A phonological awareness test for deaf children using Brazilian Sign Language

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Research on phonological awareness has been developed in different languages, because the ability to access knowledge and manipulate the segments (sounds) of a given oral language favorably impacts on the learning process of reading and writing of languages that are represented in an alphabetical code.

In the absolute majority of research on phonological awareness, informants hear and speak an oral language which has a written representation. Nevertheless, there has also been interest in investigating this ability in deaf informants, both users and non-users of a given sign language (Hanson 1989; Paul and Jackson 1993; Perfetti and Sandak 2000; Nielsen and Luetke-Stahlman 2002; Souza and Bandini 2007). Usually, the main purpose has been to investigate whether the development of phonological awareness in deaf individuals living amidst users of an oral language contributes to the literacy process of that written language, thus facilitating the learning of reading and writing and increasing the level of proficiency in them.

While research on the phonological awareness of hearing or deaf individuals using oral languages is found in the literature, research on the awareness of the phonological aspects of a given sign language, typically the native language of deaf individuals, is not easily found.

Nevertheless, research on phonological awareness of sign language users by way of an instrument which specifically considers a visuospatial system may contribute in several ways: i) to studies on the phonology of that language, ii) to studies on the language acquisition process of deaf children, and iii) to studies on the learning of a written alphabetical system. Light can be shed on questions like:

- Which is the adequate format for an instrument destined to evaluate phonological awareness in a visuospatial language?
- What aspects of phonology should the instrument test?
- Is it possible to determine typical/expected answers on phonological awareness in deaf children who acquire sign language early?
- Do deaf children who acquire sign language late, or deaf children who present some sort of language disability, have difficulty in their ability to think about their own language?
Do children who are stimulated to think about the phonology of their sign language benefit from this stimulation in their language acquisition process?

Is phonological awareness related to the learning process of a written first language even when it is non-alphabetical, like Sign-Writing, or of a second language, like the written representation of oral languages?

Here we are interested primarily in the first two questions: in the adequate format for an instrument to assess phonological awareness in a visuospatial language, and which aspects of phonology should be tested.

This chapter presents and discusses a phonological awareness test in Brazilian Sign Language (from now on LSB, for Lingua de Sinais Brasileira), taking into consideration one of the sublexical parameters of signs - the handshape.

Initially we describe the test and also the methodology for data analysis. We analyze the children’s performance according to their period of linguistic exposure¹, and also differences between the answers given by children and by adults who took a pre-test.

Our results show that the period of linguistic exposure influences the children’s performance both as regards lexical knowledge and as regards their performance in tasks on phonological awareness of the handshape parameter.

The evaluation instrument, designed to be used with deaf children, was applied in a playful but at the same time efficient way and was considered adequate to measure phonological awareness of the handshape parameter.

1. The evaluation test: description and application

The test which we propose to use to evaluate phonological awareness of handshape (HS) in deaf children using LSB is a pioneer proposal for LSB.

It comprises two parts: in the first part, the children’s lexical proficiency is assessed, so as to be sure that the participants are familiar with the vocabulary which is going to be used (comprehension and production of the signs). In the second part, their phonological awareness of the HS parameter is assessed.

A linguistic test for children presents additional challenges to those inherent to any test for adults. Besides the linguistic questions which are at its basis, there are specific cognitive, maturational and psychological factors to be considered, namely:
A phonological awareness test for deaf children using LSB

- limitations in attention span and in physical capacity;
- vocabulary has to be age and development appropriate;
- words have to refer to concrete objects or animate beings, to be represented by easily recognizable pictures;
- directions have to be very clear and simple;
- application has to be playful and attractive to the participants.

A first version of the phonological awareness test was presented to five deaf adults who were native users of LSB. The purpose in conducting this pre-test with adults was: to initially avoid the specificities of interaction with children, being able to concentrate on the test itself (structure, wording of the orders, number of tasks, length, and so on); to assess the level of figure-match recognition; to check whether any signs evoke more than one item for a referent; and to select the production which is considered standard or most used by the children’s linguistic community, in the event of finding linguistic variation.

In accordance with the adult’s reactions, commentaries and difficulties in the pre-test, some adjustments were made and the instrument was then tested on fifteen deaf children aged between 6:0 and 11:12 who began their language acquisition in LSB between 0:0 and 4:1. These children attended a bilingual3 school for deaf people at the city of Porto Alegre, Brazil. The children have no visual4, neurological or developmental disabilities, and they had average to good grades at school5.

