



An investigation of the first lexicon of Turkish hearing children and children with a cochlear implant



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ABSTRACT

Introduction: Research on early cochlear implantation and first language milestones is limited. To compare language performance in cochlear implant (CI) users and hearing children, the establishment of normative data for both groups would be of benefit. To aid the data collection for Turkish hearing children and children with a CI diaries can be used.

Aims: This study aimed to document the first 100-word lexicon acquired by Turkish hearing children and children with a CI during the first 2 years of hearing experience, to determine the distribution of the first 100-word lexicon per word category, the rate of acquisition of words and the effects of age at implantation on language performance.

Methods: First word data was collected from 63 Turkish hearing children and 71 CI users implanted under 36 months of chronological age using a diary. The mean number of words recorded at each time interval was calculated. The time taken to achieve the first 100-word lexicon and the categories of the first words were documented. Performance under 18 months and over 24 months of age at first fitting was compared.

Results: By 19–21 months of hearing age both hearing and CI user's vocabularies were of similar size. CI users developed a lexicon earlier than hearing children, but once hearing children started to acquire words their acquisition rate was faster. The distribution of words acquired per category were similar. 83% of first words were shared by both groups. No significant difference in performance was found between: hearing versus: implanted children; or earlier (<18 months) versus later (≥ 24 months) implanted children.

Conclusions: The vocabulary of hearing children compared to CI users are similar in size and the category. Early access to auditory stimuli facilitates children with a hearing loss to develop vocabularies similar to hearing children in the short term.

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1. Introduction

Implementation of newborn hearing screening programs is driven by the knowledge that the younger a child with a hearing loss receives appropriate intervention, the more likely they are to develop spoken language; similar to that of hearing children. Several studies indicate that surgery is safe at a young age [1,2], and that the sooner a child is implanted with a cochlear implant (CI) the better the outcome in overall speech and language

development [3,4]. Researchers have reported that cochlear implantation below the age of 2 years results in advantages in speech perception and language development [5–7].

Cochlear implantation in children under 2 years of age aims to expose children with a hearing loss to spoken language via hearing and consequently minimize the gap between chronological age and the development of language skills that may exist between children with a hearing loss and hearing children of the same age [8,9]. Children implanted early with a CI have a shorter period of sound deprivation and conversely, longer auditory experience than their later implanted peers [6].

With earlier newborn hearing screening and the trend toward decreased age at intervention, new evaluation tools to monitor early speech and language development have become available, such as the LittleEARS Diary[®] [10] and the Di-EL [11]. However,

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there is relatively little research relating the benefit to the first language learning milestones [12]. First words are an important milestone for hearing infants and a major milestone eagerly awaited by parents and teachers of young children with a hearing loss [13]. Documenting emerging first words is a means of checking that a child's speech and language development are age appropriate.

To establish if a particular child's development is as expected norms need to be established from data collected from a representative sample of hearing children. Data collected from children with a hearing loss can thus be compared to hearing children. Not only the time course of word acquisition for both groups of children, but the categories of words acquired should ideally be collected.

The word frequencies of spoken English and other languages are already available; allowing lists of the most commonly used 100 and 500 words to be drawn up (e.g. Dahl [14]). However, to our knowledge there are no first words lists based on the emerging words of Turkish children with a hearing loss or their hearing peers. Dalkılıç and Çebi [15] determined several statistical properties of the Turkish language. They investigated the total number of words in the language, and different word usage ratios (i.e. how often certain words are used, and how often they are used in combination with certain other words). However, such a corpus is not directly relevant to young children's spoken language and the lists of most commonly used words are quite different from a first lexicon.

This preliminary, exploratory, study aimed to compare the mean number of receptive and expressive words of Turkish hearing children and Turkish CI users at set intervals during the first 2 years of life or device use (i.e. hearing experience); to determine the most frequently used first 100-word lexicon; to establish to which word categories the first words belonged; and to determine whether age at implantation affects the first lexicon.

2. Materials and methods

2.1. Preliminary first word data collection

A pilot study that was carried out revealed that parents often find it difficult to remember words their children know, even when prompted by word category headings. Some parents also find it difficult to distinguish between receptive and expressive vocabulary, and some are unsure what 'constitutes' a word. For these reasons we decided to collect data through interviews with parents, rather than have them file data themselves. Only one parent was interviewed; typically the mother. The parent was asked by the researcher to think about the words their child understood or could say.

