Title:

Investigating use of a parent report tool to measure vocabulary development in deaf Greek-speaking children with cochlear implants

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Abstract

Objective: There are very few measures of language development in spoken Greek that can be used with young deaf children. This study investigated the use of CYLEX, a receptive and expressive vocabulary assessment based on parent report that has recently been adapted to Standard Greek, to measure the vocabulary development of deaf Greek-speaking children with cochlear implants.

Design: A Standard Greek version of CYLEX was used to collect data on receptive and expressive vocabulary development from parents of 13 deaf children with cochlear implants aged between 21 to 71 months. These data were compared with data collected previously from typically developing hearing Greek-speaking children.

Results: Use of the test by parents of deaf children was found to be reliable. No correlation was found between children's vocabulary scores and chronological age. A positive correlation was however found between children's post-implant age and expressive vocabulary. The vocabulary skills of implanted children with a mean post-implant age of 20 months were not significantly different from those of typically developing hearing children of similar chronological age.

Conclusion: CYLEX is a reliable and useful tool for exploring vocabulary development with this clinical group. Findings confirm the results of other studies in indicating that the vocabulary size of implanted preschool-aged deaf children is related to the amount of time that children have used their implant, rather than chronological age.

Key words: deaf children, cochlear implants, vocabulary, language assessment, parent-report

Introduction

Over the past two decades, cochlear implants (CI) have had a major impact on deaf children's communication development because they provide substantial, usable hearing necessary for the development of speech and language (Govaerts, De Beukelaer, Daemers, De Ceulaer, Yperman, Somers, Schatteman, & Offeciers, 2002; McDonald Connor, Craig, Raudenbush, Heavner, & Zwolan, 2006; Svirsky, Teoh, & Neuburger, 2004). The success of implantation in children relies upon many factors, among which the most important are age at diagnosis of hearing loss, age at implantation, duration of cochlear implant use (also referred to as post-implant age), residual hearing prior to implantation, method of communication training, frequency and quality of audiological monitoring, speech/language intervention and importantly, family involvement (O'Donoghue, Nikolopoulos & Archbold, 2000; Fryauf-Bertschy, Tyler, Kelsay, Gantz, Woodworth, 1997; Geers, Nicholas & Sedey, 2003; Nikolopoulos, Gibbin & Dyar, 2004; Sharma, Dorman & Spahr, 2002).

Communication assessments are important in providing insights into deaf children's progress in language development pre- and post-implantation and can help to identify additional problems or specific abilities and skills that children may have. Since deaf children are now often implanted as early as six months (Colletti, Carner, Miorelli, Guida, Colletti & Fiorino, 2005; Schauwers, Gillis, Daemers, De Beukelaer & Govaerts, 2004; Waltzman, & Roland, 2005) there is a need for an assessment tool for Greek-speaking, cochlear implanted infants and toddlers to monitor language progress post-implantation from increasingly younger ages.

With respect to vocabulary development, existing standardized tests have been used with some success. Fagan and Pisoni (2010) used the Peabody Picture Vocabulary Test III to test children with CI between the ages of 6-14 years. The receptive vocabulary scores of children with CI were lower than those obtained by hearing children of the same chronological age. However, the authors found that deaf children's scores matched the scores of younger hearing children whose chronological age corresponded to the deaf children's post-implant age, or hearing age. They suggest that this is because the deaf child's optimum exposure to spoken language dates from the activation of their cochlear implant(s), as opposed to their date of birth.

For younger children who are unable to co-operate with formal testing, parent report techniques offer an alternative approach and are considered a valid method for reporting on deaf children's early vocabulary development (Prezbindowski & Lederberg, 2003). Parental report measures provide a simple and easy means of estimating the lexicon size and require no cooperation from the child. Furthermore, they may be perceived as more ecologically valid since they evaluate children's skills in the home environment (Feldman, Dollaghan, Campbell, Kurs-Lasky, Janosky, & Paradise, 2000; Nott et al. 2003; Prezbindowski & Lederberg, 2003).