The school’s Board as well as the children’s parents and the adult deaf participants all gave their formal, written agreement to participation in the project.

1.1 Description and application of the Lexical Evaluation Test – LET

The purpose of the lexical evaluation test – LET – was to determine the children’s knowledge of the vocabulary which is used in the second part of the test, the phonological awareness test. Each child is checked whether he/she knows and produces the 120 signs of this test, and whether he/she knows the concept represented by the figures and is able to name it. This knowledge is a pre-requisite for the phonological awareness assessment since the signs and corresponding pictures are part of it, and it guarantees that the performance of the participants is examined exclusively as to phonological awareness of the HS parameter.

A hundred and twenty colored pictures on individual flashcards were used to evaluate lexical proficiency. These pictures represent the lexicon
to be tested, which was established according to the already mentioned criteria: vocabulary has to be age and development appropriate; words have to refer to concrete objects or animate beings that can be represented by easily recognizable pictures. The vocabulary list contains many words identical to those existent in tests of spoken Brazilian Portuguese which also use pictures to elicit children’s productions in research on phonological development (Yavas, Hernandorena and Lamprecht 1992; Wertzner 2004). All of them refer to a child’s universe, referring to family members, food, toys, transportation, colors, numbers, animals, furniture and simple household appliances.

Other criteria to choose signs for the test were: to have signs of different categories and to have signs which share, or not, the HS parameter with others, to give opportunity to questions about identical or distinct HSs.

After establishing the vocabulary list, we found that there was an unequal number of signs in the four categories (1H1HS, 2H1HS, 1H2HS, 2H2HS). Due to the nature of the vocabulary itself there were more signs in certain categories than in others (e.g. more 1H1HS, less 2H2HS).

Each participant was required to sign as many of these pictures as possible in LSB. A camcorder was used to videotape the sessions. When the expected sign was not produced by the subject, the researcher used toys and objects related to the picture in addition to making comments about the concept that the picture and objects represented, with the purpose of clarifying and/or promoting the appropriation of the meaning by the child. After one or two interventions, the child was reassessed to determine whether he/she had acquired the vocabulary.

After this short intervention on the lexical level all informants were able to recall and to demonstrate understanding of the 120 signs.

1.2 Description and application of the Phonological Awareness Test – PAT

The purpose of the second part – that on phonological awareness – is to evaluate the participant’s ability to think consciously about the HS parameter.

The material used in the PAT consisted of 35 flashcards. A camcorder was used to film the activities.

The evaluation comprised 5 demonstration tasks and 30 test tasks. These were organized into five different parts, always taking in account linguistic constraints on sign formation; LSB phonology; and studies on the acquisition process of LSB phonology (Battison 1978; Ferreira-Brito 1995; Karnopp 1994, 1999; Quadros and Karnopp 2004).
We describe the five different parts of the test and the signs with different formations which are in them.

Part 1

Signs produced with one hand and one handshape (1H1HS).

Example in LSB: GREEN

Part 2

Signs produced with two hands and one handshape (2H1HS).

Most of the signs were completely symmetrical, while one of the signs had the same HS on both hands but other characteristics such as orientation or action were different.

Examples in LSB: TELEVISION and CHOCOLATE

Part 3

Signs produced with two hands and two different handshapes on different hands (2H2HS).

Example in LSB: SLIPPERS
Part 4

Signs produced with one hand and two sequential handshapes (1H2HS).

Example in LSB: LION

Part 5

Signs spontaneously recalled by the participant when shown a HS on a flash-card.

The participant was required to spontaneously recall all the signs he/she knew and remembered that can be produced with a given handshape.

Five handshapes were selected: \([\text{\textdollar}}\), \([\text{	extdollar}	ext{\textdollar}}\), \([\text{\textdollar\textdollar}}\), \([\text{\textdollar\textdollar\textdollar}}\). The first three HSs are documented in Karnopp’s (1999) longitudinal study as being acquired in different periods in LSB. The fourth handshape \([\text{\textdollar\textdollar\textdollar}}\) is part of the phonetic inventory of LSB although it was not identified in Karnopp’s study in the age range covered by that author. However, it is documented in studies by Bonvillian and Siedlecki (1996) and Boyes-Braem (1990) for ASL. The fifth handshape \([\text{\textdollar\textdollar}}\) was chosen for the demonstration task for two reasons: because it allows the production of signs with one and with two hands, and because this HS is in the LET.