Only utterances used spontaneously and meaningfully by a child that sounded very similar to a 'real' word were accepted as 'words', e.g. the child says 'Dada' for Daddy. Researchers felt that the use of a checklist would prompt parents to report more accurately. As a result of this pilot study, an electronic dictionary of probable first words was established (Appendix 1). The dictionary was organized by the word categories used in the LittleEARS Diary[®] [10], which are based on the word categories of the MacArthur Communicative Development Inventories.¹

¹ Note that there are two errors of alphabetization in the list of categories of the First Words List in the LittleEARS Diary, and one of those errors was carried over into the study and this paper. In the LittleEARS Diary First Words List, the letter L is omitted, and the letters O and P are given in reverse order. In this study too, the letter L is omitted. The letters O and P are given in the correct order, but the content and order of categories has not changed. That is, the Diary has: P) Words about time, then O) Descriptive words, while the study and paper have: O) Words about time, then P) Descriptive words. Any further correcting of alphabetization would create worse mismatches between the Diary and the study, and thus increase potential confusion for readers.

The researcher went through the electronic dictionary category by category and asked the parent if their child understood (receptive) or said (expressive) the listed words. The researcher also enquired if there were words other than the words asked that the child knew. These words were added to the electronic dictionary.

2.2. Subjects

Hearing children were recruited from child care centers in three different regions of Turkey in Istanbul, Izmir and Gaziantep. The hearing status of the children was determined through the Turkish National Newborn Hearing Screening Program (NNHSP) after birth. All hearing passed Transient Evoked Otoacoustic Emissions (TEOAEs) test criteria prior to participation in this study. To establish any additional needs of the children parents were questioned by professionals about their child's development and if, at any time, they had been referred to a doctor or care clinic. Only hearing children from families where Turkish was spoken as the first language, without additional needs were included in this study. First word data was collected cross-sectionally from 63 hearing children (27 female, 36 male) aged 9–24 months, as 9 months of age is when children usually begin to produce words. The mean age at first data collection was 17 months.

Implanted children were recruited from Turkish CI centers, in Istanbul, Izmir and Gaziantep, at routine speech processor programming sessions. Only unilateral CI users, from families where Turkish was spoken as the first language, with a severe to profound congenital, bilateral hearing loss, implanted before 36 months of age, with no apparent additional needs were included in this study. First word data for CI users was collected cross-sectionally and longitudinally from 71 unilateral MED-EL PULSAR^{CI100} users (38 female, 31 male, 2 missing information). At first data collection, the mean hearing age of the CI users was 12 months (range 1–24 months), and their mean chronological age was 37 months. Data were collected from 37 of these implanted children more than once: 23 children were evaluated twice; 6 were evaluated 3 times; 6 were evaluated 4 times; one child was evaluated 6 times; and one child 8 times.

All participants gave written informed consent for the inclusion of their data in this study.

2.3. Testing

2.3.1. Test interval

The follow-up period of all children was split into eight 3-month intervals across 0–24 months. For hearing children this interval was designated according to the chronological age at the time of data collection. For children with a CI the intervals between evaluations were determined according to their hearing age since the child was implanted, i.e. the length of time the child was using their CI.

2.3.2. Test methods

To compare the mean number of receptive and expressive words of Turkish hearing children and Turkish CI users at set intervals during the first 2 years of life or device use a parent of each child was asked to think about the words their child understood or could say. This information was collected by a researcher as described in the pilot study. The researcher went through the electronic dictionary category by category and asked the parent if their child understood or said the listed words. The researcher also enquired if there were words other than the words asked that the child knew. These words were recorded and counted toward the child's first 100 words, but were not added to the

electronic dictionary for further use in the present study. Mean numbers and standard deviation of receptive and expressive words recorded at each time interval for both CI users and hearing children were calculated. The differences in size of the receptive and the expressive vocabulary between CI users and hearing children at 3-month intervals were compared.

To determine the time-course of first word acquisition both the receptive and expressive vocabulary, of hearing children and children with a CI, were compared independently at each time interval within groups. Similarly, the size of receptive and expressive vocabularies, as determined by words at each interval, were compared between the hearing children and the CI users.

To establish the most frequently used 100 first words receptive and expressive vocabulary of the first 100 words of hearing children and children with a CI were documented according to chronological or hearing age, respectively. The frequency of each word over all data collections was calculated. The percentage of words shared, in the top 10 and 100 words, for children with a CI and for hearing children was calculated. To determine the distribution of the word categories of the first words, the median number of expressed words by word category between 19 and 21 months hearing age were calculated. At that point in time the sample size was largest, and the acquisition of words was highest, thus the distribution of word categories was deemed most representative.

