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Language development in a bimodal bilingual child with cochlear implant: A longitudinal study*

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To address the negative effects of deafness on spoken language acquisition, many clinicians suggest using cochlear implant (CI) and oral education and advise against sign language, even when combined with spoken language (i.e., bilingualism), believing that it may slow down spoken language development. In a deaf child with CI who was exposed at an early age to Italian Sign Language and spoken Italian, we evaluated language development and the relationship between the two languages. The number of words/signs produced by the child consistently increased with age, and the vocabulary growth rate in spoken Italian was equivalent to that of hearing peers. Before CI, the child relied almost exclusively on sign language; after CI, he gradually shifted to spoken Italian yet still used sign language when unable to retrieve words in spoken Italian. We conclude that bimodal bilingualism may scaffold the development of spoken language also in deaf children with CI.

Keywords: sign language, spoken language, language acquisition, deaf bilingualism, bimodal bilingualism

Introduction

Various studies have highlighted the effects of severe to profound deafness on the acquisition and development of spoken language in children, particularly with regard to developmental milestones in language acquisition and mastering (Caselli, Maragna & Volterra, 2006; Spencer & Marschark, 2006). Approximately 219,000 people worldwide received cochlear implants (CI). In the United States, roughly 28,400 children have received CI and this number is increasing (NIH, 2011). Similar estimates are not available for Italy. The overall linguistic skills of children with CI show great individual variability, which can be attributed to diverse factors, including age at diagnosis of deafness (e.g., Blamey, Barry, Bow, Sarant, Paatsch & Wales, 2001; Rinaldi, Baruffaldi, Burdo & Caselli, 2013), age at CI activation (e.g., Geers, Moog, Biedenstein, Brenner & Hayes, 2009), family environment (e.g., Spencer, 2004; Szagun & Stumper, 2012) and language(s) the child is acquiring (for a recent review on languages other than English, see Crowe & McLeod, published online February 8, 2013). Moreover, outcomes differ for different linguistic subsystems. Children seem to do particularly well in tests of vocabulary and less well in tests of productive syntax and morphology (Caselli, Rinaldi, Varuzza, Giuliani & Burdo, 2012b; Duchesne, Sutton & Bergeron, 2009; Geers et al., 2009; Niparko, Tobey, Thal, Eisenberg, Wang, Quittner & Fink, 2010).

Some studies have shown that deaf children with CI reach higher linguistic skills than deaf children with traditional hearing aids in receptive language outcomes (Baldassari, Schmidt, Schubert, Srinivasan, Dodson & Sismanis, 2009) and similar to that of hearing children whose chronological age corresponds to the time elapsed since CI activation (Caselli et al., 2012b).

Exposure to signs has been identified as a factor that influences spoken language outcome. Children can be exposed to signs in various ways, such as the use of signs to support spoken language, as in Total Communication programs, or their use as a complex linguistic system, namely, a sign language. If a deaf child is exposed to both sign language and spoken language, he/she could be considered as bimodal bilingual, which differs from unimodal bilingualism because the languages are perceived and produced through different modalities, that is, the spoken language is perceived through the ears and mainly produced through the voice, and the sign language is perceived through the eyes and mainly produced through the hands. Among unimodal and bimodal bilingual children,

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characteristics such as the time of onset of bilingualism, the amount of exposure to each language and the settings in which each language is acquired and used can vary greatly. The language that is strongest or dominant may depend on age, learning opportunities, subcomponents of language proficiency (e.g., comprehension, production, syntax), the specific topics being discussed, and context (e.g., school, home). Bilingual persons can also shift from one language to another depending on the specific individual with whom they are communicating, the context, and the purpose of communication (for a review on this topic, see Rinaldi, Caselli, Onofrio & Volterra, 2014). Moreover, contacts between the languages frequently occur, which is referred to as "code-mixing phenomena". For unimodal bilingualism, the languages usually interact in a sequential manner (referred to as "code-switching"), whereas for bimodal bilingualism the languages often interact in a simultaneous manner ("code-blending"), which is unique to bimodal bilingualism, and the code-blends are generally semantically equivalent (Donati & Branchini, 2013; Emmorey, Borinstein, Thompson & Gollan, 2008; Emmorey, Petrich & Gollan, 2012).

In Italy, as in many other countries, only 5–10% of deaf children are native signers, that is, they acquire sign language from deaf signing parents (Caselli et al., 2006). Compared to non-native signers, these children benefit from a more homogeneous language experience, although sign-language skills can vary greatly even within deaf signing families, as a result of the factors mentioned above. These differences are greater for non-native signing children because it is more difficult for their families to expose them to sign language beginning at birth. The growing number of deaf children who receive CI at an early age is not exposed to a bimodal bilingual educational approach. Indeed, some clinicians consider sign language as unnecessary (or even harmful) to the acquisition of spoken language (Percy-Smith, Cayé-Thomasen, Breinegaard & Jensen, 2010; for a recent debate on this topic, see Humphries, Kushalnagar, Mathur, Napoli, Padden, Rathmann & Smith, published online by BioMed Central Ltd., April 2, 2012; Knoors & Marschark 2012). For this reason, most deaf children with CI are enrolled in speech therapy programs in which only spoken language is used; in other cases, deaf children are exposed to signs in Total Communication programs or programs in which sign language is used only as support for spoken language.

A number of studies have been carried out to explore the impact of the mode of communication on spoken language outcomes. Two studies compared two groups of deaf children of 8–9 years of age who had received CI before 5 years of age and were enrolled in Total Communication programs or auditory-oral programs (Geers, Spehar & Sedey, 2002; Tobey, Rekart, Buckley & Geers, 2004). In the first study (Geers et al., 2002), in which 27 deaf children were evaluated longitudinally, the children who primarily used speech showed greater auditory speech perception, speech intelligibility, and comprehension and use of English syntax than did the children who mainly relied on manual communication. In the second study (Tobey et al., 2004), which was conducted among 131 deaf children, those enrolled in Total Communication programs had lower speech intelligibility scores than children enrolled in auditory-oral programs. In a subsequent longitudinal study with the same objective (Wie, Falkenberg, Tvete & Tomblin, 2007), which involved 79 deaf children with CI who used different modes of communication – i.e., Norwegian sign language (NSL) only (and written Norwegian); NSL as the first language and spoken language as the second language; spoken language as the first language and NSL as the second language; spoken language with sign support; and spoken language only – speech recognition and its rate of growth were positively associated with the level of focus on, and use of, spoken language.