The MacArthur-Bates Communicative Development Inventories or CDIs (Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick, & Reilly, 1993), measures that are used widely with hearing children, have also been used to assess young deaf children's vocabulary in spoken (Ertmer & Mellon, 2001; Mayne, Yoshinaga-Itano, & Sedey, 2000a; 2000b; Stallings, Gao, & Svirsky, 2002; Willis & Edwards, 1996) and sign language (Anderson & Reilly, 2002; Woolfe, Herman, Roy, & Woll, 2010). In Standard Greek there is a scarcity of tools available for assessing language development in preschool-aged children. There is no Greek version of the CDI currently available and another recently developed standardized language test in Greek (Economou, Besevegis, Mylonas, & Varlokosta, 2008) is not available for use by practitioners.

A cross-linguistic study of vocabulary development in Greek and English by Papaeliou and Rescorla (2011) was the first study to provide measures of expressive vocabulary for a large sample of monolingual Greek-speaking toddlers. The investigators obtained data for 273 Greek-speaking toddlers aged 1;6 to 2;11 using a Greek adaptation of Rescorla's Language Development Survey (LDS: Rescorla, 1989), which is not commercially available. The primary finding was that Greek-speaking children developed smaller lexical inventories between the ages of 1;6-1;11 compared to American English-speaking peers. However, differences in expressive vocabulary size diminished in the age groups 2;0-2;5 and 2;6-2;11. A second finding was that girls outperformed boys and thirdly, there was large variation in individual vocabulary scores, consistent with other developmental studies.

In Cyprus, where the Cypriot–Greek dialect is used, Petinou, Minaidou and Hadzigeorgiou (1999) developed the Cyprus Lexical List (CYLEX), a parent report vocabulary checklist similar to the CDI (Fenson et al., 1992). However, although 200 items (mainly animals and actions), occur in both CYLEX and the CDI, the CYLEX is not simply a translation of the CDI. CYLEX consists of 613 words selected based on the most frequent words in Cypriot-speaking children's speech as well as words found in preschool children's books (see method section for a more detailed description). Petinou, Constantinidou and Kapsou (2011) used expressive vocabulary data collected using CYLEX to differentiate between late talking (LT) and typically developing toddlers. The low scores of late talkers on CYLEX paralleled low expressive language standard scores on the Preschool Language Scale-III (Zimmerman, Steiner & Pond, 1992), adapted to Cypriot Greek for the purposes of the Petinou et al., 2011 study, and mean length of utterance–words (MLU-W) scores (see Petinou et al., 2011 for further details). A benefit of CYLEX is that, unlike the adapted version of LDS (Papaeliou and Rescorla, 2010), it measures both receptive and expressive vocabulary. For this reason, and also because of its availability, CYLEX was selected for use in the present study. However, as Cypriot-Greek is a dialect of Standard Greek, before use with Standard Greek-speaking children and their families, some words in CYLEX needed to be translated.

Parizi, Okalidou, Xaxoudi and Petinou (2013) translated 64 words (10.4%) from Cypriot-Greek to Standard Greek from the following semantic categories of CYLEX (number of words translated presented in parentheses after each category): baby words (19), animal sounds (2), animal names (1), food and drink (6), body parts (2), action words (3), outside things (2), household items (7), personal items (4), people (2), vehicles (2), clothing (4), basic concepts (1), tools (3), toys (3) and other (3). Parizi et al. (2013) administered the adapted full version of CYLEX to parents of 200 children who were speakers of Standard Greek. All children were reported as typically developing based on a parent questionnaire, i.e. had no known developmental, neurological or hearing problems. Out of the sample of 200 children, Parizi et al. reported 14 children to be at risk for language delay since their vocabulary scores fell below 1.5 standard deviations from the mean.

The purpose of the current study was to investigate the use of the Standard Greek version of CYLEX developed by Parizi et al. to measure vocabulary growth in Greek-speaking deaf children with CI. Deaf children's CYLEX scores were compared with those of 3 age groups of hearing children from the existing developmental data on CYLEX to provide preliminary data on the applicability of the available normative data to deaf children with cochlear implants.

Method

Participants

<u>*Deaf children.*</u>

Following ethical approval from the Senate Research Ethics Committee at City University London, 17 parents of deaf Greek-speaking children with CIs (seven boys) consented to participate in this study. All were recruited using convenience sampling from the Cochlear Implantation Centre of the 1st E.N.T. department of University Hospital "AHEPA", Thessaloniki, Greece. Four children found to have additional disabilities were excluded, which left a sample of 13 children (five boys). At the time of data collection, the children's chronological ages ranged from 21 to 71 months (mean 51.38 months, standard deviation [SD] 17.64). Age at implantation varied from 15 to 64 months, so this sample included both early and late-implanted children. Number of months post-implant ranged from 5 to 46 months (mean 19.08, SD 13.36).