To determine the effect of age at implantation on CI users' acquisition of the first lexicon, the outcomes of CI users, grouped according to age (before 18 months and after 24 months) at first fitting were compared.

2.4. Analyses

Descriptive statistics were used to report the basic features of the data. Quantitative data are presented as mean, standard deviation (SD) and range (minimum and maximum values); qualitative data are presented as absolute and relative frequencies.

To determine the test-retest reliability of the data collection first word data was collected from 15 CI users and re-collected from the same 15 users after one week. Outcomes of the two data collections were correlated using Pearson's Correlation Coefficient.

Independent samples *t*-tests were used to determine if there were significant differences in sizes of receptive and expressive vocabularies at each time interval for CI users and hearing children.

The Mann-Whitney *U*-test was used to determine the achievement of receptive and expressive vocabulary over the follow-up period for CI users and hearing children; to examine the difference in development of receptive and expressive vocabulary

between each time interval for both CI users and hearing children; and to examine the effect of age at implantation on CI users.

Missing data were not replaced, but treated as 'missing' values. A *p*-value of <0.05 was considered statistically significant. IBM SPSS Statistics 19.0 was used for the analyses. Graphs were created in Microsoft Office Excel 2010 (<http://www.microsoft.com>).

3. Results

3.1. Test re-test reliability

Test-retest reliability testing indicated that there was a highly significant correlation in receptive vocabulary ($r = 0.983$; $p < 0.001$) and in expressive vocabulary ($r = 0.985$; $p < 0.001$) between assessments carried out within one week.

3.2. Comparison of the expressive and receptive vocabulary of children with a CI vs. hearing children

Fig. 1 shows the mean number of acquired receptive and expressive words recorded at each time interval for children with a CI and hearing children. The increase in size of receptive and expressive vocabulary over time for both CI users and hearing children was statistically significant ($p < 0.001$). However, hearing children and CI users progressed differently over time.

CI users had significantly better expressive vocabulary than hearing children at 10–12 months ($p < 0.001$), 13–15 months ($p < 0.001$) and 16–18 months of age ($p = 0.005$). There were no significant differences between the hearing and CI users in the size of their expressive vocabulary at 19–21 months and 22–24 months.

Likewise, children with a CI had significantly better receptive vocabulary compared to hearing children between 10 and 12 months ($p < 0.001$), 13 and 15 months ($p < 0.001$.) and 16 and 18 months ($p = 0.015$). There were no significant differences in the receptive vocabulary between CI users and hearing children between 19–21 months and 22–24 months.

3.3. Comparison of the rate of acquisition of receptive and expressive vocabulary

Once children with a CI and hearing children started to acquire receptive and expressive words, the number of words recorded at each time interval appeared to increase over time (Fig. 1). The expressive vocabulary of children with a CI improved significantly between the 0–3 and 4–6 month interval ($p = 0.091$), and between the 13–15 and 16–18 month interval ($p = 0.070$). The expressive vocabulary of children with a CI between the 7–9 and 10–12 month

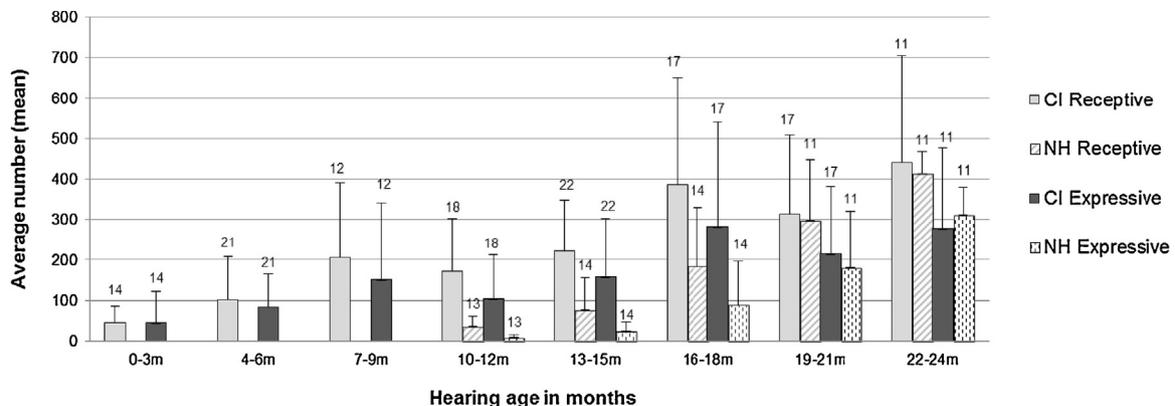


Fig. 1. Mean receptive and expressive words recorded for children with a cochlear implant (CI) and hearing children (NH) at each time interval. Error bars represent standard deviation.

interval, and between the 16–18 and 19–21 month interval did not improve significantly.

