Empirical Articles

Sign Vocabulary in Deaf Toddlers Exposed to Sign Language Since Birth

Pasquale Rinaldi*, Maria Cristina Caselli, Alessio Di Renzo, Tiziana Gulli, Virginia Volterra
Institute of Cognitive Sciences and Technologies - National Research Council of Italy

Received October 18, 2013; revisions received February 20, 2014; accepted March 2, 2014

Lexical comprehension and production is directly evaluated for the first time in deaf signing children below the age of 3 years. A Picture Naming Task was administered to 8 deaf signing toddlers (aged 2–3 years) who were exposed to Sign Language since birth. Results were compared with data of hearing speaking controls. In both deaf and hearing children, comprehension was significantly higher than production. The deaf group provided a significantly lower number of correct responses in production than did the hearing controls, whereas in comprehension, the 2 groups did not differ. Difficulty and ease of items in comprehension and production was similar for signing deaf children and hearing speaking children, showing that, despite size differences, semantic development followed similar paths. For signing children, predicates production appears easier than nominals production compared with hearing children acquiring spoken language. Findings take into account differences in input modalities and language structures.

The main objective of this study is to explore lexical comprehension and production in deaf toddlers acquiring Italian Sign Language (LIS) from birth. Previous studies conducted on early vocabulary in deaf infants and children acquiring a sign language are very few and are mainly based on indirect assessment, namely questionnaires for parents originally developed to evaluate spoken languages and then adapted to assess lexical development in sign languages. In these studies, two major issues were addressed: (a) the earlier onset of first signs and the sign advantage in terms of lexical repertoire, compared with hearing infants and toddlers acquiring a spoken language and (b) the composition of early sign vocabulary, particularly the relationship between nominals and predicates, in the lexical development of signing children. In accordance with other authors, we defined “nominals” as items denoting animals, places to go, and objects (the latter could be manipulable and/or not manipulable, natural and/or artificial) and “predicates” as items denoting actions and states (Bates et al., 1994; Caselli et al., 1995; Caselli, Casadio & Bates, 1999).

Sign language research began with an effort to highlight the similarities between signed and spoken languages, and this was also true in the field of sign language acquisition. Today, however, sign language research has reached a point where we feel more free to turn our attention also to real differences that might exist between acquisition of signed versus spoken language, both in terms of their input conditions as well as in their linguistic properties.

Early Lexical Acquisition: The Presumed Sign Advantage

Deaf children who are exposed to sign language from birth or early in life have been reported to acquire it mostly in the same way as hearing children who acquire a spoken language, following similar maturational milestones (Caselli, 1994; Cormier, Schembri, Vinson & Orfanidou, 2012; Newport & Meier, 1985; Petitto et al., 2001; Pizzuto, 2002; Pizzuto, Ardito, Caselli, &
Volterra, 2001). However, despite this general agreement, some studies report contrasting results when using a parental questionnaire developed to conduct indirect assessment of young children’s communicative and linguistic development, that is, the MacArthur Bates–Communicative Development Inventory (MB-CDI) (Fenson et al., 2007). The MB-CDI is a valid and reliable assessment tool for many different languages and cultures (for an overview, see Bleses et al., 2008). Anderson and Reilly (2002) adapted the original MB-CDI to assess American Sign Language (ASL) and collected data with parents of 69 signing children (34 followed longitudinally) from 8 to 35 months of age. Although the results of this study also confirm that signing children were acquiring ASL on the whole in a similar way to hearing children acquiring a spoken language, some notable differences did emerge. Signing children were producing signs already at 8 months of age, considerably earlier than hearing children learning English, who generally produce their first words at around 12 months of age. This apparently precocious onset of language in signing children suggested that the underlying abilities for language are in place earlier than previously thought and that it is the development of speech mechanisms that delays the age at which first words are produced. However, as discussed by some authors, the “precocious” onset of language in signing deaf children, as reported by parents in filling in the MB-CDI, may depend on the methodology used to categorize the vocabulary data (Anderson and Reilly, 2002; Hoiting, 2006). Because signs are conveyed in the visual–gestural modality and because infants (both hearing and deaf) use communicative gestures in the initial stages of language development, it is quite possible that both hearing and deaf children produce communicative gestures at younger ages, but that only deaf children are given credit for having produced a lexical item (Caselli & Volterra, 1994; Volterra & Iverson, 1995; Volterra, Iverson, & Castrataro, 2006). Additionally, the pantomimic or iconic aspects of sign languages, which have been widely recognized, might lead to the supposition that deaf children would exploit this iconicity, thus acquiring language earlier and faster than their hearing peers. But such an advantage is not observed later: At 18–23 months, the median scores and ranges for children acquiring ASL and children acquiring spoken English are very similar (Anderson & Reilly, 2002). A more recent study also does not confirm the precocious onset of language in deaf children exposed to a signed language (Woolfe, Herman, Roy, & Woll, 2010). Using an adapted version of the MB-CDI to assess the acquisition and development of British Sign Language (BSL), the authors collected longitudinal data on receptive and expressive vocabulary of 29 deaf children from 8 to 36 months, who were acquiring BSL as a first language. Results showed strong similarities in the size of receptive and expressive vocabulary between hearing–speaking and deaf signing children. Moreover, as expected, children’s receptive vocabulary consistently and significantly outpaced the expressive vocabulary for all age groups with the exception of the youngest (8–11 months).

