Sign Language Comprehension: The Case of Spanish Sign Language

I. R. Rodríguez Ortiz
Universidad de Sevilla

This study aims to answer the question, how much of Spanish Sign Language interpreting deaf individuals really understand. Study sampling included 36 deaf people (deafness ranging from severe to profound; variety depending on the age at which they learned sign language) and 36 hearing people who had good knowledge of sign language (most were interpreters). Sign language comprehension was assessed using passages of secondary level. After being exposed to the passages, the participants had to tell what they had understood about them, answer a set of related questions, and offer a title for the passage. Sign language comprehension by deaf participants was quite acceptable but not as good as that by hearing signers who, unlike deaf participants, were not only late learners of sign language as a second language but had also learned it through formal training.

In Spain, the law that officially recognizes Spanish Sign Language (LSE) has been passed recently by the Senate (Law 27/2007, dated October 23, Official State Bulletin [BOE] no. 255 from October 24, 2007). The application of this law will obligate the State to offer legal guarantees for the Deaf community to access communication in the judicial, health, administrative, and educational fields. It is precisely in the field of education where the recognition of this language is most needed. In spite of other existing laws requiring educational equality, there are still currently very few bilingual options in our country. Indeed, the Royal Decree 696/1995, dated April 28 (Official State Bulletin [BOE] no 131 from June 2, 1995), which mandates compulsory education for students with special educational needs, admits that the educational administration must contribute to the recognition and the study of sign language and thus make LSE use a viable alternative in schools. Even though this law exists, there are no more than 10 bilingual schools in the whole country.

The first project in bilingual education (sign language–spoken language) in elementary education began in 1994, and it was not until 2001 that kindergarten and prekindergarten levels were included (Fernandez-Viader & Fuentes, 2004). More than a decade later, bilingual possibilities are still scarce. This situation contrasts with the high number of interpreters who have begun to work in secondary schools.

Typically, deaf children are born to parents who can hear and thus have been educated in spoken language environments. These deaf students are exposed to sign language for the first time in secondary or postsecondary school. In these learning conditions, one might ask what level of comprehension can be reached when the students have not learned sign language until well into their teens. If signed comprehension in adolescents and adults is limited, then the placement of the interpreter in secondary schools may turn out to be an insufficient measure for deaf people to reach educational levels similar to those of their hearing peers.

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Up until now, previous studies that have tackled academic discourse comprehension of deaf students usually report low comprehension and, in all cases, inferior to the comprehension obtained by hearing students by means of spoken language. One of the first studies dedicated to this topic is Fleischer's (1975). In this study, it was observed that the deaf university students understood a conference better when it was interpreted (an average of 73%) versus received via transliteration (an average of 67%), although no main effect of presentation condition was obtained. The results were indicated by scores on written multiple-choice tests, but in neither of the cases did the deaf students score 100% on the test.

Murphy and Fleischer (1977) replicated the previous study and did not find any differences in comprehension with respect to mode of interpretation or students' communication preference, nor did they observe any statistical interaction of mode and preference. Once again the mean comprehension scores ranged only from 42% to 59%.

Livingston, Singer, and Abramson (1994) carried out a study very similar to the one above with a sample of deaf college students. They compared comprehension of a narration and comprehension of a lecture on "gender and sexism," both which were presented to the students either via interpretation or by transliteration. Student preferences were also taken into consideration with respect to communication type (American Sign Language, ASL, vs. English-like signing). Comprehension was evaluated by means of the responses to six test questions (three literal and three inferential) and resulted in an average score of 62% (ranging from 50% to 74%). In the lecture interpretation, those students who preferred ASL had higher scores than those who preferred English-like signing. No differences were there in the case of the lecture transliteration or with respect to the narration. (Again, the average signed comprehension score barely went above 50%.)

Napier and Barker (2004) interviewed four university students about the interpretation of university lectures. All of them agreed that their comprehension level never reached 100% when the lecture was interpreted and that was what they had expected. More specifically, comprehension levels, according to the deaf students' own viewpoints, ranged from 50% to 90%.

