Abstract: Aim of this study is to determine the efficacy of visual strategies for learning and improving literacy skills in prelingually deaf readers. Intervention, based on the premise that deaf learners are visual learners and thus require visual pedagogical practices, was conducted on literacy skills of a sample of 24 prelingually deaf readers with profound hearing loss (M = 9.88, SD = .86). Results suggest participants improved their performance in letter identification, lexical recognition, syntactical skills and semantic skills. The intervention program based on practices focused on deaf accelerates development of literacy skills. Study provides evidence of the need of cultural beliefs and experience of being a deaf person in order to propose effective pedagogical practices, thus reinforcing research in Deaf Epistemology.

Key words: reading, comprehension, language, children, elementary

For more than a century, the question pondered by teachers of the deaf individual all over the world has been: How should deaf students be taught to read? Likewise, the question that has concerned researchers for the last fifty years or so is: How do deaf people actually learn to read? Both these questions should be addressed in tandem in order to arrive at an effective educational response and full scientific understanding. Another point to consider is whether the strategies used in these learning processes are different or similar to those employed by the hearing readers (Kargin et al., 2012; Matthew, Hauser, & Bavelier, 2008; Miller, 2005, 2006, 2010, 2013; Piñar, Dussias, 2014). Our sincere thanks to the staff of teachers and children of the deaf school No. 1139 “Dr. Jorge Otte Gabler” in Santiago de Chile.
From a pedagogical standpoint, this question has been answered in a variety of ways. However, all the methods and pedagogical strategies used have reproduced the style of teaching received by the hearing individuals, which has contributed to reading failure and difficulties for the deaf readers (Alvarado, Puente, & Herrera, 2008; Augusto, Adrian, Alegria, & Martinez, 2002; Hermans, Knoors, Ormel, & Verhoeven, 2008). As a result, very few deaf students attain a high enough reading level to gain access to further studies or social positions that would have been within their reach were it not for these problems (Alegria, Dominguez, & Straten, 2009).

Becoming competent in literacy involves a complex and hierarchical sequential process. This ranges from letter identification, access to the alphabetic code, training in the motor skills involved in the graphic act of writing, and awareness of the language structure (grammar and syntax), all the way through to achieving comprehension, which implies activating highly complex cognitive processes. Due to their social and cultural importance, literacy skills are established in the Knowledge Society as an inalienable human right. Literacy also allows a person to learn to learn and to learn to think, which explains the determination of researchers and teachers to find educational responses that enable the deaf worldwide to access written language.

The problems encountered by the deaf readers with written language as an instrument of access to social information and interpersonal communication are mainly the product of social and linguistic difficulties caused by impaired hearing, which in turn leads to social isolation. However, deafness in itself does not explain the lack of access to information, communication and knowledge. The difficulties and limitations of communication experienced by the deaf individuals are the result of a lack of access to a language system, an insufficient educational response to their specific needs (Gutiérrez, 2004), a hearing-centric pedagogy (Hauser, O’Hearn, McKee, Steider, & Thew, 2010; Holcomb, 2010; Moores, 2010; Paul & Moores, 2010) and deaf bilingual education models (Piñar et al., 2011).

Reading problems in the deaf readers may stem from different factors: (a) ignorance of the meaning of the words in the text, (b) a greater use of familiar words, such as specific nouns and verbs, than of function words, and (c) poor written expression. A differentiating factor in reading performance is knowledge of vocabulary, and reading tasks obtained better results by deaf children of deaf parents who have had natural and fluent language since birth. Therefore, to overcome this lexical problem, sign language (SL) should be considered as the natural language of the deaf children (Augusto et al., 2002; Kovelman, Baker, & Petitto, 2008; Moores, 2010; Padden, 2006; Trezek, Wang, & Paul, 2010). SL has a positive impact on reading performance, not only at the start of early literacy, but also in the broader understanding of the concept (Andrews, Winograd, & DeVille, 1994) and there is recent evidence which supports the importance of SL in the functional organization of language in the brain (Mayberry, Chen, Witcher, & Klein, 2011; Morford, Wilkinson, Villwock, Piñar, & Kroll, 2011) and studies on learning which maintain that SL and fingerspelling contribute to improving literacy skills in prelingually deaf readers (Alvarado et al., 2008; Haptonstall-Nykaza & Schick, 2007; Padden, 2006; Padden & Ramsey, 2000; Puente, Alvarado, & Herrera, 2006).