The number of tasks was different for different parts:

- parts 1 and 2: 1 demonstration task and 10 test tasks,
- parts 3 and 4: 1 demonstration task and 3 test tasks,
- part 5: 1 demonstration task and 4 test tasks.

The difference in the number of tasks per part is due to the difference in number of signs (according to their formation) in the lexicon to be tested, as mentioned above.

To assess phonological awareness in parts 1 to 4 (1H1HS, 2H1HS, 2H2HS, 1H2HS), each participant received detailed instructions to perform the tasks. The demonstration tasks allowed the children to be comfortable with the game they were asked to play, and helped the researcher to make sure that each of them understood clearly how the tasks should be performed.

In parts 1-3, the participant was required to compare the handshape of a given target-sign and the handshapes of three other signs. He/she was shown
a picture on a flashcard, produced the target sign, looked at some alternatives on that same card and chose the picture whose sign matched the handshape of the target-sign.

Figure 1 is an example of a flashcard with a task for part 2.

![Flashcard with task](image)

**Figure 1.** Task corresponding to part 2: signs produced with 2 hands and 1 handshape – 2H1HS

In this task the target-sign is the COMPUTER. The participant is required to compare the handshape of the target-sign and the handshapes of the signs: SOCKS, PRESENT and SHIP. Only the signs for COMPUTER and SOCKS have the same handshape, as can be seen in SignWriting below.

![SignWriting](image)

In part 4, which has signs with handshape sequences (1H2HS), the participant was required to compare the final handshape of a given target-sign and the final handshape of three other signs: a rhyme task in sign language.

It was explained to the child that the target-sign had two parts (initial and final configuration), and it was also explained that the initial configuration could be seen in the photo at the side of the target picture but that the final configuration could not be seen (empty space at the side of the photo). The child was then told to compare the final configuration of the target-sign to
the final configurations of the alternatives on the flashcard. After comparing them, he/she then should choose the picture which had the same final configuration as the target-sign.

The participant looked at the target picture, produced the target-sign, looked at the alternatives and chose, among the alternatives, the picture whose sign had the same final handshape of the target sign.

Figure 2 is an example of a flashcard with a task for part 4. The final handshapes for the signs MOON and TOUCAN are identical, as can be seen in SignWriting below.

![Figure 2. Task corresponding to part 4: signs produced with one hand and two sequential handshapes – 1H2HS](image)

In Part 5, the participant was required to spontaneously recall any signs he/she knew and remembered at that moment that are produced with a given handshape when shown that HS on a flashcard. The signs could be of everyday usage or recently learned during the lexical evaluation test: there were absolutely no restrictions.
The pictures of the demonstration task are shown in figure 3.

![Figure 3. Task corresponding to part 5: pictures used in the demonstration and test tasks](image)

2. Coding for the Lexical Evaluation Test – LET – and the Phonological Awareness Test – PAT

2.1 LET: data organization

The adults’ productions in the pre-test and the children’s productions in the LET were classified into five categories, as follows.

Expected sign

The sign produced by the participant matched the picture and the target which had been established. Example: the sign HOUSE was expected when the picture of a house was provided, and the participant (adult or child) produced the sign HOUSE. Phonological variation is an expected possibility in any language, and occurred with a few signs in this instrument. Example: TOOTHBRUSH may be produced with handshapes [a] or [l].

Non-expected sign

The sign produced by the participant matched the picture, but it did not match the target. Example: the picture of a man was signed as FATHER.

Modified expected sign

The sign produced by the participant matched the picture and the target, but a parameter was modified during the production. The modification was identi-
fied when comparing the sign produced by the child and the standard (adult) sign. Example in LSB:
Signs KNIFE and BLACK produced by adults

![Signs KNIFE and BLACK produced by adults]

Signs KNIFE and BLACK produced by a girl and a boy

![Signs KNIFE and BLACK produced by a girl and a boy]

Comment, classifier or mime

The participant produced a comment about a given picture, signing, for example, THE TEACHER HAS THE SAME!; or a classifier, as in manually representing the shape of the building in the picture he was shown; or a mime, as in doing the movement with his feet as though ‘kicking a ball’.

No sign

The participant did not sign or claimed not to know the sign to match the picture he was shown.

For the LET analysis, data were organized into four tables corresponding to the different handshape possibilities: one hand and one handshape (1H1HS); one hand and two handshapes (1H2HS); two hands and one handshape (2H1HS); two hands and two handshapes (2H2HS). LET data were
also distributed in tables corresponding to the five categories of productions: expected sign; non-expected sign; modified expected sign; comment/ classifier/ mime; no sign.