Marschark, Sapere, Convertino, Seewagen, and Maltzen (2004) also compared the comprehension obtained through ASL interpretation of a lecture with the transliteration of the same lecture in a sample of deaf college students who, among themselves, differed with respect to their communicative abilities. Some were more skilled in ASL, whereas others were more skilled in English-based sign language. In the results, no differences were found between the communication methods, nor was there any interaction between the interpretation mode and the students' language skills. Written or signed tests were used to evaluate comprehension, and in all cases it was low.

Similar results were found in the series of experiments carried out by Marschark, Sapere, Covertino, and Seewagen (2005a) with a sample of college students. From these experiments, it was deduced that the interpretation mode does not have any effect on learning and that signed comprehension of the deaf students is insufficient.

From the research outlined above, one can draw the conclusion that signed comprehension of deaf students does not normally reach 100% of the lecture material. This finding is supported by findings observed in other studies that examine if the level of comprehension is similar to that obtained by hearing students exposed to spoken lectures.

One of these first studies is that of Jacobs (1977), in which the researcher compared deaf and hearing students in terms of their capacity to receive and remember information from a lecture that was delivered in sign and spoken language, respectively. Jacobs (1977) presented deaf and hearing college students with six lectures from social science, natural science, and humanities. Using written multiple-choice tests from the lecture material, Jacobs came up with results in which the hearing students obtained higher scores than the deaf students. Specifically, deaf students gave correct answers to 84% of the total items that were correctly answered by hearing students. Test score averages were 83% for hearing students and 69% for deaf students.

Marschark et al. (2004) obtained very similar results in three experiments in which they studied deaf

college students' comprehension. They observed that the overall average comprehension score for the deaf students in the postlecture tests was only 59%, significantly lower than the 87% obtained by hearing peers. Likewise, in another one of their experiments they also observed the difficulties that deaf students had in predicting their outcome on comprehension tests from interpreted lectures. To be exact, students were asked to predict the number of questions they would get correct on the comprehension test. In the case of the hearing students, such prediction correlated with the score obtained, whereas in the case of the deaf students no correlation was found.

Marschark, Pelz, et al. (2005) examined the effects of live versus video-recorded comprehension of sign language interpreting and the exposure to simultaneous multiple sources of visual information. The results indicated that no differences existed between the interpreting conditions; however, they did show that the scores of the deaf students were quite low compared to the scores of their hearing peers, who only participated in the televised version.

In another series of experiments, Marschark et al. (2005a) observed that the scores on multiple-choice learning tests used to evaluate the deaf students' comprehension of signed lectures ranged from 60% to 70%, whereas hearing students' comprehension rose to 85%–90%. From this we can deduce that deaf students acquire less from interpreted college-level lectures than hearing peers do from oral versions of the same lectures. In this study, a novelty was included with respect to studies reported above. Marschark et al. analyzed how the familiarity with the interpreter influenced comprehension. In order to carry out this research, there was a 15-min social period between lectures which interpreters and students were encouraged to use for sharing information about students' educational backgrounds and communication preferences in the classroom. In addition, the familiarity with the interpreter was also assessed by asking the intepreters if they had met deaf students before. Comprehension results showed no differences in performance of the students with respect to how well they knew the interpreter.

In a more recent study, Marschark et al. (2006) found significantly lower performance of deaf people with respect to the comprehension of signed lectures as compared to hearing people with respect to spoken lectures. In order to arrive at this conclusion, the researchers carried out four experiments to examine the usefulness of real-time text in supporting deaf students' learning from lectures in postsecondary and secondary classrooms. In these studies, the effectiveness of sign language interpreting and the real-time text on signed comprehension was compared. The first experiment indicated that comprehension was better in the case of real-time text; however, the three other experiments failed to replicate the real-time text advantage. The most significant finding was that in all the conditions the performance of the deaf students was considerably lower than that of the hearing students who saw the lectures without any support services.