Interest in gaining a deeper understanding of the relations between SL, fingerspelling and reading led Puente et al. (2006) to carry out a study with deaf Chilean children in which they examined the role of Chilean Sign Language (ChSL) and fingerspelling in the development of reading and writing skills in prelingually deaf readers. The researcher concludes that fingerspelling may facilitate the internal representation of words for the deaf readers and serve as a support mechanism for the acquisition of reading skills. Deaf students have a higher level of achievement in literacy tasks if they are taught using strategies based on the visualization of ChSL.

Alvarado et al. (2008) conclude that, just as an understanding of the correspondence between phonemes and graphemes facilitates literacy learning in hearing children, understanding the correspondence between cheremes (shapes made by the hand) and graphemes has the potential to play a similar role in prelingually deaf readers. Along the same lines, Haptonstall-Nykaza and Schick (2007) have investigated the extent to which fingerspelling serves as a phonological-visual link to help decipher written English. The authors consider whether fingerspelling can provide a link between the phonology of ASL (American Sign Language), semantic meaning and English spelling. The authors conclude that the use of fingerspelling allows the child to establish a more reliable link between sign and writing and thus aiding the process of learning, and that it may also help to provide a phonological link with the written text.

Piñar et al. (2011) point that to better understand the relationship between sign language and written language, it is necessary to pay more attention to the fact that the majority of deaf readers are bilingual in sign language and written language, that in most cases, is their second language.

In a review of the learning and acquisition of fingerspelling in deaf children, Padden (2006) points out that acquiring fingerspelling as part of ASL involves certain skills. At first, deaf children recognize fingerspelled words as complete units. When they start learning to read and write, they begin to understand that the fingerspelled words represent cheremes, which correspond to the letters of the alphabet. The author maintains that fingerspelled words are frequently and constantly used in the language of the deaf individuals, and are firmly rooted in ASL grammar. Padden reflects on the use of strategies that benefit the development of literacy in the deaf readers, and
argues that visually based strategies are the most suitable for enhancing literacy skills.

Herrera, Puente, Alvarado and Ardila (2007) undertook a review of research that in recent decades has attempted to establish the causes of problems of reading in the deaf readers and possible solutions. After analyzing the linguistic components and visually based codes found in reading by the deaf readers, they propose a reading model that gives prominence to visual learning strategies such as SL, fingerspelling, visual phonology, lip-reading and kinetic stimuli, all of which are aimed at improving the phonological component (visually based) of reading in the deaf readers.

Holcomb (2010) explores what the criteria for knowledge are that are crucial for deaf education, and considers three questions that need to be answered: (a) Which issues should be taken into consideration in teaching deaf individuals in order to obtain a satisfactory educational response to their literacy requirements? (b) How can literacy skills be developed in deaf students from practices with a deaf-centric bilingual educational focus? and (c) How does the systematic use of visual learning strategies and the natural linguistic ability of prelingually deaf readers promote literacy skills?

The present study sets out to assess a reading intervention for teaching prelingually deaf children, based on visual learning strategies that enhance students’ reading performance. The main hypothesis put forward in the study is that an intervention in literacy of prelingually deaf signers that use visual learning strategies improves literacy skills in prelingually deaf readers.

Test

The subjects’ reading competence was assessed with the PROLEC reading comprehension test (Cuetos, Rodríguez, & Ruano, 1998), which assesses the overall reading ability of the child and the different strategies used in the reading comprehension processes: letter identification (ID), word recognition (LEX) and syntactic (SIN) and semantic (SEM) processes. Lexical recognition was assessed based on the identification of real or invented words. The syntactical processes were evaluated based on the capacity to identify the syntactical functions of words in a phrase or sentence. The semantic processes were assessed based on the understanding of phrases and sentences.