2.2 LET: comments on the data analysis

The pictures in the flashcards were found to be mostly age appropriate, clear and recognizable. Adult individuals in the pre-test signed 91% of the pictures and children signed 77.4% in accordance to what had been established as expected sign. Some pictures, nevertheless, were unsatisfactory because a number of children attributed one and the same non-expected sign to certain pictures, e.g. five children signed FATHER when seeing the flashcard for: man.

Differences stemming from phonological variation were found in the production of expected signs in adult data. Identification of phonological variation in LSB signs that make up the LET was very important, since variable forms in the children’s production were then considered expected signs in the analysis. Therefore, these were counted as correct lexical productions, unlike the productions with some other modifications at the phonological level. Nevertheless, if a child’s form is used less by the deaf community, the researcher demonstrated the prevalent (adult) sign, and required that this should be used in the tasks. In this way all the segments were the same for all participants, and correlated with the segments which were under assessment in the test. Among adults, in the pre-test, 15.8% of the signs were produced with some variation.

As to the free recall of signs from pictures of HSs, a qualitative difference was found between adults and children. The children produced all five categories of signs - expected signs, non-expected signs, no sign, modified expected signs, or comments/ classifiers/ mimes. The adults produced only the first three categories: expected signs, non-expected signs or no sign.

We looked in our data for the possibility of a relationship between the children’s production of signs and different shape complexity of signs. In the production of signs with 1H1HS, results showed more expected signs, less non-expected signs, still less modified expected signs and less production of comments/ classifiers/ mimes. On the other hand, in the production of signs with 2H2HS, results showed much less expected signs, more non-expected signs, more modified expected signs and more production of comments/ classifiers/ mimes. As for no sign production, there was only a small difference between these two shapes: 4.09% in signs with 1H1HS and 3.75% in signs with 2H2HS.
In table 1 we show percentages of usage in each of the two categories of signs – less complex and more complex – to contribute to the discussion about the possible relationship between the children’s production and different shape complexity of signs.

<table>
<thead>
<tr>
<th></th>
<th>1H1HS</th>
<th>2H2HS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected signs</td>
<td>83.18%</td>
<td>68.33%</td>
</tr>
<tr>
<td>Non-expected signs</td>
<td>9.24%</td>
<td>15.83%</td>
</tr>
<tr>
<td>Modified expected signs</td>
<td>0.45%</td>
<td>5.41%</td>
</tr>
<tr>
<td>Comments/classifiers/mimes</td>
<td>3.03%</td>
<td>6.6%</td>
</tr>
</tbody>
</table>

The results of our LET confirm Karnopp (1994). In longitudinal research on children acquiring LSB, Karnopp corroborates Carter (1983) and McIntire (1977) when she finds that there are several different factors which may influence the production of HSs by deaf children. The most important ones are the complexity of the movement and the area in which the HS is articulated. Karnopp also found that 1H1HS signs were produced by all the children who were her informants, and in higher proportion than those produced with two hands. 2H1HS signs seem to be established earlier than 2H2HS signs.

The children in our study also produced more 1H1HS signs, and there were more modified signs in the production of 2H2HS signs, which are of late acquisition. Karnopp’s (1994) subjects and this chapter’s subjects can be compared even though they differ in some aspects, like beginning of language acquisition, chronological age and linguistic exposure period. But what they have in common is that they are still in the process of language acquisition, and that the language component which is analyzed is phonology.

Materials and procedures used in the evaluation of lexical proficiency proved to be efficient. They enabled the researchers to assess participants’ knowledge of vocabulary and of the form of production, and also gave participants an opportunity to acquire vocabulary or adequate production.

2.3 PAT: children’s strategies

During the PAT we observed that adults (in the pre-test) and children reacted in different ways while they executed the tasks. Different strategies were used to choose the alternative which was considered to be the correct answer.
Children’s performance was more variable, both in strategies as in achievement. They produced all six of the strategies listed below - a) to f) - while adults produced only the last three - d) to f).

Strategies employed only by children:

a) holding the HS of the target-sign in one of the hands, and to perform the alternative answer signs with the other hand - then compare both HSs\(^{11}\);
b) repeating the sign of alternative answers a few times before choosing among them;
c) producing the sign of some of the incorrect alternative answers using the HS of the target-sign; Strategies employed by both children and adults;
d) producing the target-sign, then producing the signs corresponding to each picture and eventually choosing among the alternatives;
e) producing the target-sign, holding the HS and then choosing the alternative answer;
f) producing or not producing the target-sign and then choosing the alternative answer after looking at the pictures.\(^{12}\)

We will discuss some questions raised by the use of different strategies as well as by the greater number of strategies used by children than by adults, and the use of different strategies by some participants.