Composition of the Lexical Repertoire

The literature on English and Italian acquisition, as well as on other spoken languages, has shown that hearing infants’ success in learning predicative expressions lagged well behind their success in learning nominal expressions (Bates et al., 1994; Caselli et al., 1995; 1999). These authors, using the MB-CDI categories, have attributed this difference to the fact that concepts of objects (labeled by nominals) are perceptually and conceptually more stable and therefore more readily acquired than concepts of actions or events (labeled by predicates), involving relations among objects. These differences could reflect deep-seated differences in language typology. Some researchers have argued that the early noun advantage is not a universal feature of human language but a consequence of the particular language being acquired. For infants acquiring noun-friendly languages (e.g., English and Italian), nouns outpace verbs in early acquisition, but for infants acquiring verb-friendly languages (e.g., Mandarin, Korean), the noun advantage is attenuated or absent (for a recent review on this topic on spoken languages, see Waxman et al., 2013). This holds true also for sign languages, an issue that will be considered in the presentation of the results as well as in the final discussion. As pointed out by Slobin (2008), an important typological distinction across languages is between “dependent-marked” languages and “head-marked” languages.
and such a distinction is determined on grounds of linguistic expression of verbs and their arguments. Slobin has shown how ASL as some spoken languages (i.e., Yucatec, a Mayan language spoken on the Yucatán Peninsula of Mexico) are both head-marked languages that use polynuclear verbs that indicate the roles of arguments.

The first words of children exposed to a spoken language and the first signs of children exposed to a signed language reflect similar content and mainly refer to people, animals and things to eat. However an interesting difference in the composition of the lexical repertoire emerged from the data collected by Anderson and Reilly (2002). Compared with English-speaking children, the percentage of predicates in the vocabulary of the signing children was consistently higher than those of the English-speaking children. The authors suggested that the increased presence of predicates might be related to the structure of ASL, which often places verbs in the initial position of an utterance, thus making it quite salient for the receiver.

The issue of vocabulary composition in early acquisition of sign language is also addressed in a study by Hoiting (2006, 2009), who refers to it as “the noun/verb controversy.” Using the MB-CDI adapted for use in the Sign Language of the Netherlands (SLN), Hoiting has analyzed the lexical acquisition of 30 deaf children followed longitudinally from 16 to 36 months. Only four children were from deaf parents and were exposed to SLN, while the remaining 13 children were from hearing parents and were either exposed to SLN (13 children) or to an artificial sign system, Sign Supported Dutch (13 children). The author found that the percentage of predicates, out of total vocabulary, was consistently higher in deaf children acquiring SLN than in hearing peers acquiring spoken language. The percentage value was five times larger at the start and still twice as large at the end of the period considered. According to Hoiting, these results could be explained considering the significant differences in the organization of SLN and spoken Dutch and probably reflect general differences between language types. For example, signed predicates contain more explicit referential information than verbs in many spoken languages, and it has been already noted that sign languages have rich verbs that are full of information about entities in combination with movement of various kinds (Slobin, 2005). Hoiting explained her results also by suggesting that signed “verb forms” may be more salient in perception, as well as more active in production.

It is important to note that nominals and predicates are defined on the basis of lexical categories in adult language, but we recognize that children, hearing and deaf, may use both words and signs in ways that vary from adult use. In addition, as in other sign languages, the assignment of signs to existing lexical categories is at times problematic (Hoiting, 2006; Woolfe et al., 2010). The same sign in different contexts could potentially be classified as either a nominal or a predicative expression (e.g., COMB). As pointed out by Slobin (2008), we must be careful about expecting to find familiar lexical categories in other languages.