The PROLEC has been validated in Spanish samples using the teacher’s rating of reading ability and the authors reported a good reliability (Cronbach’s alpha = .92). In order to assess the psychometric properties of the reading test in a Chilean sample, it was administered to a group of 91 Chilean hearing students (34 girls and 57 boys) with ages ranging from 7 to 10 (M = 8.42, SD= .78) who were currently studying 2nd, 3rd and 4th grade of primary education. We obtained an acceptable reliability (Cronbach’s alpha = .85) and observed that the measure was sensitive to increasing reading proficiency with grade and age: the correlation between reading score and grade is r =.333 (p=.002) and the correlation reading score and age is r = .356, p = .001. Thus, the reading test scores are validated by the grade or age criteria (see Suggate, 2010) in Chilean students.

Procedure

Following an initial contact with a bilingual deaf children school in the City of Santiago de Chile, educational intervention was applied to prelingually deaf children between the 1st and 3rd grade of primary school. The participants’ reading comprehension was assessed in the four processes at the beginning and the end of the study.

The intervention designed to incorporate effective visual learning (Herrera et al., 2007) was administered to the group of deaf children for six months in two weekly sessions of 90 minutes each, and was based on the following precepts: (1) ChSL as a first language, (2) teaching of literacy as a second language, (3) use of visual learning strategies for lexical, syntactical and semantic development (fingerspelling, images, lip-reading, spelling, morphology, etc.), (4) use of metacognitive strategies (planning, review, production), and (5) participation of deaf teachers to teach their visual learning strategies to the students.

The proposal for educational intervention was based on training those strategies that deaf adult readers considered to be the most important. This involved conducting a series of interviews in ChSL, which were
video-recorded, transcribed into Spanish and subsequently analyzed to find out the types of strategy that were mostly used. Also taking part in the study were fifteen deaf adults whose ages ranged from 20 to 39 years. All had completed their secondary and/or post-secondary education and showed different strategies that we later included as cognitive, linguistic or affective strategies.

In accordance with the strategies indicated by the deaf adult readers and the importance of learning metacognitive competences, a program was designed based on developing visual learning strategies, which we called the Programa Inicial de Enseñanza de la Lectura y Escritura en Niños Sordos (Initial Program for Teaching Reading and Writing to Deaf Children, Herrera, 2010).

The activities and strategies for intervention (Table 1) were designed to address each reading process (ID, LEX, SIN and SEM). The activities were devised and reviewed by a team of deaf and hearing teachers and the researchers who took part in the study. Weekly work sessions were performed to improve and evaluate the effectiveness for each strategy, taking into account the knowledge of deaf teachers as native signer of ChSL, knowledge of the practices of visual teaching of teachers of the deaf students and the theoretical contributions of the researchers. Two bilingual teachers (ChSL/Spanish), one deaf and one hearing, worked together on each of the sessions in the intervention with the deaf children.

### RESULTS

Figure 1 contains the results obtained in the pre-test and post-test, and shows an improvement in reading measures in the post-test as compared to the average for the pre-test. A repeated-measurement analysis of variance (ANOVA) was performed in order to assess the degree of statistical

<table>
<thead>
<tr>
<th>Table 1. Activities and strategies for intervention</th>
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<td><strong>Reading process</strong></td>
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<td>Global reading</td>
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<tr>
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<td>Syntactical processes</td>
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significance of this improvement, using the intervention (measured pre and post-test), the four reading processes (ID, LEX, SIN and SEM) as repeated variables and evaluate grade and sex also.

The ANOVA shows a principal significant effect of the intervention $F(1, 20)= 43.087, p<.001, \eta^2 =.683$, grade $F(1, 20)= 15.967, p=0.001, \eta^2 =.444$, and of the reading processes $F(3, 60)=44.720, p<0.001, \eta^2 =.691$ (ID and LEX which are higher than SIN and SEM measures). Sex was not significant $F(1, 20)=.012, \text{n.s.}$.

The only significant interaction was grade x reading processes $F(3, 60)=3.518, p<0.020, \eta^2 =.150$ (see Figure 1, the little effect of improvement in 3rd graders comparing to 1st graders). Note that interaction between the intervention and reading processes was not significant $F(3, 60)=1.091, \text{n.s.}$ and indicates that the intervention represents a similar improvement in the development of the four reading processes.