As for the fact that children employ strategies that adults don’t employ, attention is here called to two facts: in these strategies the HS stays the same; there is a tendency to repetition of signs. A question is raised: could expressive language (i.e., producing a sign with one’s hands) be a tool to help the child to identify the HSs he/she is shown, to compare them and to choose ‘the best’? This is a hypothesis to be considered, because expressive signed language was constantly present during the whole activity. In the other strategies this tool was very little or not at all employed. With little or no use of expressive language the task turned into a greater mental effort.

As for the distinct use of strategies among children, it may be said that all of them employed more than one strategy, and that some who had a shorter period of linguistic exposure had a preference for strategies (a) to (c). Others began by making use of these first strategies but very soon dismissed the use of expressive language. A possibility which can be thought of is that this variety in the use of strategies is related to a child’s linguistic level. On the other hand, it could indicate that a certain task calls for a more complex phonological analysis.
The analysis of the LET and of the children’s performance according to the period of their exposure to sign language suggests that the choice of strategies could be related to three reasons: to the level of language development, to signs of different shapes, and to the complexity of the tasks.

While performing the tasks, some children spontaneously expressed their views on the selection of answers, whereas others chose the correct alternative after producing the target-sign, according to the instructions they had received. This fact demonstrates that some of the children went beyond the task that was being given to them, since they made comments on certain aspects of their own language.

2.4 PAT: data organization and analysis

Data obtained for parts 1 to 4 of the PAT were organized in tables to be analyzed according to the level of complexity of tasks with differently formed signs (1H1HS, 2H1HS, 2H2HS, 1H2HS). Table 2 is an example of these tables.

Table 2. Answers given by the participants to tasks in part 2 (2H1HS) – Children

<table>
<thead>
<tr>
<th>Task 1</th>
<th>Alternatives</th>
<th>Task 2</th>
<th>Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Tent</td>
<td>Target</td>
<td>Chocolate</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>Bed</td>
<td>Bear</td>
<td>Knife</td>
<td>Rice</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Rain</td>
<td>0</td>
<td>Library</td>
<td>2</td>
</tr>
<tr>
<td>NA</td>
<td>0</td>
<td>NA</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task 3</th>
<th>Alternatives</th>
<th>Task 4</th>
<th>Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Train</td>
<td>Target</td>
<td>Ball</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>Donkey</td>
<td>Clouds</td>
<td>Coconut</td>
<td>Umbrella</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Broom</td>
<td>0</td>
<td>Dress</td>
<td>2</td>
</tr>
<tr>
<td>NA</td>
<td>0</td>
<td>NA</td>
<td>0</td>
</tr>
</tbody>
</table>
By means of these tables we were able to analyze the children’s choice of answers, and also to determine if the tasks in parts 1, 2, 3 and 4 varied in complexity in phonological terms.

Data obtained for part 5 were organized in tables according to the different sign formations (1H1HS, 2H1HS, 2H2HS, 1H2HS) of the spontaneously recalled signs, permitting the comparison of the four handshapes which were being assessed.

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<table>
<thead>
<tr>
<th>Task 5</th>
<th>Target</th>
<th>Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Socks</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Computer</td>
<td>Present</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ship</td>
</tr>
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<table>
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<th>Task 6</th>
<th>Target</th>
<th>Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>House</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Robot</td>
<td>Monkey 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Balloon</td>
</tr>
<tr>
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<table>
<thead>
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<th>Task 7</th>
<th>Target</th>
<th>Alternatives</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Videocassette</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Television</td>
<td>Skirt</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Corn</td>
</tr>
<tr>
<td></td>
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<td>NA</td>
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</table>

<table>
<thead>
<tr>
<th>Task 8</th>
<th>Target</th>
<th>Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Towel</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Car</td>
<td>Kangaroo</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alligator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NA</td>
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<table>
<thead>
<tr>
<th>Task 9</th>
<th>Target</th>
<th>Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Football</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Backpack</td>
<td>Rabbit</td>
</tr>
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</tr>
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<td></td>
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<table>
<thead>
<tr>
<th>Task 10</th>
<th>Target</th>
<th>Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bus</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Ox</td>
<td>King</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Building</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NA</td>
</tr>
</tbody>
</table>

Legend:
NA: no alternative
Correct alternatives are highlighted in **bold**.
Table 3 is an example of these tables.