Goal of the Present Study

As shown in the brief review reported above, similarities as well as some interesting differences between children acquiring sign language and children acquiring spoken language have been found. These results, all based on indirect assessments, have not yet been confirmed using direct assessment. Direct assessment implies that communicative and linguistic development are evaluated using standardized procedures directly with children, for example, asking them to label pictures or describe videos. In fact, from 2 years of age it is possible to obtain systematic and reliable data using structured direct tests (Bates, 1993). At present there are extremely few tests to directly assess sign language development in children younger than 4 years of age (Haug & Mann, 2008). Direct assessment of lexical development has been conducted only with deaf children older than 4 years, acquiring sign languages such as BSL (Herman & Roy, 2006), ASL (Maller, Singleton, Supalla & Wix, 1999), German Sign Language (Haug, 2011), SLN (Hermans, Knoors, & Verhoeven, 2010) and LIS (Rinaldi, 2008; Rinaldi & Caselli, 2014; Tomasuolo, Fellini, Di Renzo & Volterra, 2010; Tomasuolo, Valeri, Di Renzo, Pasqualetti & Volterra, 2013).

The aim of the present research is to study lexical skills in both comprehension and production of nominals and predicates in deaf signing toddlers (younger
than 4 years) and hearing–speaking controls using the same vocabulary test, namely the Picture Naming Game (PiNG, Bello, Giannantoni, Pettenati, Stefanini & Caselli, 2012). The following specific research questions will be addressed:

1. Is the vocabulary size of deaf toddlers acquiring sign language since birth larger than that of hearing–speaking toddlers? What is the relationship between comprehension and production?
2. Do signs comprehended and produced by deaf signing children refer to the same concepts as words known by their hearing peers?
3. Do deaf signing and hearing–speaking toddlers differ in the comprehension and production of nominals versus predicates?

We make the following hypotheses: (a) Vocabulary size in both comprehension and production should not differ between deaf signing children and hearing–speaking children, with comprehension outpacing production in both groups; (b) semantic content, as expressed respectively by signs and by words in each group, should be similar between groups; (c) composition of signed vocabulary (predicates vs. nominals) should differ from that of spoken vocabulary, with a relatively higher proportion of predicates produced by the deaf signing group.

The first two hypotheses are based on the strong links among early lexical development, general cognitive processes (in particular the acquisition and organization of concepts), as well as communicative patterns occurring in parent–child interactions. These hypotheses are also based on previous research reporting similar lexical size in deaf signing children and hearing–speaking children by the age of 2 years. The third hypothesis is linked to the different modalities and typological characteristics of signed versus spoken languages. If the composition of children’s vocabulary is different across spoken Italian and LIS, one might argue that structural characteristics of particular languages are also driving early lexical acquisition. As suggested by Hoiting (2006), sign languages being “head marked in typology,” make predicates more salient than nominals, by often embedding nominal arguments within sign predicates. These linguistic characteristics may influence vocabulary composition during the early stages of language acquisition.

Method

Material

A picture-naming task (PiNG), originally developed by Bello et al. (2012) to assess lexicon in hearing typically developing Italian children, has been used with deaf children in order to assess vocabulary skills in Italian Sign Language. The task consists of colored photographs divided into two sets: photographs representing objects/tools (e.g., comb), animals (e.g., penguin), food (e.g., apple), and clothing (e.g., gloves), designed to elicit labels traditionally defined as “nominals,” and photographs representing actions (e.g., eating), characteristics (e.g., small), and locative relations (e.g., inside-outside), designed to elicit labels traditionally defined as “predicates.”

The PiNG test consists of four subtests: Nominals Comprehension (NC), Nominals Production (NP), Predicate Comprehension (PC) and Predicate Production (PP), each of which consists of 20 lexical targets and 2 training items. Lexical items were selected from the normative data of the Italian version of the MB-CDI (Caselli, Pasqualetti & Stefanini 2007). The items (targets and distracters) had diverse levels of difficulty, defined on the basis of the normative sample of the Italian MB-CDI. In particular, the PiNG test included “easy” items (labeled by 75% of the normative sample), “moderately easy” items (labeled by 50–74% of the sample), and “difficult” items (labeled by fewer than 50% of the sample). Considering all the PiNG items, 25% were classified as easy, 50% as moderately easy and 25% as difficult (Bello et al., 2012).

Participants

Data on eight Italian deaf children between 28 and 38 months of age (mean age = 33 months) acquiring LIS were collected. All children had deaf parents using LIS in their everyday life and thus the deaf children had been exposed to LIS since birth. They were also exposed to spoken Italian (or mouthing) used by hearing people, children, and educators not using sign language as well as to mouthed Italian used by deaf adults, including their parents. All deaf children but one were enrolled in daycare centers with hearing children. This sample is obviously small, but
represents a good proportion of the potential population studied. The deaf children reported in this study represent approximately 10–20% of the estimated number of deaf children born to deaf parents in Italy during the 2008, based on all children born in Italy in 2008, not corrected for comorbid disability (http://dati.istat.it). Each deaf child was matched with two hearing peers of the same gender. These 16 hearing speaking children aged from 28 to 38 months (mean age = 33 months) were considered to be the control group.