Table 1 presents demographic information for the 13 children, all of whom were fitted with unilateral CIs. Demographic information gathered via questionnaire included child gender, date of birth, date of implantation, onset and aetiology of hearing loss, age at which hearing loss was diagnosed, reason for cochlear implantation and hearing aid usage prior to implantation. In addition, information was obtained regarding whether or not children attended speech and language therapy and/or nursery/kindergarten, the type of cochlear implant device used, the presence of additional disabilities and finally, parents' date of birth, educational level and occupation.

Prior to implantation, all children had a pure tone average threshold greater than 80 dB HL at 500, 1000, 2000 and 4000 Hz in both ears. Eleven of the children were born deaf; for the remainder, deafness was acquired soon after birth. In most cases, cause of deafness was unknown. Six children had their deafness diagnosed early, i.e. at or before six months of age, whereas seven were diagnosed after six months. Prior to implantation, five of the 13 children were fitted with hearing aids, six did not and information was missing for two.

All participants were monaural users of the Freedom SP CI24RE(CA) cochlear implant device with a full insertion of the electrode array. No child used a hearing aid in the non-implanted ear. All children had hearing parents and monolingual Greek-speaking families. All were developing spoken language through an oral approach within and attended speech and language therapy.

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Insert Table 1

<u>*Typically developing hearing children*</u>.

The vocabulary scores of the CI children were compared with scores from the existing developmental database of the Standard Greek adaptation of the CYLEX. Three groups of typically developing hearing children (TD) were selected from the data pool, based on age and absence of language delay or other neurological and/or developmental problems. The 49 TD children were in the following age groups:

i) 24-26 months (9 boys and 9 girls)

ii) 28-30 months (9 boys and 4 girls)

iii) 36-38 months (9 boys and 9 girls)

Materials

Children's receptive and expressive vocabulary was measured using the Standard Greek adaptation of CYLEX developed by Parizi et al. (2013). CYLEX (Cyprus Lexical List) was originally developed by Petinou, Minaidou & Hatzigeorgiou (1999). This is a vocabulary checklist comprising 613 content and function words usually found in children's early vocabulary organised into 18 semantic categories. In addition, there is a list of 14 gestures that may be used by youngsters, a section in which caregivers can add words that do not exist on the main list grouped into 3 semantic categories (people names, numbers and extra words), and a section in which caregivers can provide examples of phrases and short sentences used by their child. CYLEX is a non-standardized early language screening tool that has been used to identify toddlers with late onset of expressive language. Since this is a non-standardized tool there are major issues regarding validity, sensitivity and specificity. However, CYLEX in its present form has been administered to more than 120 Cypriot Greek-speaking toddlers longitudinally (ages 24-36 months) in an effort to enlarge the data pool. Raw scores have been transformed to Z scores for each developmental age level and a cut-off point (corresponding to 1.5 SD below the mean) has been derived for each level (e.g. 70 words production as a cut-off point for late-talker classification at the age level of 28 months (see Petinou & Spanoudis, 2014). In the absence of standardization data, CYLEX can be used in combination with other measures as an early language screening in identifying and monitoring early language development.

As Cypriot-Greek is a dialect of Standard Greek, in order to create an adapted version of the above tool, it was essential to translate some words into Standard Greek. Thus, for the Standard Greek adaptation of CYLEX, developed by Parizi et al. (2013), sixty-four words (10.4%) were adjusted from the following semantic categories (number of words that have been adjusted in parentheses after each category): *baby words* (19), *animal sounds* (2), *animal names* (1), *food and drink* (6), *body parts* (2), *action words* (3), *outside things* (2), *household items* (7), *personal items* (4), *people* (2), *vehicles* (2), *clothing* (4), *basic concepts* (1), *tools* (3), *toys* (3) and *other* (3). Furthermore, the adapted CYLEX was administered to 200 children from 20 nurseries/child day care centres, aged 0;6-3:5 years old from Northern Greece, 112 boys and 88 girls. The great majority of children, 94.5%, were recruited from urban areas and 5.5% from rural ones.