Studies conducted on the linguistic skills of children with CI who grew up in a bimodal bilingual environment (spoken language and sign language) have reported different results from those mentioned above. In one study (Hassanzadeh, 2012), speech perception, speech production and language development after CI were compared in seven deaf children with deaf parents (exposed to Persian Sign Language since birth and to spoken Persian after CI) and seven deaf children with hearing parents (raised in a monolingual spoken Persian environment); the author found that the bimodal bilingual children performed better than the other children and concluded that the acquisition of sign language as the child's first language supports later learning of a spoken language. Similar results were reported in another study (Jiménez, Pino & Herruzo, 2009) in which language development was studied both before and after CI in 18 deaf children between 4 and 8 years of age. The children were divided into two groups according to the educational environment (bilingual: spoken Spanish and Spanish Sign Language; and monolingual: spoken Spanish only); the monolingual children showed better skills in terms of pronunciation, oral comprehension and use of grammatical rules, whereas the bimodal bilingual children showed better skills in terms of verbal fluency in a task using picture stimuli, as they were able to evoke a greater number of words.

Davidson and colleagues have recently compared spoken language development of American native signing preschool children with CI and of hearing children with deaf signing parents (Davidson, Lillo-Martin & Chen Pichler, published online October 21, 2013). All children had been exposed since birth to American Sign Language (ASL) and raised in a bimodal bilingual environment (ASL and spoken English). Hearing children had been

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exposed to spoken English since birth, while deaf children had been exposed to spoken English since their CI activation. Results showed comparable spoken language skills between the two groups. Furthermore, deaf children exposed since birth to ASL showed a better performance in spoken language than previously reported in studies on deaf children with CI growing up in a monolingual environment and not exposed to sign languages, with comparable age of implantation and years of CI use.

According to studies on the developmental changes that occur in each language and in the relationship between the two, most children who have been exposed to a sign language from a very young age and who then received a CI demonstrate a modality shift from the sign language to the later acquired spoken language. In a study on three preschool children who had been exposed to American Sign Language at an early age and had received a CI before the age of three, the children shifted from signed communication to oral communication (Yoshinaga-Itano, 2006). A shift to spoken language was also reported in a study on 176 children, which found that the shift was more marked for children who had received their CI before the age of three (Watson, Archbold & Nikolopoulos, 2006). The reasons for this change toward a greater use of spoken language could be attributed to increased exposure to sound or to the fact that spoken language becomes the dominant form of communication in the child's environment after CI activation, also because CI is often chosen by parents with the goal of spoken language development (Archbold, Sach, O'Neill, Lutman & Gregory,2006) and because the majority of habilitation programs after CI mainly focus on the development of auditory and oral skills. In children that display a modality shift, the acquired sign language is, however, retained and used, which some authors have explained as a means of "back-up" when communication breakdown occurs, notwithstanding the child's speech proficiency (Spencer & Bass-Ringdahl, 2004; Watson, Hardie, Archbold & Wheeler, 2008).

Notwithstanding findings documenting the positive effect of bimodal bilingualism (sign language and spoken language) even in children with CI, the jury is still out on the positive outcomes of this coexistence, in part because the results of studies can be affected by the different means of collecting data, the different linguistic environments in which the children grow up, and the characteristics of the study participants themselves. For these reasons, further investigations on language acquisition processes in bimodal bilingual deaf children with CI are needed to understand better this particular kind of bilingualism and the impact of the exposure to sign language on linguistic development.

In the present study, we evaluated the early phases of language development in a deaf child with hearing parents who had been exposed from an early age to both Italian sign language (LIS) and spoken Italian and who had received CI at 2 years 5 months (2;5) of age. The specific objectives were to study the following: (i) lexical development in relation to both language comprehension and production, for both LIS and spoken Italian; (ii) the rate of vocabulary growth in spoken Italian, in comparison to hearing peers; and (iii) the relationship between the two languages (in terms of shift from one language to another and code-mixing strategy), taking into account the time elapsed since CI activation.

Methods

Participant

Our participant, whom we shall call Giulio, was diagnosed with severe bilateral sensory neural deafness when he was one year old; at one year and eight months (1;8 years) of age he received digital hearing aids and began speech therapy with a bimodal approach. This approach is different from bimodal bilingual education. Indeed, bimodal speech therapy relies on simultaneous communication, which consists of the spoken language and the simultaneous use of lexical signs from sign language (in our case, LIS), yet following the grammatical structure of the spoken language (in our case, spoken Italian).

At 2;5 years of age he received a CI, which was activated after one month. Giulio has always lived in a bilingual environment. In fact, at the time of diagnosis his parents decided to bring him to a bilingual daycare center where LIS and spoken Italian were used. He was exposed to LIS by one deaf teacher and his deaf classmates and to spoken Italian by his hearing teachers and hearing classmates. Giulio has one older brother and one older sister, both hearing children; his brother was sent to the same bilingual school and his mother and sister started studying LIS. Even after having received CI and well beyond kindergarten, Giulio continued to attend bimodal speech therapy and to live in a bilingual environment. His parents believed that it would be very helpful for him to attend a bilingual school, as this would allow their child to be in contact with deaf culture and sign language. However, after Giulio's CI was activated, his family mainly used spoken language; and in the family environment LIS was used only in a limited number of contexts (e.g., when Giulio was not wearing the CI or when he needed to understand concepts that his parents defined as "complex").

Materials

We evaluated various aspects of Giulio's linguistic skills using the age-appropriate tools described below.

Leiter International Performance Scale-R

We administered the brief version of the Leiter International Performance Scale-R (four of the ten subtests:

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Figure Ground, Form Completion, Sequential Order and Repeated Patterns), which is a nonverbal cognitive test yielding a Brief IQ (Roid & Miller, 1997). This test is particularly appropriate for deaf children, in that it consists of nonverbal tasks with nonverbal instructions.

Il Primo Vocabolario del Bambino Sordo, PVB-s (The First Vocabulary of the Deaf Child)

The PVB-s is a parental report questionnaire for the evaluation of communication and language development in deaf children (Caselli & Rinaldi, 2005; Rinaldi & Caselli, 2009). It is used to evaluate spoken language and sign language or "home signs" and is an adaptation of the Italian version of the MacArthur-Bates Communicative Development Inventories (MB-CDI – Caselli, Pasqualetti & Stefanini, 2007; Fenson, Marchman, Thal, Dale, Reznick & Bates, 2007). In this study, we used the vocabulary checklist of the Words and Sentences Short Form. The checklist consists of 100 items, and parents are asked to tick their child's comprehension and production of each lexical item, whether spoken and/or using a gesture or LIS. Parents are instructed not to record meanings expressed by a pointing gesture, unless explicitly requested, such as for body parts (e.g., eyes) or pronouns (e.g., me). The lexical items are the same as those used in the short form for hearing children.