In addition, the data collected in LIS with deaf signing toddlers were compared with normative data collected with hearing children in spoken Italian.

Procedure

All of the children were tested individually in our Lab, at their nursery school, or in their homes. The two photographs sets for nominals and predicates were presented separately, and the order of photographs presentation within each set was fixed. After a brief period of familiarization, the experimenter placed three photographs in front of the child, including the target item, a semantic distracter (corresponding to the target for the production subtest), and another distracter, not related semantically or phonologically to the target in both spoken Italian and LIS. To test comprehension, the adult asked the child to point to or touch the photograph corresponding to the label produced. For example, the experimenter asked “Where is the cat?,” presenting photographs of a cat, a dog and a television; or the observer asked “Who is drinking?,” presenting photographs of a child drinking, eating and grasping.

If the child indicated the wrong photograph or did not respond at all, no second chance was given. Once the child provided an answer, the adult removed the photographs of the comprehension target and of the unrelated distracter. The remaining photograph (i.e., the semantically related distracter) was used to test production. The experimenter asked “What is this?” for photographs of nominals, “What is he/she doing?” or “How/where is this?” for photographs depicting predicates. When the photographs were presented, the experimenter sometimes pointed to the image in order to help the child in focusing his/her attention on the target but otherwise avoided to produce any other kind of gesture. When a child provided an incorrect response or no response on the first attempt, he/she was given a second chance. In these cases, a “best response” criterion was adopted, that is, if the child provided a correct response on the second attempt, he/she was given credit for providing a correct response. If neither response was correct, the first one was counted.

The same procedure was used for deaf children and hearing children, the only difference being that deaf participants were requested to perform the task in LIS by a deaf signing experimenter and hearing participants were requested to perform the task in spoken Italian by a hearing experimenter. The mean duration of the task was about 45 min, but short breaks were allowed when needed.

Transcription

All sessions were videotaped and all productions provided by deaf and hearing participants were later transcribed according the procedure already adopted in previous studies (Bello et al., 2012). For the data collected in LIS with deaf signing children, SignWriting (SW) was used. SW is a writing system originally designed by Valerie Sutton (1995) for representing Sign Languages and has been recently adapted to LIS (Petitta, Di Renzo, Chiari & Rossini, 2013). The precise transcription of parameters through SW in the signed answers allowed rapid and easy comparisons between children’s and adults’ productions and therefore allowed coding whether the sign produced could be accepted as correct or not (for more details, see the following section).

Coding

For the task administered to hearing children, the coding system used in previous studies was adopted (Bello et al., 2012). The same coding system was adapted to codify answers provided by deaf signing children performing the task in LIS. For the comprehension subtests (NC and PC), if the child indicated the photograph corresponding to the sign produced by the adult, the answer was considered to be correct. If the child indicated the no target photograph or did not respond at all, the response was classified, respectively, as incorrect or no response.
In both production subtests, answers were also classified as correct, incorrect, or no response. Responses were coded as correct when the child provided the expected sign for the photograph. In order to decide if the sign could be considered correct or not, we collected data with the same materials on 11 Italian deaf signing adults (age range: 25–45 years) who have been requested to label the same photographs with a LIS sign. We considered the sign produced by the child as correct if we found a similar production in the adult sample. (For more details on adult sign production see Lucioli, Gulli, Petitta, Rossini & Volterra, 2014.)

For some photographs, more than one signed answer was accepted as correct. For example, for the photograph of the “lion,” two different regional sign variations were accepted: a one-handed sign performed with a bent handshape (()), moving diagonally and downward from the opposite shoulder toward the flank of the side of the dominant hand; a two-handed sign with bent handshapes ()), palms facing outward, moving in a shaking motion from the side of the head (without contact) toward the neutral space in front of the signer. For the photograph representing the action “to wash (hands),” two sign variations were accepted, one performed with an open handshape (x) and one with a bent handshape (()). In both cases, the same variations were observed in the adult sample.