The receptive vocabulary of children with a CI improved significantly between the 0–3 and 4–6 month interval ($p = 0.049$), the 4–6 and 7–9 month interval ($p = 0.047$), and the 13–15 to 16–18 month interval ($p = 0.037$). The receptive vocabulary of children with a CI did not improve significantly between the 7–9 and 10–12 month intervals nor between the 16–18 and 19–21 month interval.

After the 4–6 month interval for children with a CI the receptive vocabulary of the children was greater than the expressive vocabulary. At all time intervals the difference between the number of expressive words and receptive words was not significant in children with a CI ($p = 0.101$ to $p = 0.995$). Children with a CI appeared to have a wide variation in receptive and expressive word scores. This variation was most apparent between CI users at 22–24 months of hearing age. At this interval the standard deviation from the mean was greater for CI users compared to hearing children (mean \pm SD: 441.2 ± 263.9 vs. 414.6 ± 51.8).

A significant improvement in the expressive vocabulary of hearing children was found between the 10–12 and 13–15 month interval ($p = 0.007$), the 13–15 and 16–18 month interval ($p = 0.034$), the 16–18 month and 19–21 month interval ($p = 0.016$) and the 19–21 and 22–24 month interval ($p = 0.028$).

The receptive vocabulary of hearing children improved significantly, or showed a tendency toward improvement between the 10–12 and 13–15 month interval ($p = 0.076$), the 13–15 and 16–18 month interval ($p = 0.004$), the 16–18 and 19–21 month interval ($p = 0.017$), and the 19–21 and 22–24 month interval ($p = 0.082$).

After the 10–12 month interval for hearing children the receptive vocabulary of the children was greater than the expressive vocabulary. At all time intervals the difference between the number of expressive words and receptive words was significant in hearing children ($p = 0.001$ – 0.061).

3.4. The 100-word lexicon

On average CI users had acquired more than 100 receptive and expressive words by 6–9 months of hearing age. On average hearing children had acquired more than 100 receptive and expressive words by 16–18 months of chronological age. Table 1 shows the most frequently documented 100 words for CI users and hearing children. Six of the top 10 words were shared by both groups. Eighty-three percent of the top 100 words were shared by both CI users and hearing children.

3.5. The word categories of the first 100-word lexicon

Fig. 2 shows the median number of words expressed per word category by CI users and hearing children at 19–21 months of hearing age. CI users tended to express more words than hearing children between 19 and 21 months; however, the distribution of words per category were similar. The word categories with the most words for both groups of children were: A) sound effects and animal sounds; E) food and drink; K) people's names; and N) action words. Other categories with relatively higher medians were: B) animal names; D) toys; F) clothing; G) body parts; and M) routines. Neither of the groups had words in categories: O) descriptive words; R) question words; S) prepositions and locations; U) auxiliaries; or V) connecting words.

3.6. To determine the effect of age at implantation on CI users' first words

Age-stratified analyses between CI users younger than 18 months at the time of their first fitting and CI users older than 24

months at first fitting revealed no significant difference in the expression of words at all time intervals ($p = 0.221$ to $p = 0.825$), except at 4–6 months ($p = 0.017$); where the CI users older than 24 months at first fitting had significantly more first words (Fig. 3). Comparing the two age-stratified CI groups to hearing children, the CI users performed better. The expressive word acquisition of both groups of children with a CI was significantly better than the hearing children's at the 10–12 ($p = 0.006$ and $p = 0.001$), 13–15 ($p = 0.008$ and $p = 0.001$) and 16–18 month intervals ($p = 0.017$ and $p = 0.027$). There was no significant difference between the two CI groups and the hearing children at 19–21 month interval (< 18 m: $p = 0.741$; ≥ 24 m: $p = 0.732$), or between CI users older than 24 months at first fitting and hearing children of 22–24 months ($p = 1.000$). CI users younger than 18 months at first fitting had significantly fewer words than the hearing children at 22–24 months of hearing age ($p = 0.052$) (Fig. 3).

4. Discussion

The word acquisition of Turkish children with a CI increased significantly over time and was similar to the word acquisition of Turkish hearing children. The extent of receptive vocabulary was similar between children with a CI and hearing children. Children with a CI acquired their first 100 words earlier than their hearing peers, although the distribution of the words per category were similar for both groups of children. The results of the present study show that children fitted early with a CI can develop receptive and expressive vocabularies similar to those of hearing children.