A comparative study between signed (LSE) and spoken comprehension has also been carried out on lectures at elementary, secondary and postsecondary levels (Rodríguez and Mora Roche, in press). This study used a sample of 36 deaf signers and 36 hearing people who had no knowledge of sign language. After being exposed to the lectures, the participants had to tell what they had understood about them, answer a set of related questions, and offer a title for the lecture. Sign language comprehension by the deaf participants was acceptable (they mentioned 68% of explicit contents of the lecture), but when comparing deaf participants with hearing participants, the first group made more comprehension errors (they made more mistakes in the recall of the lectures) than the hearing peers and their scores with respect to questions about the lectures were lower than the hearing group in all cases.

In short, in previous studies, the comprehension of signed lectures by deaf participants shows that it is normally below that of hearing participants receiving the lectures auditorially. Nevertheless, with this type of comparison the doubt can arise whether this difference in favor of the hearing groups is due to the language used (spoken vs. signed) or to the confluence of other variables.

Looking at the aspect of the language used, the previously mentioned study of Marschark, Pelz, et al. (2005) examined comprehension of bilingual

interpreters who had seen an ASL-interpreted lecture (without sound) and compared it to comprehension of the signed lecture by deaf college students. Whereas the first group achieved top performance, the deaf participants, even though they saw the interpreted lecture with sound, only achieved an average score of 53%. This score was similar to that of the interpreters who had responded to questions about the lecture without having previously seen it (57%). The differences between deaf and hearing participants cannot be attributed to the language used in the lectures as both groups used sign language as the means of communication.

With respect to the influence of specific variables on signed comprehension, the studies done by Marschark et al. (2004, 2005a) and Marschark, Pelz, et al. (2005) have demonstrated that signed comprehension is not influenced by sociodemographic and communication variables. Likewise, no differences were found in the level of comprehension in deaf college students according to the degree of hearing loss, parental hearing status, the age at which they learned to sign, their ASL skills, or several other academic measures (except reading levels indicated by the scores on the Michigan tests and California test). Nevertheless, we must keep in mind that in these studies, lecture comprehension is only evaluated by multiple-choice tests on the lecture content. For that reason, it is necessary to corroborate if the same absence of effect of these variables is produced when other complementary comprehension measures are used. Therefore, it is necessary to carry out other types of studies that complement the ones already done in order to compare the comprehension of deaf and hearing people and extend the measurement of comprehension to other more varied indicators such as the number of explicit content ideas the participants are able to mention, the number of comprehension errors, etc. Specifically, it is of utmost importance to carry out this type of study in LSE because in this language we find a shortage of studies dedicated to settling these questions.

Our concern is to determine exactly what the signed comprehension is that can be achieved at a secondary level by participants who have learned sign language in their teens. Specifically, this study focuses on responding to the following questions: (a) to determine to what extent deaf people comprehend academic information that is presented through sign language, especially related to hearing signers, and (b) to determine the possible influence of variables such as sociodemographic variables on their comprehension.

Methods

Participants

Two groups of participants were selected. The difference between the groups was their hearing status (Table 1).

Group 1 (Deaf with good mastery of LSE) included 36 prelingual deaf people, all of whom had hearing impairment in both ears (17 with severe hearing impairment and 19 with profound hearing impairment, according to the classification criteria of the *Bureau Internacional d'Audiophonologie*, *BIAP*, that is, taking as a reference the average auditory loss for the frequencies 250, 500, 1000, and 2000 Hz). All the members of this group knew LSE and made use of it on a regular basis. Mastery of this language was assessed through a referential communication test and a signed narration. The answers obtained in each of the tests were assessed by a deaf native signer and by an interpreter. They both confirmed that the participants had at least an intermediate knowledge of LSE (i.e., they were able to communicate with native signers at a sufficient level of fluency and naturalness and that all participants could communicate without difficulty). Regarding gender, 20 were men and 16 were women, and the average age of this group was 26.72 years (SD = 7.65, minimum 14 and maximum 47).