A sign in which only one parameter was differently produced (with respect to the adults’ productions) was accepted as correct. Incorrect responses included productions, which did not refer to the target items expected to be elicited by the photographs or resulted unrecognizable. In some cases, the answers provided by the children did not look like the signs produced by adults signers but rather they resembled some cospeech gestures produced by hearing children performing the same task while speaking. For example, for the photograph representing the action “to kiss,” one child kissed the photograph itself and another child blew a kiss in the air, instead of performing the correct LIS sign, a closed handshape (y) touching the cheek. For the photograph of the “umbrella,” one child performed the action of protecting his head with an open handshape instead of performing the correct LIS sign (i.e., both hands with grasping handshapes (3) and the dominant hand moving up, as opening an umbrella). In both cases, the same gestures were performed by hearing children who had no exposure to LIS, performing the same task in spoken Italian (Pettenati, Stefanini & Volterra, 2010). All these cospeech like gestures produced by Italian toddlers see Capirci, Di Renzo, Gulli, Pettenati & Volterra, 2012.)

When children either stated that they did not know the sign corresponding to a photograph, or did not provide any answer, the item was coded as a no response. When children gave an incorrect answer or a no response at their first attempt, a second chance to provide the correct answer was given. A “best answer” criterion was adopted in those cases, so that if the child initially gave an incorrect response and then provided the correct one, he/she was given credit for providing a correct response.

Results
All responses provided by the children, deaf and hearing, were analyzed according to the coding system described in the Method section to determine whether or not they corresponded to the expected answer. The scores obtained for correct answers in the comprehension and in the production subtests by deaf and hearing children are shown in Figure 1.

Due to the small number of the children, the data were analyzed with nonparametric statistics (Mann–Whitney U was used for comparisons between groups and Wilcoxon test was used for comparisons within groups). Both groups showed a similar trend with the number of correct answers in comprehension significantly higher than the number of correct answers in production (z = 2.524, p < .05 and z = 3.444, p < .01, for deaf and hearing children, respectively).

The number of correct answers provided by deaf children in production was significantly lower with respect to those provided by hearing children (z = −2.055, p < .05), whereas in comprehension, the difference was not significant (z = −1.918, p = .061).

With regard to individual differences among children, two indexes of variability (SD/M) were calculated for comprehension and for production within each group. In both groups, variability in production was
higher than that found in comprehension. Variability for production was very wide (.22 and .24 for deaf and hearing children, respectively), whereas individual variability in comprehension among deaf children was larger than that found among hearing children (.14 and .06 for deaf and hearing children, respectively).

Percentage of Correct Answers by Item

Percentage of correct answers for comprehension and production provided by deaf and hearing children are reported in the Tables 1 and 2. The items are ordered according to the percentages of correct answers provided by deaf children.

In order to verify if the items were ordered in similar ways in the two groups, that is, if the deaf signing children and the hearing–speaking children found the same items more “easy” or more “difficult,” three separate Spearman’s rank correlations have been calculated on the percentages of correct answers provided by the children for: (a) the 40 items in comprehension subtests, (b) the 40 items in production subtests, and (c) collapsing all the 80 items. The three Spearman’s rho were all significant: for comprehension, \( Rho(40) = .66, p < .01 \); for production, \( Rho(40) = .60, p < .01 \); and collapsing all the 80 items, \( Rho(80) = .70, p < .01 \). These correlations show that the items were ordered in very similar way across deaf and hearing children: that is, the more difficult items for one group appear to be also difficult for the other group despite the labels in LIS and in spoken Italian (signs and words, respectively) for each photograph being very different.

Interestingly, also the typology of incorrect answers provided by deaf and hearing children looked very similar in the semantic content expressed. For example, for the photograph of a roof, both deaf and hearing children provided very often the incorrect label for “house,” or for the photograph of a beach, some deaf and hearing children provided a sign or a word meaning “sea,” showing in both cases a similar categorization of semantic domains.

Vocabulary Composition

Considering the results in each subtest, some interesting similarities as well as differences were found. For both groups, the number of correct answers provided in the NC subtest were significantly higher than those provided in the PC subtest (\( z = 2.384, p < .05 \) and \( z = 3.314, p < .01 \), for deaf and hearing children, respectively).

In the production subtest, the differences between nominal and predicate subtests did not reach significance in either group. However, looking at the raw scores presented in Figure 2, the number of correct responses provided by deaf children is higher for the...
predicate subtest than for the nominal subtest, but for hearing children, the opposite pattern is evident.

According to the coding system described in the Method section, we calculated the percentages of correct answers, incorrect answers and no responses for deaf and hearing children in each of the four subtests separately and tested the differences between deaf and hearing children. These data are shown in Table 3.

In lexical comprehension of both nominals and predicates, deaf children gave a significant lower percentage of correct answers than did the hearing children.
children and made a higher percentage of no responses. There was no difference between the groups in the percentage of incorrect answers.