Various studies have found that MB-CDIs are effective in characterizing children's early language skills (Caselli, Rinaldi, Stefanini & Volterra, 2012a; Dale, Bates, Reznick & Morisset, 1989; Fenson et al., 2007; Thal, O'Hanlon, Clemmons & Fralin, 1999;). It has been used in populations with typical development (e.g., Dale, Dionne, Eley & Plomin, 2000; Farrar & Maag, 2002; Feldman, Dollaghan, Campbell, Colborn, Janosky, Kurs-Lasky, Rockette, Dale & Paradise, 2003), as well as in those with atypical development, including deaf children (Mayne, Yoshinaga-Itano & Sedey, 2000; Mayne, Yoshinaga-Itano, Sedey & Carey, 2000; Rinaldi & Caselli 2009; Rinaldi et al., 2013; Stallings, Gao & Svirsky, 2002; Thal, DesJardin & Eisenberg, 2007; Yoshinaga-Itano, Snyder & Day, 1998). For the Words and Sentences Italian version, norms are available for hearing children between the ages of 18 and 36 months (Caselli et al., 2007).

Picture Naming Game

The Picture Naming Game (PiNG) (Bello, Giannantoni, Pettenati, Stefanini & Caselli, 2012) is a test for the assessment of lexical comprehension and production in preschool children. PiNG consists of four subtests: Noun Comprehension (NC), Noun Production (NP), Predicate Comprehension (PC) and Predicate Production (PP), each of which consists of 20 lexical targets and two training items. Only the NP subtest was administered. Norms are available for hearing children between 19 and 37 months of age (Bello et al., 2012).

Peabody Picture Vocabulary Test – Revised

The Peabody Picture Vocabulary Test – Revised (PPVT-R) (Stella, Pizzoli & Tressoldi, 2000) is a test for the evaluation of comprehension based on standard Italian. The items are presented in a multiple-choice format. The examiner provides a vocabulary word and the child points to the black and white picture that corresponds to it. Depending on the child's age, there are different starting points. The test ends when the child makes six errors within eight consecutive items. Norms are available for hearing children between 3;9 and 11;6 years of age.

Boston Naming Test

The Boston Naming Test (BNT) (Kaplan, Goodglass & Weintraub, 1983; Riva, Nichelli & Devoti, 2000) is a picture naming test frequently used to evaluate the expressive skills of school-aged children and of adults with aphasia. Each of the 60 items is a black and white drawing; the child is asked to name them. Norms are available for hearing children between six and ten years of age and for adults. The score expected for six-year-old hearing children in spoken Italian is 26 (standard deviation = 8). This test has been used to evaluate the lexical skills of older Italian deaf signing children (Tomasuolo, Fellini, Di Renzo & Volterra, 2010). Although normative data on Italian preschool children are not available, we decided to use this test because there are no other standardized tests for evaluating lexical skills in this age group. The scores obtained are discussed in terms of developmental changes across the different observations.

Procedures

Giulio was followed from 2;6 years of age to 5;1 years of age (i.e., from immediately before CI activation to two and a half years after activation). Study sessions took place every 5–8 months and were aimed at evaluating lexical comprehension and production in both LIS and spoken Italian.

The evaluations were classified as either "evaluation in LIS" or "evaluation in spoken Italian", depending on the hearing status of the examiner (deaf or hearing) and the language that the examiner used when administering the tests (LIS or spoken Italian). In other words, when the tests were administered to the child in sign language by a deaf signer (with good skills in spoken Italian), the observation was considered to be "in LIS"; when the tests were administered to the child in spoken Italian by a hearing examiner (with good skills in LIS), it was considered to be "in spoken Italian". This differentiation was possible only for the lexical comprehension tests and not for lexical production, because during all of the observations Giulio was free to use the language he preferred or to switch from one language to the other; all of his lexical productions

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were accepted, regardless of the language used and the examiner's hearing status, and he was not asked to produce them in the "other" language. All observations were videotaped and later transcribed and analyzed.

For the evaluation of lexical comprehension with PiNG, adult deaf native signers were asked for their advice as to whether or not the sign was acceptable, given that there can be more than one correct sign for a single item and that the test had never been administered to deaf children; for each item, the sign corresponding to the target and the correct formal execution were identified. For the evaluation of lexical comprehension with PPVT-R, the adaptation in LIS was available because this test has already been used in previous studies with deaf children and adolescents (Pizzuto, Ardito, Caselli & Volterra, 2001; Tomasuolo, Valeri, Di Renzo, Pasqualetti & Volterra, 2013).

Regarding the assessment of lexical production in LIS (PiNG and BNT), no adaptation was necessary. The signs produced by the child were analyzed with an adult deaf native signer who evaluated the accuracy of the productions with respect to the targets.

Normative data on deaf children or on bilingual children are not available for any of the tools used. Therefore, we will refer to normative data on hearing monolingual Italian children.

In accordance with recent studies on lexical production in bilingual children, we considered the Total Conceptual Vocabulary (TCV) (Bedore, Peña, García & Cortez, 2005; Pearson, Fernandez & Oller, 1993). TCV focuses on the number of "concepts" the child produces, regardless of the language used, counting only once the lexical items produced with a word and with a sign. This procedure has been widely used to assess vocabulary in unimodal bilingual children (Bedore et al., 2005; Marchman, Fernald & Hurtado, 2010; Onofrio, Rinaldi & Pettenati, 2012; Patterson, 2004; Pettenati, Vacchini, Stefanini & Caselli, 2011), as well as in bimodal bilingual deaf children (Rinaldi, 2008). In our study, as was done for the indirect observations through PVB-s, we counted the total number of lexical items produced by the child in spoken Italian only, in LIS only, and in both (e.g., the parent ticks the child's production for the word "dog" and for the LIS sign for "dog"); the latter counted only once.

As for direct observations through PiNG and BNT, we counted the total number of lexical items produced by the child in spoken Italian only, in LIS only, and in both (e.g., if the child, while viewing the picture of a dog, correctly answered by stating "dog" and also produced the LIS sign for "dog"); the latter counted only once.

For lexical comprehension evaluated using PVB-s, it was not possible to determine whether the child understood a sign or whether he understood a word in spoken Italian, given that the questionnaire does not distinguish between the two. Thus the parent was asked to tick the box for lexical comprehension if the child demonstrated that he understood the given concept, regardless of the mode of presentation (i.e., word, sign, word and sign).

Results

Cognitive development

During the longitudinal study, cognitive development was evaluated only once, when Giulio was three years old. Since his IQ was within normal limits (IQ = 104), no further cognitive evaluation was performed.

Lexical skills between ages of 2;6 and 3;5

PVB-s

The number of lexical items from the vocabulary checklist of the MB-CDI that Giulio understood and produced over time is reported in Figure 1. In assessing production, we considered the TCV.