The final 18 semantic categories include the following classes: baby words (29 words), animal sounds (11 words), animal names (41 words), food and drink (57 words), body parts (24 words), action words (94 words), outside things (53 words), household items (57 words), rooms (14 words), personal items (23 words), people (40 words), vehicles (16 words), clothing (29 words), basic concepts (53 words), adjectives (12 words), tools (14 words), toys (31 words) and other (15 words).

For the purpose of this study, the vocabulary scores of the CI children were used in two principal ways. Firstly, scores from the 18 semantic categories plus the additional three semantic categories where the parents added words that their children produced were used to evaluate the deaf participants' language development and to investigate the validity and reliability of the measure. Secondly, CI children's scores from the 18 categories only were compared with the equivalent scores of the TD children from three age groups, approximately corresponding to the CI group's mean post-implantation age.

Procedure

<u>*Data collection*</u>.

Copies of the CYLEX accompanied by a letter describing the project, a consent form and a questionnaire requesting demographic characteristics were mailed to parents of the CI group. Each parent was contacted twice by phone: the first telephone conversation was to inform the parents about the aim of the study, the procedures to be followed and instructions for completing CYLEX. The second telephone conversation aimed at resolving any queries concerning completion of the CYLEX.

Parents were asked to mark on the checklist those words that their child understood and expressed spontaneously, to write down any extra words that were not part of the list, to indicate if their child used word combinations, to write down five of the child's best phrases and to provide demographic information for both their children and themselves. Parents were instructed to include all words that their child used spontaneously in everyday contexts, even those that the child was unable to pronounce accurately. Parents were given one week to complete CYLEX and mail it back to the hospital. In total, data collection extended over a two month period.

Each score sheet contained a column of target words, a column for receptive vocabulary headed 'understands' and a column for expressive vocabulary headed 'says'. Two sets of scores were generated, one from the 18 categories (the 'categories' score) and one from the 18 categories plus the three additional categories in which parents added words (the 'total' score).

The post-implant ages of children were determined by subtracting the date of activation of their implant from the date at which the CYLEX was completed.

Reliability

Test-retest reliability was assessed by re-administering CYLEX within a month of initial data collection, with the assumption that children's vocabulary scores would not change significantly during this period. Eleven copies of CYLEX were returned on the second occasion and were used for the purposes of reliability analysis.

Results

Vocabulary skills of CI Greek-speaking children

Table 2 lists the mean scores and standard deviations for receptive and expressive vocabulary using CYLEX for the group of 13 CI children according to chronological and post implant age. Two types of mean scores were reported, one for items contained in the 18 semantic categories of CYLEX and another one containing the words additionally reported by parents (total scores). In both cases, the scores obtained for receptive vocabulary were higher than those for expressive vocabulary. As seen in Table 2, both the sample characteristics and the scores were highly variable.

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Insert Table 2

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The differences in total scores between receptive and expressive vocabulary were tested statistically, as being more representative of children's vocabulary knowledge. A Wilcoxon matched pairs test revealed highly significant differences between receptive versus expressive total scores ($Z=2.59, p<0.01$). Hence, the data varied according to the CYLEX predetermined categories. Furthermore, Spearman Rank Order correlations were calculated for the receptive and expressive vocabulary measures to obtain an estimate of internal item consistency of the test. These are shown in Table 3 below. A significant correlation of 0.71 ($p<0.05$) was found between receptive and expressive measures.

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Insert Table 3

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Comparison of vocabulary scores as a function of chronological versus post-implant age.

A cross-sectional examination of the effect of chronological versus post-implant age on vocabulary scores was conducted. As shown in Table 3, Spearman Rank Order correlations between chronological age and vocabulary scores were not significant, either for receptive or expressive scores.

The correlation between post-implant age and receptive vocabulary scores was also not significant. However, the correlation between post-implant age and expressive vocabulary scores was significant, $r=0.85$ $p<0.05$ (Table 3). This indicates that in the present sample, larger expressive vocabulary sizes were observed for children with longer use of the implant device.