**Table 3.** Signs produced in part 5: handshape \[\text{\textvisiblespace}\]$l$ – Children

<table>
<thead>
<tr>
<th></th>
<th>1H1HS</th>
<th>1H2HS</th>
<th>2H1HS</th>
<th>2H2HS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signs</td>
<td>44</td>
<td>9</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Modified expected signs</td>
<td>0.45%</td>
<td>Modified expected signs</td>
<td>5.41%</td>
<td></td>
</tr>
<tr>
<td>Total signs</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Differences in complexity can be found among tasks and parts. One example of this can be seen in the analysis of results according to the period of linguistic exposure (LE) (see graph 3). Part 4, the rhyme task, seems to be the less complex one since children with different lengths of time of LE reached 100% of correct answers.

Analysis of the children’s answers to the tasks proved to be very interesting. In table 2 there was a high level of correct answers (80%) in most of the tasks (1, 2, 3, 4, 5, 6, 7, 9). In case of incorrect choices, in 62.5% of them different children chose the same incorrect alternative. In task 5, for example, twelve children chose the correct answer SOCKS and three children selected the same incorrect alternative PRESENT. The option SHIP wasn’t chosen. Analyzing the parameters which constitute the signs of the incorrect answers, there is a similarity among them because both signs share location with the target-sign, as can be seen below.

<table>
<thead>
<tr>
<th>Computer -Socks (correct option)</th>
<th>Computer -Present (incorrect option)</th>
<th>Computer -Ship (incorrect option)</th>
</tr>
</thead>
<tbody>
<tr>
<td>■ HS</td>
<td>□ HS</td>
<td>□ HS</td>
</tr>
<tr>
<td>■ L</td>
<td>■ L</td>
<td>■ L</td>
</tr>
<tr>
<td>□ M</td>
<td>□ M</td>
<td>□ M</td>
</tr>
<tr>
<td>□ Or</td>
<td>□ Or</td>
<td>□ Or</td>
</tr>
<tr>
<td>■ NM (not necessary)</td>
<td>■ NM (not necessary)</td>
<td>■ NM (not necessary)</td>
</tr>
</tbody>
</table>

Legend:

- ■ Parameter common to target-sign
- □ Parameter not common to target-sign
- Or: Orientation of the palm
- NM: Non-manual features

HS: Handshape
L: Location
M: Movement
But preference for a certain incorrect option seems also to be related to other aspects of the signs. Both in the pair COMPUTER - SOCKS (correct option) and in the pair COMPUTER - PRESENT (incorrect option) hands are not in contact and each hand produces its movement in different directions, while in SHIP hands do have contact while the movement is in one direction only, as can be seen below in SignWriting.

The children looked at the two incorrect options and chose the one which had greater similarity to the target in terms of phonological characteristics. The same happened in other tasks: the preferred incorrect answer options were those that had greater phonological resemblance to the target, even though they did not share the target handshape similarity.

It is interesting to observe in task 10 of this same part 2 that, differently from task 5, seven children chose an incorrect option. Once again there was a clear majority: six of them chose one and the same incorrect alternative: KING. In this case, the correct pair OX - BUS shares the HS parameter, as can be seen below in SignWriting.

The pair OX-KING shares the same location but the pair OX-BUILDING doesn’t have any parameters in common, as can be seen below.

<table>
<thead>
<tr>
<th>Ox-Bus (correct option)</th>
<th>Ox-King (incorrect option)</th>
<th>Ox-Building (incorrect option)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ CM</td>
<td>□ CM</td>
<td>□ CM</td>
</tr>
<tr>
<td>□ L</td>
<td>□ L</td>
<td>□ L</td>
</tr>
<tr>
<td>□ M</td>
<td>□ M</td>
<td>□ M</td>
</tr>
<tr>
<td>□ Or</td>
<td>□ Or</td>
<td>□ Or</td>
</tr>
<tr>
<td>■ NM</td>
<td>■ NM</td>
<td>■ NM</td>
</tr>
<tr>
<td>(not necessary)</td>
<td>(not necessary)</td>
<td>(not necessary)</td>
</tr>
</tbody>
</table>
Legend:
■ Parameter common to target-sign
□ Parameter not common to target-sign
HS: Handshape
L: Location
M: Movement
Or: Orientation of the palm
NM: Non-manual features

Results suggest that the children who chose the same incorrect option compared the location parameter and not the HS parameter. The preference for the same incorrect answer reinforces the hypothesis that children are conscious of the phonological aspects of the signs and that the incorrect choice wasn’t random. There is also the possibility that this task was more complex for two reasons: one incorrect alternative shared the location parameter with the target, and all alternatives were similar in terms of the fingers which have to be selected in the production of each sign.