For both comprehension and production, a growth in the lexical repertoire was evident. In lexical comprehension (for which we were not able to distinguish between spoken Italian and sign language, and normative data for this age are not available), Giulio's repertoire increased by 17 labels between the first and second evaluations and by another 16 labels between the second and third evaluations. In lexical production, at the first evaluation, when Giulio was 2;6 years old and had been attending speech therapy sessions for 10 months, he produced 59 labels, regardless of the language used. When comparing his TCV with normative data from monolingual hearing peers, Giulio's performance was between the 25th and 50th percentiles. At the second evaluation, he produced 79 labels, and his TCV remained between the 25th and 50th percentiles, based on normative data on monolingual hearing three-year-olds. At the third evaluation, when Giulio was 3;5 years old, the questionnaire was at its ceiling in both lexical comprehension and production (100 labels understood and produced). Data are shown in Table 1. Normative data are not available for this age.

Subsequent analyses were performed to check the rate of lexical development in spoken Italian and to study the relationship between spoken Italian and LIS. The number of words produced (in spoken Italian) increased from 2 at the pre-implant evaluation to 18 at the evaluation performed five months after CI activation. These findings are very similar to those observed in a cross-sectional sample of hearing peers using the same vocabulary checklist (Caselli et al., 2007). In fact, the 50th percentile of word production at 30 and 36 months corresponded to 75 and 92 words, respectively, meaning that monolingual hearing children expand their vocabulary by 17 words in the six months between 30 and 36 months of age. It

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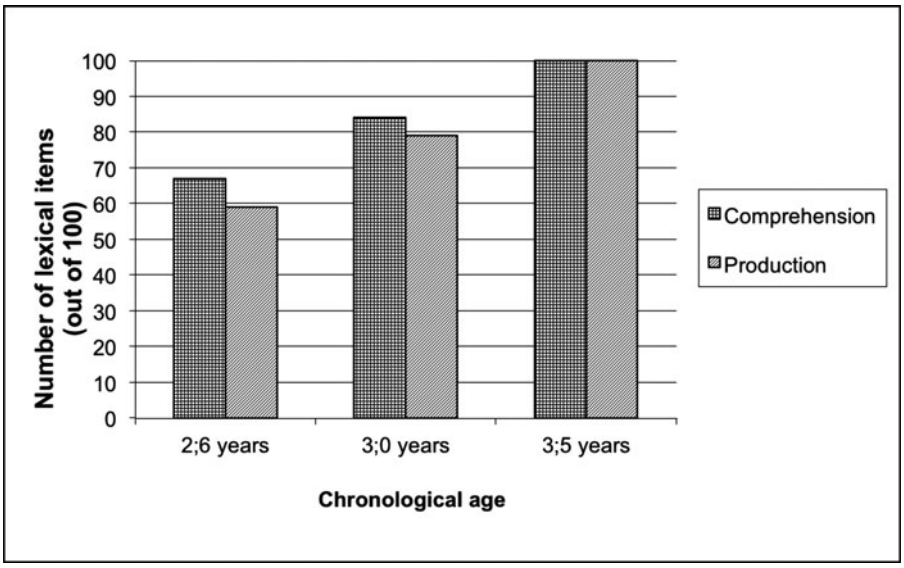

Figure 1. Number of lexical items understood and produced, evaluated using PVB-s at the ages of 2;6, 3;0 and 3;5.

Table 1. *Child's score and percentiles in the evaluation at 2;6, 3;0 and 3;6 with PinG and PVB-s.*

	Evaluation in:		
	LIS and spoken Italian	LIS and spoken Italian	LIS and spoken Italian
Chronological age (in years;months)	2;6	3;0	3;6
PVB-s			
Number of lexical items produced only in LIS	57	61	31
Number of lexical items produced in LIS and in spoken Italian	2	18	67
Number of lexical items produced only in spoken Italian	0	0	2
Total Conceptual Vocabulary	59	79	100
Percentile (normative data on monolingual hearing children)	>25th <50th	>25th <50th	Not available
PiNG			
	Spoken Italian	Spoken Italian	—
CORRECT ANSWERS			
Number of lexical items produced only in LIS	8	7	—
Number of lexical items produced in LIS and in spoken Italian	1	5	—
Number of lexical items produced only in spoken Italian	0	1	—
Total Conceptual Vocabulary	9	13	—
Percentile (normative data on monolingual hearing children)	>10th <25th	>10th <25th	—

can be argued that Giulio, who expanded his vocabulary by 16 words between 30 and 36 months, had the same vocabulary growth of his hearing peers. Ten months after CI activation, the increase in the number of words produced was remarkable: Giulio had expanded his vocabulary by 51 words (he produced 69 words) and partially bridged the gap with his hearing peers. The percentage of lexical elements produced with a word only, with a sign only and with both, over time, is reported in Figure 2.

In the first two evaluations Giulio mainly used LIS, and all of the words produced in spoken Italian were accompanied by the corresponding sign. In the third evaluation, a high percentage of production in LIS still remained, but an increase in the percentage of spoken words produced with the corresponding sign was

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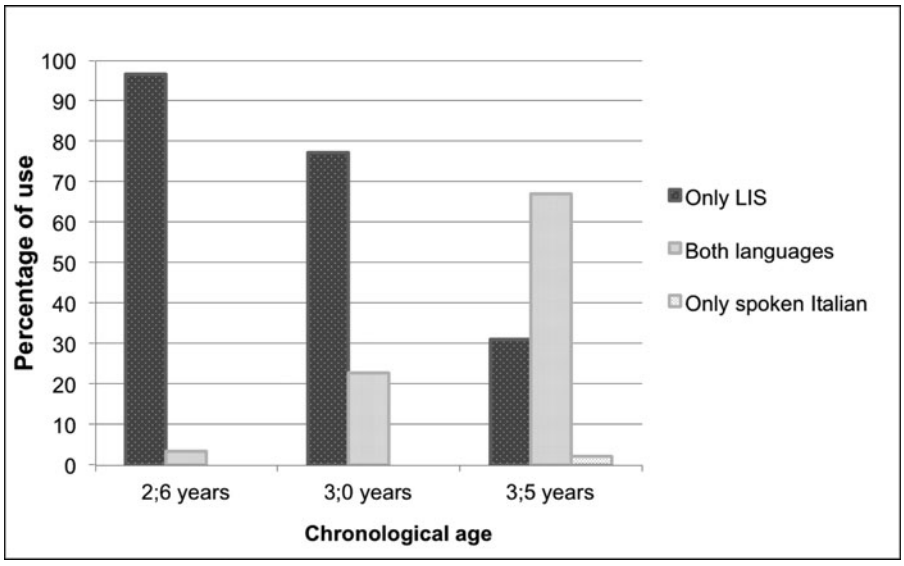

Figure 2. Percentage of lexical items produced only with signs, only with spoken words and with signs and spoken words, evaluated using PVB-s at the ages of 2;6, 3;0 and 3;5.

observed, so that a shift in the mode of communication was already evident, from signed modality to bimodal bilingual productions.