Reliability

Test-retest reliability was conducted on data from the 11 returned questionnaires based on the 18 categories of CYLEX. Significant correlations between the two administrations of CYLEX (n=11) were found for both the receptive vocabulary score ($r= .97$, $p<.001$) and the expressive vocabulary score ($r= .98$, $p< .001$). This suggests that the measure can be considered reliable for assessing deaf children's vocabulary. It also suggests that parents' were reliable in reporting their children's vocabulary scores.

Comparisons of CI and TD children

The purpose of this comparison was to examine the extent to which the scores of the CI children fell within the range of scores for TD children. This is important in indicating whether CYLEX norms for TD children are applicable to deaf CI children. The categories vocabulary scores of the CI children were compared with those of the TD children from the CYLEX developmental data corpus at three age intervals.

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Insert Table 4

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As seen in Table 4, at the mean age of 51.38 months, the average score of the CI group for receptive vocabulary was 342. This is closest to the performance of the youngest TD group, aged 24-26 months, whose mean score was 355, but not close to the mean values of the TD children aged 28-30 and 36-38 months (437 and 491 respectively).

For receptive vocabulary scores, paired group comparisons via the Wilcoxon Matched Pairs test were made between the group of children with CI and each of the TD groups. Significant differences in receptive vocabulary scores between the children with CI and TD children were found only for the oldest TD children in the sample, aged 36-38 months ($Z=1.99$, $p<0.05$). Similarly, the expressive scores of the CI children were compared with each group of TD children The average score of the CI children for expressive vocabulary (270) was higher than that of TD children aged 24-26 months (233), but lower than the one obtained for the TD group aged 28-30 months (364) and 36-38 months (464). Paired group comparisons using the Wilcoxon Matched Pairs test indicated significant differences only between the CI group and the oldest TD group, who where 36-38 months old ($Z=2.27$, $p<0.02$). It appears that the mean receptive and expressive vocabulary performance of CI children in the current sample with a mean chronological age of around 50 months falls within the range of TD children aged 28-30 months old.

For both receptive and expressive vocabulary scores, the mean post-implant age of the CI children of around 20 months, rather than their chronological age, was closer to the chronological age of the youngest TD group. Of further interest, the overall variability in CI children's vocabulary scores was greater than that of the youngest group of TD children, as revealed by coefficients of variation (see Table 4), yet the difference in coefficients of variation was small between CI children's expressive vocabulary and the youngest TD group.

Discussion

The purpose of the present study was to conduct a preliminary investigation on the use of a new Standard Greek adaptation of CYLEX to measure the vocabulary development of young children with CI. CYLEX was found to be a useful measure that was easy for parents to use with their deaf children, evidenced by the high return rates from parents. Retest data confirmed the reliability of parents' judgments on their children's vocabulary using CYLEX. However, further research involving a larger sample is needed to confirm reliability and also the accuracy of parent assessment. For example, Lee, Chiu, Van Hasselt & Tong (2009) found that involvement of parents and teachers led to a more accurate assessment of deaf children's vocabulary than when parents alone were used. This is because home and school present different language opportunities which, when both are sampled, provide a more accurate representation of a deaf child's vocabulary. Future research, particularly of older deaf children who are already in school, should therefore involve teachers as well as parents using CYLEX.

The vocabulary skills of implanted children fell within the predetermined categories of CYLEX. Furthermore, statistically different scores were obtained for receptive and expressive scores (including all the words added by parents) for the CI group, as has been found in other research.

Using CYLEX, the mean vocabulary size of our CI participants was smaller than would be expected given their chronological age and closer to that of the youngest age group of TD children for whom CYLEX scores were available. Delayed or slower language development has been frequently observed in deaf children compared to their hearing peers (Blamey et al., 2001; Moeller, Osberger & Eccarius, 1986). This finding suggests that CYLEX is a sufficiently sensitive tool in identifying differences between the vocabulary development of deaf and hearing children.

The development of both receptive and expressive vocabulary as measured by CYLEX were highly variable in the CI group and did not increase as a function of chronological age, unlike previous research using CYLEX with a Cypriot Greek speaking TD group (Petinou et al., 2011). Among our data were cases where an older CI child (e.g. a 62-month old girl) performed more poorly than a younger one (e.g. the 30-month old girl). Again, such findings are in line with those of previous studies that have shown deaf children to exhibit increased variability in their language skills in comparison with hearing peers (Blamey et al., 2001; Lederberg & Spencer, 2005; Moeller, Osberger, & Eccarius, 1986; Svirsky, Robbins, Kirk, Pisoni & Miyamoto, 2000).