Regression analysis

The regression analysis is a useful method for determining whether a program is effective when a randomized control group is not available (e.g. Kleinbaum, Kupper, Nizam, & Muller, 2007; Reis & Judd, 2000). Figure 2 shows that the intervention had effects at all age levels, although it is higher in older subjects, the slope of the regression line reading-age increases and the goodness of fit data significantly improves ($R^2_{\text{Pre-test}} = .31$ vs. $R^2_{\text{Post-test}} = .41$, t(21) = 2.256, p = .018).

Using the regression analysis it was possible to estimate the advance represented by the intervention beyond the usual learning level. In view of the positive relations between age, grade and reading level, it was decided to perform a regression analysis to assess whether the effect of the intervention represented valid improvement in the advance in schooling shown by the subjects, and if so, whether it was possible to quantify this advance in terms of age. Table 2 shows the scores on the pre-test, the predicted scores based on regression at 6 months, and the scores the students received on the post-test. Based on the regression analysis, the intervention is estimated to have produced an overall advance of 18 months in the six months the intervention lasted.

Discussion

The present study shows that the use of visual learning strategies as part of an educational intervention has a positive impact on the learning of literacy skills in prelingually deaf readers. The intervention accelerated the development of literacy skills in deaf students, pro-
duc ing a global advance of 18 months in six months of intervention.

The intervention also significantly improved lexical recognition and syntactical skill. With regard to this last element, it is worth reflecting on the significance of this improvement, as this is one of the skills that present the greatest deficit in reading competence in deaf readers (Lichtenstein 1998; Marschark, 1993; Paul, 1998). In this regard, Paul (2003) states that syntactical knowledge for deaf people, and for other speakers of second languages, is a good predictor of reading level, as skill is required to integrate information between connected linguistic units such as clauses, sentences or paragraphs. Miller (2000) maintains that although most prelingually deaf readers have problems developing skills relating to reading, it is in the area of syntax where they lag furthest behind their hearing peers. The findings of Berent et al. (2007) show that if a program of direct instruction focuses on syntax and lexicon (focus on form) from the visual route, the students succeed in improving their mastery of language.

The improvement in the results of the reading processes assessed after the intervention can be explained by the generation of literacy teaching practices based on visual learning strategies, a sign language as L1 and written language as L2 and the inclusion of both deaf and hearing teachers throughout the process (Hauser et al., 2010; Holcomb, 2010; Moores, 2010; Paul & Moores, 2010; Piñar et al., 2011). This made it possible to constantly

Table 2. Means and standard deviations (in parentheses) in the four reading skills obtained in the pre-test, post-test and predicted at 6 months using regression

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Predicted</th>
<th>( R^2 )</th>
<th>Regression Equation</th>
<th>Estimated Advance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification</td>
<td>7.17 (2.71)</td>
<td>10.54 (2.06)</td>
<td>8.38 (1.69)</td>
<td>.31</td>
<td>1.86 (age) – 10.94</td>
<td>22 months</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>5.17 (3.90)</td>
<td>8.54 (3.86)</td>
<td>7.22 (2.65)</td>
<td>.39</td>
<td>2.92 (age) - 23.07</td>
<td>13 months</td>
</tr>
<tr>
<td>Syntactic</td>
<td>2.17 (3.03)</td>
<td>5.96 (4.01)</td>
<td>3.72 (2.17)</td>
<td>.42</td>
<td>2.40 (age) - 21.17</td>
<td>19 months</td>
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<tr>
<td>Semantic</td>
<td>2.67 (2.88)</td>
<td>5.04 (3.68)</td>
<td>3.90 (1.52)</td>
<td>.23</td>
<td>1.67 (age) - 13.48</td>
<td>17 months</td>
</tr>
<tr>
<td>Mean</td>
<td><strong>4.29 (2.57)</strong></td>
<td><strong>7.52 (2.84)</strong></td>
<td><strong>5.81 (2.01)</strong></td>
<td>.51</td>
<td><strong>2.21 (age) - 17.17</strong></td>
<td>18 months</td>
</tr>
</tbody>
</table>