PiNG

The results of PiNG, which was administered twice (at 2;6 and 3 years), in spoken Italian, are shown in Table 1. On both occasions, Giulio's performance was between the 10th and 25th percentiles and thus within normal limits.

Regarding the mode of communication used, the percentage of items named with a word only, with a sign only, and with both are shown in Figure 3.

At 2;6 years of age, about 90% of the correct answers were expressed only in LIS; no correct answer was expressed only in spoken Italian; and only one item was expressed in both. At 3 years of age, the percentage of correct answers produced with bimodal production (spoken Italian and sign) had grown to 46%, and one answer was provided in spoken Italian alone.

As already shown by indirect observations in the same period, there was a gradual shift in the mode of communication. In fact, Giulio mainly used sign language, though the number of words produced together with the corresponding sign gradually increased.

Lexical comprehension and production between ages of 3;11 and 5;1

Six months after the last observation with the PVB-s, lexical comprehension and production were evaluated three times in spoken Italian, at 6–8-month intervals (at 3;11, 4;5 and 5;1 years of age), and once in LIS, when the child was 3;11 years old. The results of the PPVT-R and BNT are reported below.

PPVT-R

The scores obtained in lexical comprehension are reported in Table 2. Regarding the administration in LIS, when the child was 3;11 years old, we calculated the scaled score by comparing the raw score obtained with the normative data available on hearing children (performing the test in spoken Italian). The scaled scores provided in the test's manual have a mean value of 100 and a standard deviation of 15 (Stella et al., 2000). The scaled score obtained by Giulio in LIS was 90, which is within normal limits. The scaled scores obtained in the three administrations in spoken Italian were stable, lower than that in the administration in LIS, and between the first and the second standard deviation below the mean, thus slightly below normal.

BNT

The results from the BNT are shown in Table 2. In the evaluation in LIS, when the child was 3;11 years old, the criteria for interruption were not reached; thus all 60 items were administered. The raw score was 23. With regard to the three evaluations in spoken Italian, an improvement in Giulio's performance over time was evident at three different levels: i) the number of correct responses, regardless of the language used, increased from 8 to 16 to 27; ii) the number of correct responses in spoken Italian (whether accompanied or not by the corresponding sign) increased from 8 to 15 to 21; iii) the number of items administered before reaching the ceiling increased from 23 to 47 to 60. Both in the evaluation in LIS, when Giulio was 3;11 years old, and in the last evaluation in spoken Italian, when he was 5;1 years old, the scores were very

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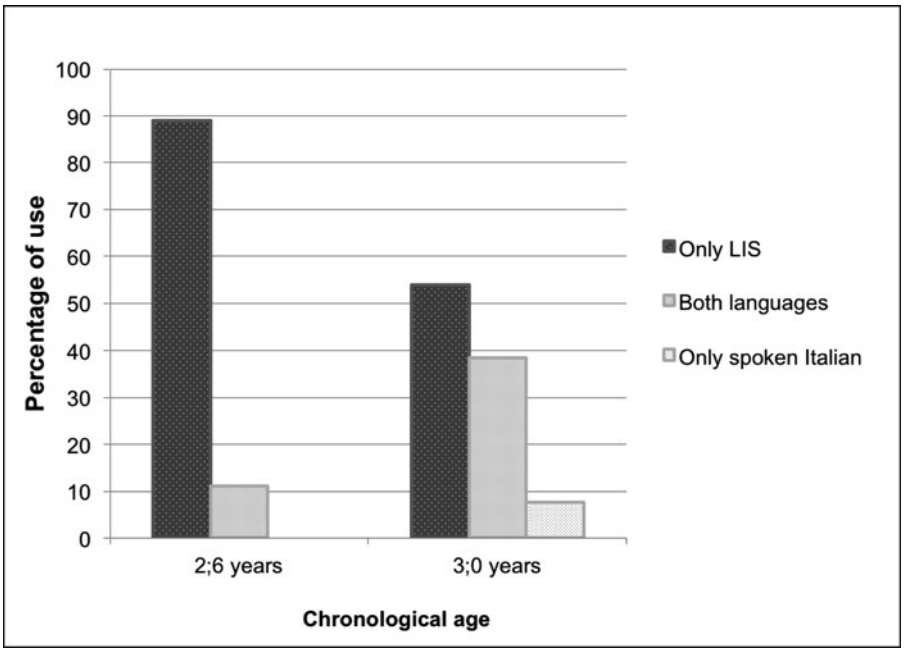

Figure 3. Percentage of lexical items produced only with signs, only with spoken words and with signs and spoken words, as evaluated through Ping at the ages of 2;6, and 3;0.

Table 2. *Results at the PPVT-R (lexical comprehension) and BNT (lexical production) between ages of 3;11 and 5;1.*

	Evaluation in:			
	LIS	Spoken Italian	Spoken Italian	Spoken Italian
Chronological age (years;months)	3;11	3;11	4;5	5;1
Peabody Picture Vocabulary Test-R				
Raw scores	43	29	41	60
Scaled scores based on chronological age	90	81	78	77
Boston Naming Test				
Items administered until ceiling:				
6 consecutive errors	60	23	47	60
Lexical items produced only in the requested modality	19	8	6	16
Lexical items produced in LIS and in spoken Italian	3	0	9	5
Lexical items produced only in the not requested modality	1	0	1	6
Correct answers (Total Conceptual Vocabulary)	23	8	16	27

close to the Italian norms for 6-year-old hearing children who had performed the test in spoken Italian.

With regard to the language used in the first two administrations, one in LIS and the other in spoken Italian, Giulio primarily responded in the language in which the test was administered, whereas in the two later administrations (both in spoken Italian), he mainly used bimodal production. When he was 4;5 years old, more than half of the correct answers were provided in both languages, and when he was 5;1 years old, about 18% of the correct answers were bimodal productions and about 22% were only in sign language.

Discussion

We evaluated lexical development in comprehension and production in a deaf child with CI, born from hearing parents and exposed from an early age to both spoken Italian and LIS. We also studied the rate of vocabulary growth in spoken Italian and the relationship between spoken Italian and LIS, taking into account the time elapsed since CI activation.