Participants showed great interest and attention during the PAT. They liked the game they were asked to play. Our findings suggest that the material which was used and the procedures which were adopted provided adequate understanding of the test.

3. Analysis of children’s performance in the Lexical Evaluation Test and in the Phonological Awareness Test, according to period of linguistic exposure

Children’s performance in lexical proficiency and phonological awareness was evaluated according to the length of time of their exposure to LSB. Participants were classified in three periods of linguistic exposure (LE):

- < 4:6 years of LE = 3 children
- 4:6 to 6:6 years of LE = 7 children
- > 6:6 years of LE = 5 children.

As could be expected, participants with longer LE signed more pictures than participants with LE between 4:6 to 6:6 who, in turn, outdid informants with LE < 4:6.
Graph 1 shows that there is a relationship between length of time of LE and the participant’s level of lexical proficiency, considering 120 LSB signs. While the amount of expected signs tends to increase as the length of time of LE increases, there is a decrease in each of the other categories of signs individually. In other words, there is an enhanced knowledge of vocabulary and of more accurate productions. We see that linguistic knowledge grew in terms of vocabulary in a direct relation to the time of LE, in the same manner as happens with children who are exposed to oral languages and who develop a typical language acquisition process in that modality.

Legend:
ES: expected sign
NES: Non-expected sign
MES: Modified expected sign
C/CL/Mm: comment/classifier/mime
NS: No sign

Graph 2 shows the rise of the category of expected signs with the increase of LE, and the simultaneous, corresponding fall of all the other categories of signs taken together (non-expected signs, modified expected signs, comments/classifiers/mimes and no signs). As children have a longer span of LE, their vocabulary not only grows in quantity – which is shown by the increase in number of expected signs and the decrease in comments/classifiers/mimes and no signs – but also grows in quality, by more accurate productions – which is shown by the decrease in modified expected signs.
A certain amount of variability was found in the performance in phonological awareness tasks of participants who had the same period of LE. Additionally, the performance of one informant with LE > 6:6 was deemed discrepant from his peer group. Because of such discrepancy, data were analyzed two ways: with and without this participant.

In graph 3 the mean performance in parts 1 to 4 of the three groups of children, according to length of LE, is shown. It can be observed that the level of phonological awareness in LSB grows as the length of LE increases.
Table 4 shows these data in more detail.

Table 4. Percentage of correct answers in parts 1 to 4 of the PAT, relative to period of linguistic exposure

<table>
<thead>
<tr>
<th>Parts</th>
<th>LE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 4:6</td>
<td></td>
<td>20 – 30%</td>
<td>20 – 70%</td>
<td>33%</td>
<td>20 – 100%</td>
</tr>
<tr>
<td>4:6 to 6:6</td>
<td></td>
<td>40 – 100%</td>
<td>60 – 100%</td>
<td>66 – 100%</td>
<td>66 – 100%</td>
</tr>
<tr>
<td>&gt; 6:6</td>
<td></td>
<td>30 – 100%</td>
<td>80 – 100%</td>
<td>66 – 100%</td>
<td>66 – 100%</td>
</tr>
<tr>
<td>&gt; 6:6 *</td>
<td></td>
<td>80 – 100%</td>
<td>100%</td>
<td>100%</td>
<td>66 – 100%</td>
</tr>
</tbody>
</table>

*Leaving out data of participant with discrepant performance.

In table 4, where one of the participants was left out, a gradual growth in performance can be seen. If that same participant is included, correct answers in parts 1 and 3 grew gradually or were the same. In part 4 the percentage of correct answers grows.

Interestingly, there were some children with less linguistic exposure who answered all questions correctly, while there were other subjects with longer exposure who didn’t.

The majority of children in all three linguistic exposure groups had 100% correct answers in part 4. Possibly this task is less complex; a study with a higher number of subjects and/or more tasks might explain these results better.

In part 5 the total number of signs which were spontaneously recalled by the children was 222 signs. These data were distributed in 4 tables according to the HS of the spontaneously recalled signs and according to the possibilities of production of signs with different configurations. Data for each linguistic exposure period were taken in account.
In table 5 there is an example of one of these tables, according to period of LE.