Our findings also shed light on the vocabulary development of CI children. Using CYLEX, the study found a significant correlation between vocabulary development and post implant age rather than chronological age, albeit for expressive vocabulary only and despite use of hearing aids prior to implantation (for some of the sample). This is in line with Fagan and Pisoni's (2010) findings, although in their case the correlation was with post-implant age in a group of younger children and receptive vocabulary. The present study's finding of increased vocabulary development as a function of duration of implant use for preschool-aged children is also consistent with a study by Nicholas and Geers (2006) who evaluated the spoken language skills of 76 CI children at the age of 3;06 using a standardized 30-minute language sample analysis, the CDI and a teacher language-rating scale. The children in that study were also of preschool age, had received their cochlear implant between 12 and 38 months of age and the duration of their cochlear implant use at the time of testing ranged from 7 to 32 months. The authors found a strong positive coefficient associated with duration of implant use, indicating that children who had used their implant for a longer period of time exhibited better language skills.

However, the results of the present study do not support the generalization of findings from a case study by Willis and Edwards (1996). They examined the acquisition of vocabulary in a single case study: a 4-year old CI child, fitted at 14 months with hearing aids and then implanted at age 3. The researchers followed both receptive and expressive vocabulary growth in English during the child's first year of cochlear implant use and compared her performance with that of typically developing hearing children who had a chronological age similar to her post-implant age, that is 12 months. Their findings revealed that the CI child acquired vocabulary at approximately twice the rate of the hearing children. In contrast to this single case study, the implanted children in the current sample did not significantly exceed the vocabulary performance of younger typically developing children of the control group matched approximately for post-implant age, despite the fact that the former were chronologically older.

The discrepancy between Willis and Edwards (1996) and the current findings may be attributed to the following reasons: a) the current sample was heterogeneous with respect to both post-implantation and chronological age - a few children were implanted later than 3 years of age and some were much older; and b) the children spoke a different language, Standard Greek, thus it cannot be readily assumed that vocabulary growth is comparable to English since the former has a more complex word structure (e.g., clusters and multisyllabic words). Indeed, in the Papaeliou & Rescorla (2011) study, it was shown that Greek-speaking children at ages younger than 24 months develop smaller-sized lexicons as compared to English-speaking ones.

It is also important to note that our finding with respect to post-implantation age outcomes for vocabulary skills may not hold for older populations of late-implanted children where vocabulary development may be slower. Thus, it should not be assumed that deaf children fitted at school-age will show similar vocabulary growth as a function of CI use. Future studies collecting longitudinal data with CYLEX and/or other measures would provide confirmation of this finding and additionally give an estimation of vocabulary growth as a function of age.

Taken together, findings from the majority of available studies including the present one suggest that preschool-age CI children develop their vocabulary skills as a function of years of CI use. An implication of this is that for the preschool period, chronological age may not be the appropriate parameter for cross-group language comparisons of CI and TD hearing children. Rather, post-implant age would seem to be a better indicator for matching language performance scores (in this case, vocabulary) of children with CI to TD children.

However, certain limitations should also be noted concerning the current study. The sample of CI children was small and heterogeneous on a number of variables, not least in terms of chronological and post-implant ages. Moreover, the use of convenience sampling in recruitment of participants from a single cochlear implant centre limits the wider generalisability of findings. Further research using a larger and more representative sample is needed to confirm these findings. Data from a larger sample could also investigate other areas such as gender differences. In addition, participants varied in their use of hearing aids pre-implantation. For these reasons, the obtained results should be interpreted with some caution. A further issue is that comparability in vocabulary size does not mean that the same lexical items are represented. The content of implanted children's vocabulary in comparison to typically developing children needs to be investigated in future research.

It would be of interest to conduct a longitudinal investigation of the vocabulary growth of this group of CI children. By collecting data every six months from the first completion of CYLEX, one may be able to observe whether the rate of vocabulary development is similar to that of typically developing children, whether it accelerates or decelerates. Research is also needed to follow up CI children into their school years in order to determine whether early language advantages lead to age-appropriate language levels in comparison with their hearing classmates.