CI users implanted before 3 years of age develop receptive and expressive vocabularies similar to those of hearing children over a time course of 24 months. However, the data showed that the two groups developed vocabularies at different rates. Although CI users had significantly larger receptive and expressive vocabularies than hearing children, when compared between 10 and 18 months, after 19 months of age hearing children and CI users vocabularies were similar. The acquisition of words by the CI users earlier in the study than hearing children can probably be accounted for by their higher chronological age and related cognitive maturity. The CI users in this study were on average 20 months older than the hearing children. In addition, some of the CI users who benefited from acoustic amplification had already acquired some words prior to implantation. Schramm et al. [16] compared spoken language development of 5 early implanted children with 5 hearing children. They reported that onset of canonical babbling occurred in CI users between 0 and 4 months hearing age, but in hearing children between 4 and 9 months chronological age. As in the present study, the CI users in Schramm et al.'s study showed earlier development than hearing children when hearing age was used for CI users and chronological age for hearing children.

The hearing children in our own study acquired a number of words similar to the CI users, but in a shorter period of time. Taking this faster rate of word acquisition for hearing children into consideration, it seems probable that if the vocabulary of older hearing children had been compared with the development of CI users with a hearing age greater than 24 months, then the hearing children would have had larger vocabularies. This prediction is supported by recent data by Duchesne et al. [17], who found that among children implanted under the age of 2 years, only 50% have a similar word level to their hearing peers at 6 years of age. Moreover, a study by Yoshinago-Itano et al. [18] shows that 8 out of 10 CI users maintain their rate of developmental growth, which suggests that over time hearing children would 'outperform' CI users.

A wide degree of variation in the response of CI users was observed in the present study. The finding of an uneven increase in word acquisition across intervals for CI users highlights the heterogeneous performance of those subjects, which decreases the

Table 1

The most frequently documented 100 words for Turkish children with a cochlear implant (CI) and Turkish hearing children. Words highlighted in bold were not shared by CI users and hearing children.