With regard to spoken Italian, the growth rate in lexical comprehension and production was very similar to that observed in the child's hearing peers. This was evident

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both in the early evaluations (from 2;6 to 3 years of age, immediately after CI activation) and at later ages (from 3;11 to 5;1 years of age, which corresponded to 1;4–2;6 years after CI activation), as shown by the finding that the child obtained very similar scaled scores at different ages. Lexical comprehension was slightly below the normal range. In lexical production, when considering TCV, Giulio's skills were at the same level as those of his monolingual hearing peers. In accordance with studies on unimodal bilingualism, our data demonstrate that fully evaluating both languages could help better to estimate the linguistic skills of bilingual children (Onofrio et al., 2012; Pearson et al., 1993; Pettenati et al., 2011). However, the extraordinary heterogeneity of experiences and proficiency of bilingual children present some formidable challenges for researchers who wish to develop procedures and standardized norm-referenced measures appropriate for any particular group of dual-language learners, especially when the bilingualism includes a sign language. In fact, methodologies and tools that could allow for a more reliable evaluation of the acquisition of sign languages, as well as the relationship between spoken language and sign language, have been developed only recently and not for all sign languages (Haug, 2012; Rinaldi et al., 2014). In studying language development in bilingual children, the assessment of skills in each of the languages must in fact be integrated with the observation of the relationship between the two languages, in order to analyze the changes that occur over time.

Studies on unimodal bilingualism have shown that language shift from a minority language to the majority language often occurs in bilingual individuals. The amount of contact with native speakers (in particular peers) of the majority language and the motivation to use the majority language are the most important factors related to the language shift (May, 2005; Michel, Tizmann & Silbereisen, 2012). Changes in mode of communication from sign (minority) language toward spoken (majority) language were observed also in deaf children after CI activation, and thus after systematic exposure to spoken language (Watson et al., 2006; Watson et al., 2008). In our study, before CI activation, sign language was clearly dominant: Giulio used this language almost exclusively and produced only two words in spoken Italian, both of which were accompanied by the corresponding sign. Later, 5–10 months after CI activation, sign language was still dominant, yet the child began to increase his lexical repertoire in spoken Italian, although the words were always accompanied by the corresponding sign. Finally, approximately one and a half years after CI activation, Giulio began to differentiate more effectively between the two languages and their contexts of use: words were produced also without the corresponding signs, yet he still used many bimodal productions, particularly in the second and third evaluations in spoken Italian. What appears to have been a reverse trend when the child was shifting toward spoken Italian (i.e., an increase in the use of a sign alone) probably could be explained by the fact that in the second and third evaluations in spoken Italian a higher number of items were administered and the difficulty of the test increased; for this reason, the child may have been relying on sign language both to "help" himself find the word corresponding to the item and to name items for which the corresponding words were not yet known. We can thus conclude that early exposure to sign language in a bilingual environment allowed the child to express ideas and concepts that he was not yet able to speak, opening a window onto new potential learning in spoken language (Lillo-Martin, Quadros, Koulidobrova & Chen Pichler, 2010).

Some studies have shown that deaf children with CI exposed to spoken language only had better performance in certain linguistic outcomes compared to children with CI exposed to signs, in particular when signs support the spoken language, as in Total Communication programs. However, for Giulio, the signs are part of an actual language (i.e., sign language), which the child acquired as his first language and on which the acquisition of his second language (i.e., spoken Italian) was based.

In conclusion, although our results were obtained from a single child, they suggest that the use of signs (through early exposure to sign language) can promote the construction of conceptual representations and support the acquisition of the spoken language. Encouraging deaf children to communicate in sign language from a very early age, before CI, appears to improve their ability to learn spoken language after cochlear implantation (Hassanzadeh, 2012). Thanks to exposure to sign language, Giulio has had the opportunity to understand what is going on around him, asking questions and getting answers in a language he can understand and produce. We can also speculate that, especially in the early stages of Giulio's development, this stimulated his curiosity and fed his intelligence, allowing him to establish good and communicative relations with others (e.g., family members, deaf educators, and speech therapists). Since cochlear implantation (and also thanks to speech therapy), Giulio has had the opportunity to learn spoken Italian in what could be argued to be a much more "natural" way than other deaf children with limited access to linguistic elements.

Our results support the findings of other studies (Boudreault & Mayberry, 2006; Mayberry, 2007) which have found that the acquisition of first and second languages is interdependent. The proper acquisition of the first language, regardless of the specific modality through which it is expressed and perceived, is a critical factor in child development, including further language development. It is thus essential to provide all deaf children, once diagnosed, with the opportunity to acquire

sign language (even if the family plans for cochlear implantation) and spoken language, both of which are necessary for the child's development and enable the child to interact easily with hearing people and other deaf people.

References

Archbold, S. M., Sach, T. H., O'Neill, C., Lutman, M. E., & Gregory, S. (2006). Deciding to have a cochlear implant and subsequent after-care: Parental perspectives. *Deafness and Education International, 8,* 190–206.

Baldassari, C. M., Schmidt, C., Schubert, C. M., Srinivasan, P., Dodson, K. M., & Sismanis, A. (2009). Receptive language outcomes in children after cochlear implantation. *Otolaryngology – Head and Neck Surgery, 140,* 114–119.

Bedore, L. M., Peña, E. D., García, M., & Cortez, C. (2005). Conceptual versus monolingual scoring: When does it make a difference? *Language, Speech, and Hearing Services in Schools, 36,* 188–200.

Bello, A., Giannantoni, P., Pettenati, P., Stefanini, S., & Caselli, M. C. (2012). Assessing lexicon: Validation and developmental data of the Picture Naming Game (PiNG), a new picture naming task for toddlers. *International Journal of Language & Communication Disorders, 47,* 589–602.

Blamey, P., Barry, J., Bow, C., Sarant, J., Paatsch, L., & Wales, R. (2001). The development of speech production following cochlear implantation. *Clinical Linguistics & Phonetics, 15,* 363–382.

Boudreault, P., & Mayberry, R. I. (2006). Grammatical processing in American Sign Language: Age of first-language acquisition effects in relation to syntactic structure. *Language and Cognitive Processes, 21,* 608–635.

Caselli, M. C., Maragna, S., & Volterra, V. (2006). *Linguaggio e sordità. Gesti, segni e parole nello sviluppo e nell'educazione* [Language and deafness: Gestures, signs and words in development and education]. Bologna: Il Mulino.

Caselli, M. C., Pasqualetti, P., & Stefanini, S. (2007). *Parole e frasi nel "Primo vocabolario del bambino". Nuovi dati normativi tra 18 e 36 mesi e scheda breve del questionario* [Words and sentences in "The first vocabulary of the child": New normative data from 18 to 36 months and short form of the questionnaire]. Milano: Franco Angeli.

Caselli, M. C., & Rinaldi, P. (2005). *Il Primo vocabolario del bambino sordo. Forma breve* [The first vocabulary of the deaf child: Short form]. Roma: ISTC-CNR.