Table 5. Signs produced in part 5, handshape \([\frac{\square}{\square}]\), according to the period of linguistic exposure

<table>
<thead>
<tr>
<th></th>
<th>1H1HS</th>
<th>1H2HS</th>
<th>2H1HS</th>
<th>2H2HS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LE &lt; 4:6</td>
<td>4 signs</td>
<td></td>
<td>2 signs</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4:6 to 6:6</td>
<td>18 signs</td>
<td>5 signs</td>
<td>5 signs</td>
<td>2 signs</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 4:6</td>
<td>22 signs</td>
<td>4 signs</td>
<td>3 signs</td>
<td>4 signs</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total/handshape</td>
<td></td>
<td></td>
<td></td>
<td>69 signs</td>
</tr>
</tbody>
</table>

For our analysis, the number of signs produced with each HS in each period of LE was summed up and divided by number of children. The amount of signs spontaneously recalled and adequately produced by participants, for each LE, was:

- LE < 4:6: 18 signs, mean of 6 signs per participant
- LE 4:6 to 6:6: 92 signs, mean of 13.1 signs per participant
- LE > 6:6: 112 signs, mean of 22.4 signs per participant

Besides the gradual increase in the amount of signs which were produced there was also an increase in signs per category in the four HS categories, according to the increase in LE. This relationship can be seen in Table 5, above. The table shows very clearly that there is an important gain from the first group (<4:6) to the second group (4:6 to 6:6), both in the absolute number of signs and in the number per HS category.
Conclusions

We described and discussed the Phonological Awareness Test (PAT), designed for deaf children who are signers of LSB, as well as the Language Evaluation Test (LET), which is integral part of it.

The test is efficient, user friendly and opens the way to a great number of analyses. It is applicable to children in a playful, easy and attractive manner.

This research shows that deaf children have the ability to access their knowledge of the phonology of the language in which they sign, meaning that phonological awareness is not contingent on the modality in which language is expressed. A gradual evolution of this ability occurs in hearing as well in deaf children, and performance grows in all areas and parts which were tested according to longer exposure to language.

It is our belief that a validated test for the assessment of phonological awareness of a given sign language may contribute to investigations on the linguistic development of deaf children. It provides an instrument to check a child’s sensitivity to the phonological aspects of his/her own language, to identify the level of development of phonological awareness (typical/atypical, considering the period of linguistic exposure or age), as well as to follow up the evolution of this important linguistic skill. This instrument can also contribute to studies on sign language phonology and on other questions about phonological awareness of deaf children and adults which are without answers.

In schools for hearing children games, rhyming activities and songs which help the increase of phonological awareness are already everyday practice. It is necessary to consider whether in educational practice with deaf students this kind of activity should also occur or be emphasized, thus contributing to the linguistic development of deaf children.
Each of the participants had a different age at the beginning of exposure to sign language: since birth (0:0) or, the oldest, at 4:1. This was considered a very important factor for language awareness.

At their school, LSB is the native language of the majority of the students and constantly used by the children and teachers; written Brazilian Portuguese is taught as a Second Language.

Reliability of the children’s data is guaranteed by the fact that the first author has been a speech and language therapist at the school for 15 years.

Data about the subjects’ age, beginning of language acquisition (production), period of exposure to LSB, general health conditions, as well as about the parents and the parents’ learning and use of LSB were considered because our purpose was to create a test of phonological awareness for deaf children with typical development in terms of language acquisition.

For example: the participant was expected to represent the figure of a whale with the sign WHALE, but one of the children used the sign FISH, which was not expected.

Chosen from an educational game: “Configuracoes de Maos em LSB”, Nelson Pimenta (Copyright © 2000 LSB Video).

These modifications seem to be repair strategies (also known as substitution processes), very common in phonological acquisition.

The possibility of modifications at the phonological level - repair strategies/substitution processes - was raised since the children were still in the language acquisition process in LSB, which includes phonological acquisition.

Karnopp’s (1994) informants were four deaf children born of deaf parents, aged between 2:8 and 5:9. They were exposed to Brazilian Sign Language (LSB) from birth.

Signs produced with 1H1HS.

Some of the children looked at the flashcard and indicated their choice by pointing or by putting a plastic token on the picture.

Alternative NA was added to the tables because some of the informants declared that all the three answer options were incorrect.
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