CI USERS					HEARING CHILDREN			
	Dict. code*	Turkish word	Meaning of word	Word frequency	Dict. code	Turkish word	Meaning of word	Word frequency
1	K3	Baba	Father	112	E6	Mama	Food	59
2	K2	Anne	Mother	108	K3	Baba	Father	55
3	A1	Hav hav	Woof woof	101	K2	Anne	Mother	48
4	C1	Araba	Car	100	K10	Dede	Grand-father	44
5	E3	Su	Water	100	A1	Hav hav	Woof woof	41
6	D3	Top	Ball	94	M6	Bay bay	Bye bye	34
7	M6	Bay bay	Bye bye	94	M2	Alo	On phone	31
8	D4	Bebek	Doll/baby	93	E3	Su	Water	30
9	K10	Dede	Grand-father	92	N10	Gel	Come	29
10	K4	Abi	Older brother	91	A16	Ce-e	Surprise	28
11	A2	Miyav	Miow	87	A2	Miyav	Mioww	27
12	K5	Abla	Older sister	87	D3	Top	Ball	27
13	N10	Gel	Come	87	N5	Aç	To open	27
14	M5	Merhaba	Hello	86	K5	Abla	Older sister	27
15	N23	Al	Take	84	A9	Cis	Do not touch	24
16	A6	Mee	Baa	77	N13	At	Throw	24
17	N5	Aç	To open	77	T6	Yok	Not present	24
18	A5	Mö	Moo	76	N1	Bitti	Finished	23
19	E6	Mama	Food	76	A17	Ho-op	Jump	22
20	N4	Ver	Give	76	B4	kuş	Bird	22
21	M8	Hayır	No	75	D4	Bebek	Doll/baby	22
22	N1	Bitti	Finished	69	N11	Git	Go	22
23	G2	Göz	Eyes	68	N23	Al	Take	22
24	N11	Git	Go	66	A6	Mee	Baa	21
25	A4	Vak vak	Wak wak	65	G3	Burun	Nose	21
26	K7	Amca	Uncle	65	N4	Ver	Give	21
27	B3	Kedi	Cat	64	P7	Pis	Dirty	21
28	E4	Süt	Milk	64	G2	Göz	Eyes	20
29	N7	Otur	Sit	64	B3	Kedi	Cat	19
30	M2	Alo	Hallo	63	B6	At	Horse	19
31	N13	At	Throw	63	C1	Araba	Car	19
32	G3	Burun	Nose	62	E4	Süt	Milk	19
33	A3	Cik cik	Tweet tweet	61	E17	Muz	Banana	18
34	N6	Kapat	Close	61	G5	Saç	Hair	18
35	B2	Köpek	Dog	59	I 4	Kaşık	Spoon	18
36	G5	Saç	Hair	59	K4	Abi	Older brother	18
37	K8	Teyze	Aunt	59	K12	Anneanne	Granny	18
38	Q1	Ben	Me	58	P8	Çirkin	Ugly	18
39	G8	El	Hands	57	B2	Köpek	Dog	17
40	A17	Ho-op	Jump	56	E8	Şeker	Sugar/sweets	17
41	M9	Çiş	Wee wee	55	J3	Park	Park	17
42	B6	At	Horse	54	K8	Teyze	Aunt	17
43	C2	Uçak	Airplane	54	M9	Çiş	Wee wee	17
44	G6	Kulak	Ears	54	P16	Cici	Nice	17
45	A9	Cis	Do not touch	53	A5	Mö	Moo	16
46	E5	Çay	Tea	53	F13	Ayakkabı	Shoes	16
47	K9	Hala	Auntie	53	G4	Ağız	Mouth	16
48	E15	Elma	Apple	53	H9	Kapı	Door	16
49	F3	Çorap	Sock	52	M8	Hayır	No	16
50	K12	Anneanne	Granny	52	N8	Yapma	Don't do it	16
51	A16	Ce-e	Surprise	51	N37	Bak	Look	16
52	B4	Kuş	Bird	51	A11	Ayy	Excited	15
53	E7	Ekmek	Bread	51	E7	Ekmek	Bread	15
54	G4	Ağız	Mouth	51	F3	Çorap	Sock	15
55	N2	Uyu	Sleep	51	G6	Kulak	Ears	15
56	A10	Of	Bored	49	K7	Amca	Uncle	15
57	N16	Kalk	Get up	49	M5	Merhaba	Hello	15
58	F13	Ayakkabı	Shoes	48	N34	Koy	Place	15
59	H9	Kapı	Door	48	A15	E	Dirty	14
60	J8	Ağaç	Tree	48	E15	Elma	Apple	14
61	A15	E	Dirty	47	G7	Diş	Teeth	14
62	G9	Ayak	Feet	47	G9	Ayak	Feet	14
63	J9	Çiçek	Flower	46	N12	Ye	Eat	14
64	N12	Ye	Eat	46	N16	Kalk	Get up	14
65	A14	Ooo	To pet	45	N18	Öp	Kiss	14
66	I 4	Kaşık	Spoon	45	R2	Nerede	Where	14
67	N8	Yapma	Don't do it	45	U1	Me/Ma	Negative suffix	14
68	N18	Öp	Kiss	44	E5	Çay	Tea	13
69	B1	Ayı	Bear	43	E9	Yumurta	Egg	13
70	N35	Dur	Stop	43	K9	Hala	Auntie	13
71	P5	Sıcak	Hot	43	N7	Otur	Sit	13
72	A11	Ayy	Excited	42	P5	Sıcak	Hot	13
73	K13	Nine	Grandma	42	Q1	Ben	Me	13

Table 1 (Continued)

CI USERS				HEARING CHILDREN				
Dict. code*	Turkish word	Meaning of word	Word frequency	Dict. code	Turkish word	Meaning of word	Word frequency	
74	N9	Oyna	Play	42	A4	Vak vak	Wak wak	12
75	I 14	Bardak	Glass	41	B7	Eşek	Donkey	12
76	M7	Evet	Yes	41	B8	Balık	Fish	12
77	A8	Aahh!	Expression	40	D2	Oyuncak	Toys	12
78	I 11	Telefon	Telephone	40	E14	Pasta	Cake	12
79	Q6	Benim	Mine	40	G8	El	Hands	12
80	G7	Diş	Teeth	39	G17	Dil	Tongue	12
81	P7	Pis	Dirty	39	H8	Yatak	Bed	12
82	N37	Bak	Look	38	I 3	Tabak	Plate	12
83	R2	Nerede	Where	38	I 14	Bardak	Glass	12
84	D1	Balon	Baloon	37	N2	Uyu	Sleep	12
85	F6	Pantolon	Trousers	37	N35	Dur	Stop	12
86	I 5	Çatal	Fork	37	A3	Cik cik	Tweet tweet	11
87	K17	Özel isim 1	Special name 1	37	A8	Aahh!	Expression	11
88	N19	Koş	Run	37	A10	Of	Bored	11
89	N34	Koy	Place	37	C2	Uçak	Airplane	11
90	P9	Küçük	Small	37	E11	Çorba	Soup	11
91	B8	Balık	Fish	36	E13	Pilav	Rice	11
92	P16	Cici	Nice	36	H7	Masa	Table	11
93	E17	Muz	Banana	35	J 9	Çiçek	Flower	11
94	I 3	Tabak	Plate	35	K17	Özel isim 1	Special name 1	11
95	N3	Bekle	Wait	35	N6	Kapat	To close	11
96	T6	Yok	Not present	35	Q6	Benim	Mine	11
97	K11	Babaanne	Grand-mother	34	B10	Ördek	Duck	10
98	K22	Dayı	Uncle 6	34	B13	Kuzu	Lamb	10
99	N22	Sus	Be quiet	34	E2	Çikolata	Chocolate	10
100	P10	Büyük	Big	34	E10	Yoğurt	Yogurt	10