In the NP subtest, deaf children had a significantly lower percentage of correct answers than the hearing children and made a higher percentage of no responses. Again, there was no difference in the percentage of incorrect answers. In the PP subtest, no difference was found between deaf and hearing children in the percentage of correct answers, but the deaf children made a lower percentage of incorrect answers and a higher percentage of no responses than did the hearing children.

In order to verify if hearing children represent a reliable control group, we compared the scores obtained by all our participants with the PiNG’s normative data available for Italian speaking hearing children (Bello et al., 2012). As for hearing–speaking children, all the participants reached scores close to or higher than the 25th percentile in the NC, PC, and PP subtests. Only

---

**Figure 2** Number of correct answers provided by deaf ($N=8$) and hearing ($N=16$) children in each subtest. Error bars represent standard deviations.

**Table 3** Percentage of correct answers, incorrect answers, and no responses for deaf ($N=8$) and hearing ($N=16$) children in each of the four subtests and statistical analysis

<table>
<thead>
<tr>
<th></th>
<th>Nominals</th>
<th>Predicates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Deaf</td>
<td>Hearing</td>
</tr>
<tr>
<td>% Correct answers</td>
<td>86.53</td>
<td>96.56</td>
</tr>
<tr>
<td>% Incorrect answers</td>
<td>5.14</td>
<td>2.81</td>
</tr>
<tr>
<td>% No responses</td>
<td>8.33</td>
<td>.63</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Nominals</th>
<th>Predicates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Deaf</td>
<td>Hearing</td>
</tr>
<tr>
<td>% Correct answers</td>
<td>52.5</td>
<td>68.75</td>
</tr>
<tr>
<td>% Incorrect answers</td>
<td>23.13</td>
<td>20.94</td>
</tr>
<tr>
<td>% No responses</td>
<td>24.38</td>
<td>10.31</td>
</tr>
</tbody>
</table>

*Note.* Statistical analysis: Mann–Whitney $U$ test.
two children fell close to the 5th percentile in the NP subtest. Individual deaf participants’ scores in each of the four subtests were plotted in relation to percentiles. See Figures 3–6.

In the NC and PC subtests, one deaf child fell below the 5th percentile. One child was at the 10th percentile in the NC subtest and two children were at the 10th percentile in the PC subtest. In these subtests, the remaining children were close or above the 50th percentile. In the PP subtest, the scores of all deaf signing children but one were close to the 50th percentile, while in the NP subtest, the scores of only three signing children fell close (but still below) to the 50th percentile.

**Discussion**

The objective of this investigation was to directly observe vocabulary comprehension and production of deaf toddlers exposed to LIS since birth, comparing the size and content of their repertoires with hearing children.

**Figure 3** Comparison of scores obtained by deaf participants (N = 8) in nominals comprehension with the Picture Naming Game’s normative data (percentiles) available for Italian speaking hearing children.

**Figure 4** Comparison of scores obtained by deaf participants (N = 8) in predicates comprehension with the Picture Naming Game’s normative data (percentiles) available for Italian speaking hearing children.
peers. To the best of our knowledge, this is the first direct sign vocabulary assessment of native signing deaf children below the age of 3 years.

Our first hypothesis was that groups would not differ in vocabulary size both displaying higher comprehension than production. Presence of higher comprehension than production was confirmed in both groups. As for vocabulary size, comprehension was similar between groups, while a significant gap was found in production, with hearing–speaking children producing more correct answers than deaf signing children. As expected from our second hypothesis, semantic contents expressed by signs and words were similar in deaf signing children and in hearing–speaking children. Our data only partially confirmed the third hypothesis on different composition of signed versus spoken vocabulary, showing no significant differences between the two groups, although deaf children tended to produce a higher number of correct answers for predicates than for nominals. These findings will be discussed in more detail in the following sections.

Figure 5 Comparison of scores obtained by deaf participants ($N=8$) in nominals production with the Picture Naming Game’s normative data (percentiles) available for Italian speaking hearing children.

Figure 6 Comparison of scores obtained by deaf participants ($N=8$) in predicates production with the Picture Naming Game’s normative data (percentiles) available for Italian speaking hearing children.
Size and Content of Lexical Repertoire

For both deaf and hearing toddlers, comprehension is higher than production, confirming data collected on children acquiring different spoken and signed languages and living in different cultures. Both groups showed a higher individual variability in production than in comprehension. When comparing individual variability between the two groups, deaf children showed a larger individual variability in lexical comprehension with respect to hearing controls.

The comparison in vocabulary size showed that the group of deaf children provided a significant lower number of correct responses in production than did the group of hearing controls, whereas in comprehension, the number of correct answers provided by the two groups of children did not differ.

