diseases, 137*(5), 381–386. https://doi.org/10.1016/j.anorl.2020.01.010

Cox, R. M., & Alexander, G. C. (1995). The Abbreviated Profile of Hearing Aid Benefit. *Ear and Hearing, 16*(2), 176–186. https://doi.org/10.1097/00003446-199504000-00005

Cray, J. W., Allen, R. L., Stuart, A., Hudson, S., Layman, E., & Givens, G. D. (2004). An investigation of telephone use among cochlear implant recipients. *American Journal of Audiology, 13*(2), 200–212. https://doi.org/10.1044/1059-0889(2004/025)

Gatehouse, S., & Noble, W. (2004). The Speech, Spatial and Qualities of Hearing Scale (SSQ). *International Journal of Audiology, 43*(2), 85–99. https://doi.org/10.1080/14992020400050014

Guignard, J., Senn, P., Koller, R., Caversaccio, M., Kompis, M., & Mantokoudis, G. (2019). Mobile Internet telephony improves speech intelligibility and quality for cochlear implant recipients. *Otology & Neurotology, 40*(3), e206–e214. https://doi.org/10.1097/MAO.0000000000002132

Hinderink, J. B., Krabbe, P. F., & Van Den Broek, P. (2000). Development and application of a health-related quality-of-life instrument for adults with cochlear implants: The Nijmegen Cochlear Implant Questionnaire. *Otolaryngology—Head & Neck Surgery, 123*(6), 756–765. https://doi.org/10.1067/mhn.2000.108203

Kobosko, J., Jedrzejczak, W. W., Pilka, E., Pankowska, A., & Skarzynski, H. (2015). Satisfaction with cochlear implants in postlingually deaf adults and its nonaudiological predictors: Psychological distress, coping strategies, and self-esteem. *Ear and Hearing, 36*(5), 605–618. https://doi.org/10.1097/AUD.0000000000000179

Krosnick, J. A., & Fabrigar, L. R. (1997). Designing rating scales for effective measurement in surveys. In L. Lyberg, P. Biemer, M. Collins, E. de Leeuw, C. Dippo, N. Schwarz, & D. Trewin (Eds.), *Survey measurement and process quality* (pp. 141–164). Wiley. https://doi.org/10.1002/9781118490013.ch6.

Mantokoudis, G., Koller, R., Guignard, J., Caversaccio, M., Kompis, M., & Senn, P. (2017). Influence of telecommunication modality, Internet transmission quality, and accessories on speech perception in cochlear implant users. *Journal of Medical Internet Research, 19*(4), e135. https://doi.org/10.2196/jmir.6954

McRackan, T. R., Bauschard, M., Hatch, J. L., Franko-Tobin, E., Droghini, H. R., Nguyen, S. A., & Dubno, J. R. (2018). Meta-analysis of quality-of-life improvement after cochlear implantation and associations with speech recognition abilities. *The Laryngoscope, 128*(4), 982–990. https://doi.org/10.1002/lary.26738

Mosnier, I., Bebear, J. P., Marx, M., Fraysse, B., Truy, E., Lina-Granade, G., Mondain, M., Sterkers-Artières, F., Bordure, P., Robier, A., Godey, B., Meyer, B., Frachet, B., Poncet-Wallet, C., Bouccara, D., & Sterkers, O. (2015). Improvement of cognitive function after cochlear implantation in elderly patients. *JAMA Otolaryngology—Head & Neck Surgery, 141*(5), 442–450. https://doi.org/10.1001/jamaoto.2015.129

O'Leary, T. J., Slutsky, J. R., & Bernard, M. A. (2010). Comparative effectiveness research priorities at federal agencies: The view from the Department of Veterans Affairs, National Institute on Aging, and Agency for Healthcare Research and Quality. *Journal of the American Geriatrics Society, 58*(6), 1187–1192. https://doi.org/10.1111/j.1532-5415.2010.02939.x

Rey, P., Cochard, N., Rizzoli, M., Laborde, M.-L., Tartayre, M., Mondain, M., & Deguine, O. (2016). Technical aids for speech understanding in cochlear implanted adults using cell-phones. *European Annals of Otorhinolaryngology, Head and Neck Diseases, 133*(4), 253–256. https://doi.org/10.1016/j.anorl.2016.04.005

Rumeau, C., Frère, J., Montaut-Verient, B., Lion, A., Gauchard, G., & Parietti-Winkler, C. (2015). Quality of life and audiologic performance through the ability to phone of cochlear implant users. *European Archives of Oto-Rhino-Laryngology, 272*(12), 3685–3692. https://doi.org/10.1007/s00405-014-3448-x

Saris, W. E., & Gallhofer, I. N. (2014). *Design, evaluation, and analysis of questionnaires for survey research*. Wiley.

Slattery, E. L., Voelker, C. C., Nussenbaum, B., Rich, J. T., Paniello, R. C., & Neely, J. G. (2011). A practical guide to surveys and questionnaires. *Otolaryngology—Head & Neck Surgery, 144*(6), 831–837. https://doi.org/10.1177/0194599811399724

Sonnet, M. H., Montaut-Verient, B., Niemier, J. Y., Hoen, M., Ribeyre, L., & Parietti-Winkler, C. (2017). Cognitive abilities and quality of life after cochlear implantation in the elderly. *Otology & Neurotology, 38*(8), e296–e301. https://doi.org/10.1097/MAO.0000000000001503

Sousa, A. F., Carvalho, A. C., Couto, M. I., Tsuji, R. K., Goffi-Gomez, M. V., Bento, R. F., Matas, C. G., & Befi-Lopes, D. M. (2015). Telephone usage and cochlear implant: Auditory training benefits. *International Archives of Otorhinolaryngology, 19*(3), 269–272. https://doi.org/10.1055/s-0034-1390301

Tan, B. Y., Gluth, M. B., Statham, E. L., Eikelboom, R. H., & Atlas, M. D. (2012). Mobile and landline telephone performance outcomes among telephone-using cochlear implant recipients. *Otolaryngology—Head & Neck Surgery, 146*(2), 283–288. https://doi.org/10.1177/0194599811424120

Warner-Czyz, A. D., Loy, B. A., Evans, C., Wetsel, A., & Tobey, E. A. (2015). Self-esteem in children and adolescents with hearing loss. *Trends in Hearing, 19*. 2331216515572615. https://doi.org/10.1177/2331216515572615

Wolfe, J., Morais Duke, M., Schafer, E., Cire, G., Menapace, C., & O'Neill, L. (2016). Evaluation of a wireless audio streaming accessory to improve mobile telephone performance of cochlear implant users. *International Journal of Audiology, 55*(2), 75–82. https://doi.org/10.3109/14992027.2015.1095359