Caselli, M. C., Rinaldi, P., Stefanini, S., & Volterra, V. (2012a). Early action and gesture "vocabulary" and its relation with word comprehension and production. *Child Development, 83,* 526–542.

Caselli, M. C., Rinaldi, P., Varuzza, C., Giuliani, A., & Burdo, S. (2012b). Cochlear implant in the second year of life: Lexical and grammatical outcomes. *Journal of Speech, Language, and Hearing Research, 55,* 382–394.

Crowe, K., & McLeod, S. A systematic review of cross-linguistic and multilingual speech and language outcomes for children with hearing loss. *International Journal of Bilingual Education and Bilingualism*, doi:10.1080/13670050.2012.758686. Published online by Taylor & Francis, February 8, 2013.

Dale, P. S., Bates, E., Reznick, J. S., & Morisset, C. (1989). The validity of a parent report instrument of child language at twenty months. *Journal of Child Language, 16,* 239–249.

Dale, P. S., Dionne, G., Eley, T. C., & Plomin, R. (2000). Lexical and grammatical development: A behavioural genetic perspective. *Journal of Child Language, 27,* 619–642.

Davidson, K., Lillo-Martin, D., & Chen Pichler, D. Spoken English language development in native signing children with cochlear implants. *Journal of Deaf Studies and Deaf Education*, doi:10.1093/deafed/ent045. Published online by Oxford University Press, October 21, 2013.

Donati, C., & Branchini, C. (2013). Challenging linearization: Simultaneous mixing in the production of bimodal bilinguals. In T. Biberauer & I. Roberts (eds.), *Challenges to linearization*, pp. 93–128. Berlin: Mouton de Gruyter.

Duchesne, L., Sutton, A., & Bergeron, F. (2009). Language achievement in children who received cochlear implants between 1 and 2 years of age: Group trends and individual patterns. *Journal of Deaf Studies and Deaf Education, 14,* 465–485.

Emmorey, K., Borinstein, H., Thompson, R., & Gollan, T. H. (2008). Bimodal bilingualism. *Bilingualism: Language and Cognition, 11,* 43–61.

Emmorey, K., Petrich, J. A. F., & Gollan, T. H. (2012). Bilingual processing of ASL–English code-blends: The consequence of accessing two lexical representations simultaneously. *Journal of Memory and Language, 67,* 199–210.

Farrar, M. J., & Maag, L. (2002). Early language development and the emergence of a theory of mind. *First Language, 22,* 197–213.

Feldman, H. M., Dollaghan, C. A., Campbell, T. F., Colborn, D. K., Janosky, J., Kurs-Lasky, M., Rockette, H. E., Dale, P. S., & Paradise, J. L. (2003). Parent reported language skills in relation to otitis media during the first 3 years of life. *Journal of Speech, Language, and Hearing Research, 46,* 273–287.

Fenson, L., Marchman, V. A., Thal, D. J., Dale, P. S., Reznick, J. S., & Bates, E. (2007). *MacArthur-Bates communicative development inventories: User's guide and technical manual* (2nd edn.). Baltimore, MA: Brookes.

Geers, A. E., Moog, J. S., Biedenstein, J., Brenner, C., & Hayes, H. (2009). Spoken language scores of children using cochlear implants compared to hearing age-mates at school entry. *Journal of Deaf Studies and Deaf Education, 14,* 371–385.

Geers, A., Spehar, B., & Sedey, A. (2002). Use of speech by children from total communication programs who wear cochlear implants. *American Journal of Speech-Language Pathology, 11,* 50–58.

Hassanzadeh, S. (2012). Outcomes of cochlear implantation in deaf children of deaf parents: Comparative study. *Journal of Laryngology & Otology, 126,* 989–994.

Haug, T. (2012). Methodological and theoretical issues in the adaptation of sign language tests: An example from the adaptation of a test to German Sign Language. *Language Testing, 29,* 181–201.

Humphries, T., Kushalnagar, P., Mathur, G., Napoli, D. J., Padden, C., Rathmann, C., & Smith, S. R. (2012). Language acquisition for deaf children: Reducing the harms of zero tolerance to the use of alternative approaches. *Harm Reduction Journal,* doi:10.1186/1477-7517-9-16. Published online by BioMed Central Ltd., April 2, 2012.

Jiménez, M. S., Pino, M. J., & Herruzo, J. (2009). A comparative study of speech development between deaf children with cochlear implants who have been educated with spoken or spoken + sign language. *International Journal of Pediatric Otorhinolaryngology, 73,* 109–114.

Kaplan, E., Goodglass, H., & Weintraub, S. (1983). *The Boston Naming Test*. Philadelphia, PA: Lea & Febiger.

Knoors, H., & Marschark, M. (2012). Language planning for the 21st Century: Revisiting bilingual language policy for deaf children. *Journal of Deaf Studies and Deaf Education, 17,* 291–305.

Lillo-Martin, D., Quadros, R. M., Koulidobrova, H., & Chen Pichler, D. (2010). Bimodal bilingual cross-language influence in unexpected domains. In J. Costa, A. Castro, M. Lobo & F. Pratas (eds.), *Language Acquisition and Development: Proceedings of GALA 2009*, pp. 264–275. Newcastle upon Tyne: Cambridge Scholars Press.

Marchman, V. A., Fernald, A., & Hurtado, N. (2010). How vocabulary size in two languages relates to efficiency in spoken word recognition by young Spanish–English bilinguals. *Journal of Child Language, 37,* 817–840.

May, S. (2005). *Language and minority rights*. New York: Routledge.

Mayberry, R. I. (2007). When timing is everything: Age of first-language acquisition effects on second-language learning. *Applied Psycholinguistics, 28,* 537–549.

Mayne, A. M., Yoshinaga-Itano, C., & Sedey, A. (2000). Receptive vocabulary development of infants and toddlers who are deaf or hard of hearing. *Volta Review, 100,* 29–52.

Mayne, A. M., Yoshinaga-Itano, C., Sedey, A., & Carey, A. (2000). Expressive vocabulary development of infants and toddlers who are deaf or hard of hearing. *Volta Review, 100,* 1–28.

Michel, A., Tizmann, P. F., & Silbereisen, R. K. (2012). Language shift among adolescent ethnic German immigrants: Predictors of increasing use of German over time. *International Journal of Intercultural Relations, 36,* 248–259.

National Institutes of Health – National Institute on Deafness and Other Communication Disorders (2011). https://www.nidcd.nih.gov/staticresources/health/hearing/FactSheetCochlearImplant.pdf. January 27, 2014.