**Note:** two individuals were eliminated from the analysis of regression to be atypical cases (outliers). Their inclusion caused a worse fit of the linear model and as a consequence one increase greater than the advance estimate for intervention.
carry out tasks of ChSL/Spanish translation that enabled the students to observe the differences between both languages (with different modalities), compare and understand them. The research presented here represents a contribution to generating effective educational responses for teaching literacy skills to profoundly deaf without direct phonological access (i.e. cochlear implants or other hearing enhancement devices), particularly because it is based on the premise that these readers use different strategies from those of hearing readers. Prelingually deaf people approach learning to read like a second language, which they can usually neither hear nor speak, and propose a methodology which includes the elements inherent in their natural language (ChSL and fingerspelling), as well as taking into account deaf learners’ characteristics as visual learners when acquiring literacy skills (Banner & Wang, 2011; Hauser et al., 2010; Holcomb, 2010; Moores, 2010). The efficacy of the intervention is ascribed to a new line of research into reading by deaf people which maintains that deaf learners are visual learners and therefore require educational responses centred on the specific way they learn and understand the world.

This study follows the line of investigation which maintains that deaf children who have SL as their first language from birth obtain better academic results than deaf children who do not use SL as their first language (Daniels, 2001; Hoffmeister, 2000; Miller, 2013; Neese, Erting, Erting, & Thumann-Prezioso, 2009; Padden & Ramsey, 2000; Strong & Prinz, 2000; Trezek et al., 2010). It is suitable for hearing parents with deaf children to learn SL. This requires setting aside the view of deafness as an illness or pathology, and valuing it as a concept (Hauser et al., 2010; Ladd, 2003) that perceives the lack of hearing as a difference and not as a deficiency.

The results of the present study agree with the proposals of Miller (2005) which suggests that it is not the deficit in processing the written word at the lexical level or the phonology per se that prevents prelingually deaf people from becoming competent readers, but rather the absence of deaf-centric practices (Moore, 2010). In consequence, this study follows the line of research in Deaf Epistemology (Hauser et al., 2010; Holcomb, 2010; Ladd, 2003; Moores, 2010) that takes into consideration cultural belief and the experience of being deaf.

This research responds to the requirement formulated in the review of Schirmer and McGough (2005) with regard to the need of developing research into teaching literacy skills to deaf people that provide effective visual strategies for the improvement of the reading performance of these students. It is necessary to incorporate bilingual deaf professionals into any educational action aimed at improving the second language skills of school-age deaf children to allow them to “visualize” the most important strategies (e.g. indigenous strategies, Padden, 2006) needed to acquire this skill, as was done in our intervention.

Finally, this study proposes focusing the research on the differences deaf readers have in acquiring literacy skills rather than on their deficiencies.

REFERENCES


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Aceptado 12 de marzo de 2013
APPENDIX

Examples of activities for the “Initial Program for Teaching Reading and Writing to Deaf Children”.

6. Une la decidología con la palabra que corresponde.

<table>
<thead>
<tr>
<th>Decidología</th>
<th>Palabra</th>
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<tbody>
<tr>
<td>caracol</td>
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<td>flor</td>
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<td>amar</td>
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<td>jardín</td>
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<td>van</td>
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<td>lana</td>
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<td>jin</td>
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<td>jarra</td>
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<td>vela</td>
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3. Observa el dibujo y marca la oración que corresponde.

- El caballo es más grande que el gato.
- El gato es más grande que el caballo.
- El gato es más pequeño que el caballo.
- La niña juega con el gato.
- El perro juega con el gato.
- La niña juega con el perro.
- El niño toma el gato.
- El gato toma al niño.
- El niño toma al perro.
5. Mira el dibujo, lee las palabras y marca la correcta.

   - globo - gallo
   - pelota - peneza
   - fruta - flota
   - cuarto - cuarto
   - plato - plato
   - abeja - abeja
   - regla - regal

9. Marca la oración que corresponda al dibujo.

   - La niña lee un cuento.
   - La niña juega a la pelota.
   - El gato juega con el niño.
   - El gato duerme en su cama.
   - El patito salió del huevo.
   - El patito nada en el lago.

5. Escribe una oración con cada uno de las siguientes signos.

   - __________
   - __________
   - __________
   - __________
   - __________