The most frequently documented 100 words for Turkish children with a cochlear implant (CI) and Turkish hearing children. Words highlighted in bold were not shared by CI users and hearing children.

value of comparing outcomes for individual CI users with ‘norms’. The heterogeneity of this group also means that norms should be established from large populations. In this study data was collected from 71 CI users. Future studies could try to collect data from a larger population. To obtain a more precise picture of the development of receptive and expressive words over time, it would be useful to collect data longitudinally, every month over a 24-month period. CI users on average acquired a receptive and expressive first 100-word lexicon during 7–9 months of hearing age. Whereas, the hearing children on average acquired a receptive and expressive first lexicon during 16–18 months. The way this study was designed prevented the precise definition of ‘normal’ times of acquisition of a lexicon. Study intervals were 3 months

apart, and the number of words a child had was simply calculated and attributed to the appropriate age interval. In contrast, a recent study by Nott et al. [13] used diaries, filled out on a weekly basis by parents, and stopped once a receptive and expressive 100-word first lexicon was attained. This allowed the precise time of first lexicon acquisition to be defined. In the same study Nott et al. [13] also compared the lexical content of CI users’ first 50 and 100 words with hearing children. Nott et al. used fifteen word categories sorted into 4 broader categories. Nouns constituted the largest proportion of the words, followed by predicates and paralexicals, and then the smallest group, grammaticals. Most words in the first lexicon were nouns and verbs, and very few words were found in complex categories such as question words

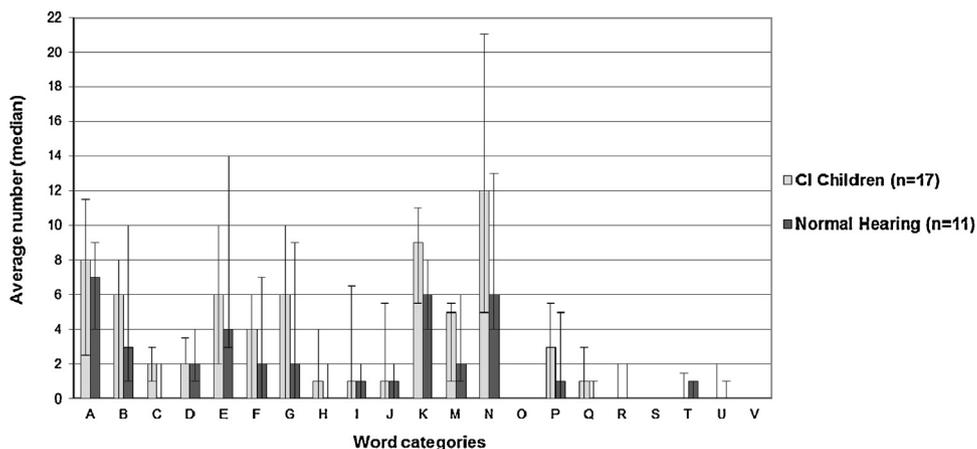


Fig. 2. Median number of words expressed by word category between 19 and 21 months of hearing age for CI users (CI Children) and hearing children (Normal Hearing). Error bars represent the 25th and 75th percentiles. The word categories are: A) sound effects and animal sounds; B) Animal names; C) Vehicles; D) Toys; E) Food and drink; F) Clothing; G) Body parts; H) Furniture and rooms; I) Small household items; J) Outside things and places to go; K) People M) Routines; N) Action words; O) Words about time; P) Descriptive words; Q) Pronouns; R) Question words; S) Prepositions and locations; T) Quantifiers and articles; U) Auxiliaries; or V) Connecting words.