The present study is the first investigation of the knowledge and use of specific vocabulary in a sample of Greek-speaking children with CI using CYLEX. Our findings suggest that CYLEX is a useful assessment for this age group with potential clinical and research applications. In addition, as CYLEX presents vocabulary in semantic categories, it allows parents and professionals to examine the range of children's vocabulary and can highlight areas of strength and areas of deficit. Such knowledge can inform clinical practice and allow therapists and families to address specific areas of deficit for individual children.

Conclusion

Hearing loss in young children significantly affects language development. Although research has shown that cochlear implants can improve outcomes for many deaf children, accurate assessment of language development remains essential in order to monitor acquisition, identify the need for clinical intervention and evaluate progress. The adapted CYLEX used in this study is a promising tool for measuring vocabulary acquisition in young deaf Greek-speaking children who use cochlear implants, for whom there is currently a dearth of suitable assessments. Findings from this study concur with other research that has reported gains in the development of vocabulary skills in relation to the duration of cochlear implant use rather than chronological age.

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Table 1. Demographic characteristics of the CI children

Gender	Chronological age (mths)	Age at implantation (mths)	Post implant age (mths)	Reason for CI	Age at diagnosis (mths)	Age at hearing aid fitting (mths)	Cause of hearing loss	Frequency of SLT sessions per week	Type of schooling
1. Girl	71	25	46	Profound HL	6	No	Congenital	3	Public nursery
2. Girl	67	30	37	Inadequate benefit from HA	6	7	Congenital	1	Private kindergarten
3. Boy	63	29	34	Inadequate benefit from HA	6	6	Congenital	2	Public kindergarden
4. Girl	62	36	26	Inadequate benefit from HA	2	6	Congenital	3	Public kindergarten
5. Boy	58	35	23	Profound HL	24	Missing	Congenital	2	Public kindergarten
6. Girl	51	29	21	Profound HL	12	No	Congenital	2	Public nursery
7. Girl	30	16	13	Profound HL	20 days	6	Cytomegalo-virus	3	Missing
8. Boy	56	44	12	Profound HL	24	No	Missing	4	Private nursery
9. Boy	59	49	10	Profound HL	36	No	Perinatal anoxia	2	Private kindergarten
10. Girl	27	19	8	Profound HL	6	No	Congenital	Missing	Public nursery
11. Boy	71	64	6	Profound HL	Missing	Missing	Congenital	2	Public kindergarten
12. Girl	32	25	7	Profound HL	12	No	Congenital	2	Missing
13. Girl	21	15	5	Inadequate benefit from HA	8	8	Congenital	1	Missing

Key: CI: Cochlear Implant; HA: Hearing Aid

Table 2. Mean receptive and expressive vocabulary scores of CI children according to chronological and post-implant age (N=13).

	Chronological age (mths)	Post-implant age (mths)	Receptive vocabulary categories	Expressive vocabulary categories	Receptive vocabulary total	Expressive vocabulary total
Mean	51.38	19.08	342	270	380	307
Minimum	21.00	5.00	14	17	14	19
Maximum	71.00	46.00	610	582	727	727
SD	17.64	13.36	217	212	250	251
Coeff. V.			0.64	0.79	0.66	0.82

Note: Scores based on the 18 categories of CYLEX are reported as ‘categories’ scores; categories scores plus the additional words reported by parents are reported as ‘total’ scores.

Table 3. Spearman rank order correlations between chronological age (CA), post-implant age (PIA), receptive vocabulary-total (RV total) scores and expressive vocabulary-total (EV total) scores of CI children (n=13).

Spearman's rho	CA	PIA	RV total	EV total
CA	1.00			
PIA	0.57*	1.00		
RV	0.22	0.55	1.00	
EV	0.47	0.85*	0.71*	1.00

*significant at $p < 0.05$

Table 4. Means receptive and expressive vocabulary scores for 18 categories of CYLEX for typically developing hearing (TD) and deaf children with cochlear implants (CI).

Age		CI children	TD children 24-26 mths	TD children 28-30 mths	TD children 36-38 mths
N		13	18	13	18
RV categories	Means	342	355	437	491
	SD	217	88	60	48
	Coeff. V	0.63	0.25	0.14	0.10
EV categories	Means	270	233	364	464
	SD	212	172	129	72
	Coeff. V	0.79	0.74	0.35	0.15