This result contrasts with studies upholding the idea that children acquiring a sign language enjoy a linguistic advantage in early vocabulary acquisition. There are several possible explanations, theoretical and methodological, to justify the small gap found in vocabulary production between deaf signing children and hearing–speaking children in the present study.

First, we must consider that LIS, like other SLs, is a minority language and thus it is used by a restricted number of people and is rarely used in larger and public contexts and by the media. In addition, in LIS as in all sign languages, face-to-face interaction is essential and the amount of language input available to a deaf child is less than the language input to which a hearing child has access from his/her hearing parents and from the broader speaking environment. Here it should not be forgotten that if the conversational partner is signing, but the child is not looking, no actual input can occur (Harris, Clibbens, Chasin & Tibbitts, 1989; Kyle, Ackerman & Woll, 1987; Swisher, 2000; van den Bogaerde, 2000). Moreover, Italian deaf signing parents are rarely accustomed to use video or printed materials to support and improve sign language acquisition and development. As a consequence of all of these factors, the amount of LIS input received by deaf signing children could be much more restricted with respect to spoken Italian input received by hearing–speaking children in the age range considered by the present study. This situation could determine a slower vocabulary growth rather than a sign advantage. Our data show that deaf signing children seem to have already narrowed this gap in lexical comprehension, but not yet in lexical production. This explanation is also supported by longitudinal studies on hearing infants and toddlers acquiring a spoken language, showing that the “spurt” in vocabulary comprehension precedes the “spurt” in vocabulary production (Harris & Chasin, 1999; Sansavini et al., 2010). Furthermore, a study on older Italian deaf signing children showed that deaf children performed at the same level as hearing peers in the Boston Naming test, assessing lexical production (Tomasuolo et al., 2013). Thus, we could hypothesize that older deaf signing children may close the gap performing at the same level as hearing peers on lexical tasks.

A second possible explanation for the small gap observed in lexical skills between deaf and hearing children could stem from the bilingual status of deaf Italian children. One could assume that, as shown in research on unimodal bilingual children (two spoken languages), the early lexicon of these deaf bilinguals is distributed between their two languages with few equivalent labels. If so, it might be possible that these children know some of the semantic meanings requested and would be able to produce the correct labels, but only in spoken Italian. Studies on bimodal bilingual Italian deaf preschoolers have shown that children often rely on “the other” language to name items for which the corresponding signs (or the corresponding words in the case of evaluation in spoken language) are not yet known (Rinaldi, 2008; Rinaldi & Caselli, 2014). As almost all Italian deaf signing children are exposed to both LIS and Italian from birth (Rinaldi, Caselli, Onofrio & Volterra, 2014), it would be useful in future research to evaluate these children in both languages in order to verify this hypothesis.

Another possible explanation for the lower performance exhibited by deaf signing children in lexical production could be related to the test used, which was originally devised for spoken Italian. In a recent cross-cultural and cross-linguistic study adopting the same test used in the present research, Japanese speaking hearing children appeared slightly delayed in lexical production with respect to Italian speaking hearing children (Pettenati, Sekine, Congestri & Volterra,
The present results with deaf LIS signing children as well as those found in the study conducted with Japanese children can indicate that cultural factors influencing the design of the test might play a role.

In any case, our data confirm that signs comprehended and produced by deaf children refer to the same concepts referred to by words comprehended and produced by hearing children at the same age. Analyses on percentage of correct answers by item revealed that deaf signing children were able to understand and produce in LIS the same items as hearing–speaking children did in Italian. Despite size differences in total vocabulary, the difficulty and ease of items in comprehension and production was similar for both groups, showing that the acquisition of meanings is driven by more general cognitive processes and follows similar developmental paths. These results confirmed that the lexical task administered in this study to directly assess vocabulary comprehension and production, is suitable to assess lexical skills in deaf children.

In light of all these considerations, we believe that the current slight gap in lexical production between deaf signing children and hearing–speaking children could be mainly due to the amount of linguistic input and of perceived uptake by deaf children, as well as their bilingual status (Rinaldi et al., 2014; van den Bogaerde, 2000).

Composition of Sign Vocabulary

Our results from the four subtests considered separately (Nominals Comprehension, Predicates Comprehension, Nominals Production, and Predicates Production), gave us the opportunity to highlight interesting similarities as well as differences between deaf signing children and hearing–speaking children in the composition of the lexical repertoire. For both groups, comprehension of nominals was higher than comprehension of predicates.