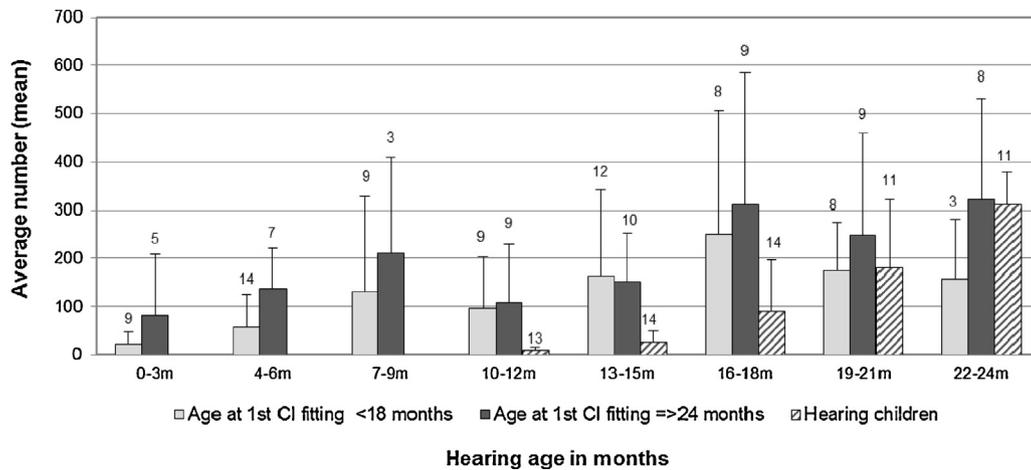


Fig. 3. Mean expressive words recorded for CI users younger than 18 months at time of first fitting or older than 24 months at time of first fitting compared to hearing children at 3 month time intervals. Error bars represent standard deviation.

and prepositions. These findings are similar to ours. Most words in the first lexicons were nouns and verbs, and very few words were found in complex categories such as question words and prepositions. Nott et al. [13] also showed that hearing and hearing impaired children had a similar distribution of words across the word categories. Likewise, we found that 83% of words in the first expressive lexicon of hearing children and CI users were shared. The rehabilitation centers and families of the CI users included in this study used a natural auditory oral approach to spoken language development. The fact that these CI users are exposed to a natural language input probably accounts for the high degree of word similarity.

In the aforementioned Nott et al. [13] study they also looked at the number of days taken to achieve certain word number targets after production of a first word. The study demonstrated that both the hearing children and the CI users demonstrated acceleration acquisition over time, but hearing children required a significantly shorter amount of time than CI users to acquire the first 50 and then the first 100 words. Similarly, our own data demonstrated that both hearing children and CI users show accelerated acquisition over time, but that hearing children, once they started to say words, acquired words at the faster rate. Nott et al. conclude that despite early fitting of a CI, hearing loss continues to impact lexical acquisition, with implanted children acquiring new words at a slower rate than hearing children.

No effect of age at implantation could be found on the number of words acquired in this study. The main reason for this may be that all children included in this study were implanted under the age of 36 months and the mean age of implantation was 26 months. Many studies have demonstrated better performance in children implanted with a CI under 2–3 years than older implanted children. However, few studies have been able to demonstrate differences in performance between young and very young implanted children. Svirsky et al. [6] could not find any significant effect of age at implantation on rate of word recognition development. More comprehensive recent outcome studies investigating performance at both word and sentence levels, although pointing out the advantages of earlier implantation, also highlight the substantial variability in language outcomes for CI users even in children implanted under 24 months of age [17,19].

Houston and Miyamoto [20] report that children implanted during the first year of life have better vocabulary outcomes than children implanted in the second year of life, but speech perception outcomes are the same. They argue that auditory experience by one year of age may be important for developing normal

word-learning skills. None of the CI users included in our study were implanted under the age of 12 months, so data to support these findings could not be collected.

5. Conclusions

This study provides valuable information about first word acquisition by Turkish hearing and cochlear implanted children. Hearing and implanted children have similar vocabularies at 24 months of chronological age and 24 months of hearing experience, respectively. Once hearing children start to acquire words, they do so at a faster rate than children with a CI. Hearing children and children with a CI use the same categories of words and 83% of the first 100-word lexicon is shared by both groups. The development and rate of acquisition of the first lexicon varied in the implanted group. No effect of age at implantation could be found on the children. Similarities in the vocabularies between hearing and implanted children suggests that early access to sound through a CI allows users to acquire words in much the same way as hearing children, when CI users are provided with similar language experiences.

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