Niparko, J. K., Tobey, E. A., Thal, D. J., Eisenberg, L. S., Wang, N., Quittner, A. L., & Fink, N. E. for the CDaCI Investigative Team (2010). Spoken language development in children following cochlear implantation. *Journal of the American Medical Association, 303,* 1498–1506.

Onofrio, D., Rinaldi, P., & Pettenati, P. (2012). Il primo sviluppo del linguaggio in bambini che imparano più lingue: una proposta per la valutazione e l'interpretazione del profilo linguistico [Early linguistic development of children who are learning more than one language: A proposal for linguistic evaluation and for linguistic profile interpretation]. *Psicologia Clinica dello Sviluppo, 16,* 661–669.

Patterson, J. L. (2004). Comparing bilingual and monolingual toddlers' expressive vocabulary size: Revisiting Rescorla and Achenbach (2002). *Journal of Speech, Language, and Hearing Research, 47,* 1213–1215.

Pearson, B. Z., Fernandez, S. C., & Oller, D. K. (1993). Lexical development in bilingual infants and toddlers: Comparison to monolingual norms. *Language Learning, 43,* 93–120.

Percy-Smith, L., Cayé-Thomasen, P., Breinegaard, N., & Jensen, J. H. (2010). Parental mode of communication is essential for speech and language outcomes in cochlear implanted children. *Acta Otolaryngology, 130,* 708–715.

Pettenati, P., Vacchini, D., Stefanini, S., & Caselli, M. C. (2011). Parole e frasi nel primo vocabolario di bambini bilingui Italiano–Spagnolo [Words and sentences in early vocabulary of Italian–Spanish bilingual children]. *Rivista di Psicolinguistica Applicata, 11,* 49–67.

Pizzuto, E., Ardito, B., Caselli, M. C., & Volterra, V. (2001). Cognition and language in Italian deaf preschoolers of deaf and hearing families. In M. Marshark, D. Clark & M. Karchmer (eds.), *Cognition, context and deafness*, pp. 49–70. Washington, DC: Gallaudet University Press.

Rinaldi, P. (2008). Competenze lessicali di bambini sordi bilingui in età prescolare [Lexical competencies in bilingual deaf preschoolers]. *Rivista di Psicolinguistica Applicata, 8,* 93–107.

Rinaldi, P., Baruffaldi, F., Burdo, S., & Caselli, M. C. (2013). Linguistic and pragmatic skills in toddlers with cochlear implant. *International Journal of Language & Communication Disorders, 48,* 715–725.

Rinaldi, P., & Caselli, M. C. (2009). Lexical and grammatical abilities in deaf Italian preschoolers: The role of duration of formal language experience. *Journal of Deaf Studies and Deaf Education, 14,* 63–75.

Rinaldi, P., Caselli, M. C., Onofrio, D., & Volterra, V. (2014). Language acquisition by bilingual deaf preschoolers: Theoretical, methodological issues and empirical data. In G. Tang, H. Knoors & M. Marschark (eds.), *Bilingualism and bilingual deaf education*, pp. 85–116. New York: Oxford University Press.

Riva, D., Nichelli, F., & Devoti, M. (2000). Developmental aspects of verbal fluency and confrontation naming in children. *Brain and Language, 71,* 267–284.

Roid, G. H., & Miller, L. J. (1997). *Leiter International Performance Scale – Revised*. Firenze: Giunti OS.

Spencer, L. J., & Bass-Ringdahl, S. (2004). An evolution of communication modalities: Very young cochlear implant users who transitioned from sign to speech during the first years of use. *International Congress Series, 1273,* 352–355.

Spencer, P. E. (2004). Individual differences in language performance after cochlear implantation at one to three years of age: Child, family, and linguistic factors. *Journal of Deaf Studies and Deaf Education, 9,* 395–412.

Spencer, P. E., & Marschark, M. (eds.) (2006). *Advances in the spoken language development of deaf and hard-of-hearing children*. New York: Oxford University Press.

Stallings, L. M., Gao, S., & Svirsky, M. A. (2002). Assessing the language abilities of pediatric cochlear implant users

across a broad range of ages and performance abilities. *Volta Review, 102,* 215–235.

Stella, G., Pizzoli, C., & Tressoldi, P. E. (2000). *Peabody – R. Test di vocabolario recettivo* [Peabody-R: Receptive vocabulary test]. Torino: Omega.

Szagun, G., & Stumper, B. (2012). Age or experience? The influence of age at implantation and social and linguistic environment on language development in children with cochlear implants. *Journal of Speech, Language, and Hearing Research, 55,* 1640–1654.

Thal, D., DesJardin, J. L., & Eisenberg, L. S. (2007). Validity of the MacArthur-Bates communicative development inventories for measuring language abilities in children with cochlear implants. *American Journal of Speech-Language Pathology, 16,* 54–64.

Thal, D. J., O'Hanlon, L., Clemmons, M., & Fralin, L. (1999). Validity of a parent report measure of vocabulary and syntax for preschool children with language impairment. *Journal of Speech, Language, and Hearing Research, 42,* 482–496.

Tobey, E. A., Rekart, D., Buckley, K., & Geers, A. E. (2004). Mode of communication and classroom placement impact on speech intelligibility. *Archives of Otolaryngology – Head & Neck Surgery, 130,* 639–643.

Tomasuolo, E., Fellini, L., Di Renzo, A., & Volterra, V. (2010). Assessing lexical production in deaf signing children with the Boston Naming Test. *Language, Interaction and Acquisition, 1,* 110–128.

Tomasuolo, E., Valeri, G., Di Renzo, A., Pasqualetti, P., & Volterra, V. (2013). Deaf children attending different school environments: Sign language abilities and theory of mind. *Journal of Deaf Studies and Deaf Education, 18,* 12–29.

Watson, L. M., Archbold, S. M., & Nikolopoulos, T. P. (2006). Changing communication mode after implantation by age at implant. *Cochlear Implants International, 7,* 77–91.

Watson, L. M., Hardie, T., Archbold, S. M., & Wheeler, A. (2008). Parents' views on changing communication after cochlear implantation. *Journal of Deaf Studies and Deaf Education, 13,* 104–116.

Wie, O. B., Falkenberg, E. S., Tvete, O., & Tomblin, B. (2007). Children with a cochlear implant: Characteristics and determinants of speech recognition, speech-recognition growth rate, and speech production. *International Journal of Audiology, 46,* 232–243.

Yoshinaga-Itano, C. (2006). Early identification, communication modality, and the development of speech and spoken language skills: Patterns and considerations. In Spencer & Marschark (eds.), pp. 298–327. New York: Oxford University Press.

Yoshinaga-Itano, C., Snyder, L. S., & Day, D. (1998). The relationship of language and symbolic play in children with hearing loss. *Volta Review, 100,* 135–164.