The deaf group gave a lower number of correct answers in comprehension compared to the hearing control group in both subtests. On the other hand, for production, no significant differences were observed between items referring to nominals and items referring to predicates in both groups. However, it is worth noting that for hearing children, the mean number of items referring to nominals correctly labeled, even though not significant, was higher with respect to the mean number of items referring to predicates correctly labeled. For signing children a slightly different pattern occurred, with a higher number of correct answers in predicates production than in nominals production. These data are confirmed by the results of the comparison with normative data that revealed that in the PP subtest only one child fell below the 5th percentile, while all other participants were close to the 50th percentile. On the other hand the NP is the subtest in which all deaf children fell below the 50th percentile, with three of them being close to the 5th percentile.

These data collected through direct observation confirm data collected using CDI parent questionnaires in ASL and BSL signing children. As pointed out by various authors (Anderson & Reilly, 2002; Hoiting, 2006, 2009), deaf children appear to have a greater proportion of predicates in their early lexicon than do hearing speaking children. One of the possible explanations proposed is that the modality of sign languages makes action and motion more salient. Predicates, in particular verbs, by their very nature, often refer to actions and therefore they could be more accessible in an “action-based” language. According to Slobin (2008) ASL as some spoken languages can be defined as a “head-marked language,” which uses polycomponential predicates to indicate the role of the arguments. Given the similarity of structures among SLs, one could propose that also LIS can be defined as a “head-marked” language in which nouns play a less important role than verbs.

In addition, it might be possible that often signing parents communicating with their children in LIS, produce the appropriate signs for predicates, but point to objects that are present in the situational context instead of producing the corresponding signs for nouns drawing therefore more attention to predicates in respect to nominals.

These possible explanations are not mutually exclusive and can explain the higher focus put on predicates compared to nominals in LIS discourse. As a consequence, children acquiring LIS are able to produce predicates more easily than nominals as compared to children acquiring spoken English or spoken Italian. This hypothesis is in accordance with the claim that
infants’ acquisition and use of different lexical categories reflect features of the particular language being learned.

Conclusions

The present study indicates that patterns of LIS lexical development are generally similar to those found for Italian spoken language. However, interesting differences were found between deaf and hearing toddlers even when the deaf children are acquiring sign language as native signers by their deaf parents. These differences are probably related to the situations in which young deaf signing infants learn to comprehend and produce labels for referents. These findings point to a need for helping deaf children from an early age in overcoming obstacles involved in the task of developing the attention switching that is required to learn sign vocabulary. Infants acquiring a spoken language can look at the object of conversation without looking at the speaking interlocutor (e.g., looking at the picture of the lion, while the interlocutor is labeling “This is a lion” or asking “What is this?”) while infants acquiring a sign language need to constantly shift their eye gaze between the contextual referent and the signing interlocutor.

Further studies are necessary to better understand lexical acquisition in sign language, also taking into account the bilingual status of deaf children in many countries. In conducting these future studies, particular attention should be paid to the tests used to evaluate children’s linguistic skills.

The results of the present study (in particular the fact that both groups show similar patterns of difficulty in relation to the item presented) confirmed that the PiNG task, originally developed to assess vocabulary in spoken languages, is suitable to directly assess lexical comprehension and production, also in deaf signing children without further adaptations. However this does not hold true for other linguistic domains. For example, tests concerning phonological or grammatical aspects should be developed taking into account (or better, starting from) the specific linguistic features of the particular Sign Language to which the child is exposed, as well as the cultural characteristics of the Deaf and hearing communities in which the bilingual child grows up (Haug, 2011; Haug & Mann, 2008). As recently pointed out by Woll (2013), there is a need to investigate the extent of variability already found in spoken languages acquisition for sign languages and to confirm existing findings on larger numbers of children. A correct assessment of sign language development is essential for designing appropriate programs and materials for families and schools. The development of tools and methodologies for sign language assessment is moving from an informal descriptive observation to proper formal assessment, made through tools and methodologies that should also take into account the specific properties and cultural characteristics of different SLs in order to compare language acquisition and development in children from different cultures and language.

Funding

Fondazione Cassa di Risparmio di Trento e Rovereto (2011.0448 to MCC); Fondazione Telecom Italia, “Progetto VOLIS” (to PR); Education, Audiovisual and Culture Executive Agency, “SignMET” (543264-LLP-1-2013-1-IT-KA2-KA2MP to PR).

Conflicts of Interest

No conflicts of interest were reported.

Acknowledgments

We wish to thank Penny Boyes Braem and Aliyah Morgenstern for their insightful comments and for the revision of the English. We are also grateful to the children and parents who participated in the study.

References


Pizzuto, E. (2002). The development of Italian Sign Language (LIS) in deaf preschoolers. In G. Morgan & B. Woll...