Table 1 Sample group's description

	Deaf signers	Hearing signers
Gender		
Men	20	3
Women	16	33
Age	26.72 (SD = 7.65)	28.44 (SD = 4.58)
LSE learning age	9.36 (SD = 7.35)	19.75 (SD = 9.88)
Level of education		
Elementary	8	1
Secondary	21	6
Postsecondary	7	29

Seventy-two percent (26) of the deaf individuals did not use hearing aids, and two reported having a cochlear implant. Sign language was learned at an average age of 9.36 years ($SD = 7.35$, minimum from birth and maximum 34 years), and the average number of years using this language was 17.36 ($SD = 11$, minimum 1 and maximum 47). Regarding level of education, 8 had completed elementary education, 21 had finished high school, and 7 completed postsecondary studies. All of them were involved in the study on comprehension mentioned above (Rodríguez and Mora Roche, in press).

Group 2 (Hearing participant users of LSE) included 36 people (3 men and 33 women) who despite being hearing had good mastery of sign language as well as spoken language (LSE proficiency was assessed as in the previous group). The average age of this group was 28.44 years ($SD = 4.58$, minimum 18 and maximum 41). Sign language was learned at an average age of 19.75 ($SD = 9.88$, minimum 0 and maximum 39), and the average number of years using this language was 8.69 ($SD = 8.85$, minimum 1 and maximum 31). In this group, there were 20 people currently working as interpreters, seven of whom were daughters of deaf parents. Another 16 professionals, not interpreters, were in this group who knew LSE well because they had close daily contact with deaf people. The education levels obtained by this group were 1 elementary education, 6 high school, and 29 postsecondary education.

The difference in age between the groups was of no statistical significance (t (57.213) = –1.159, $p = .251$); however, the difference in gender was (Pearson's χ^2 (1, $N = 72$) = 18.463, $p = .000$; Likelihood Ratio (LR) (1, $N = 72$) = 20.095, $p = .000$). There was a much higher proportion of women in the hearing signers group. This is due to the fact that this group is composed of 20 interpreters and the rest mainly have jobs related to administrative work or to education. In Spain, these positions are usually occupied by women. However, gender did not influence the results for signed comprehension in either of the sample groups and will not be mentioned further for this reason.

Age of learning LSE also showed significant differences between both groups (t (70) = –5.062, $p = .000$). The age was lower in the deaf participants' group, and as a consequence, the number of years of experience using this language was also significantly different (t (70) = 3.682, $p = .000$). Differences were also significant with respect to level of education (Pearson's χ^2 (2, $N = 70$) = 30.417, $p = .000$; LR (2, $N = 70$) = 33.254, $p = .000$), such that the participants in the hearing group had a higher number who had completed postsecondary studies, whereas the majority of deaf participants had completed secondary school. In short, both groups were equivalent with respect to age but different with respect to gender, LSE learning age, sign language experience, and educational level.

The sampling of deaf and hearing signer participants was conducted mainly through deaf associations of three Spanish cities: Seville, Cadiz, and Huelva. In each association, a meeting was held where the voluntary cooperation of participants was requested in order to carry out an investigation on comprehension of a signed lecture. The participants were contacted in those same meetings or through people who attended the meetings.

Procedure

In order to assess the comprehension of academic passages transmitted through LSE, we selected two texts corresponding to the typical comprehension level of secondary education (for more details, refer to Rodríguez Ortiz, 2005). Both texts had the same number of words and the same degree of difficulty, as evaluated by the Flesch Scale (Jones, 1993). The purpose of having two texts was to be able to alternate text use with the participants in order to prevent the possible sharing of information among the participants. Presentation order of the lectures was balanced across testing. We also made sure that the text topics did not require specific prior knowledge in order to be understood. The texts were about domestic violence and apartment searching for university students.

A questionnaire was used to gather information on sociodemographic and communication variables of the participants in the sample. The questionnaire was completed individually by the participants. The author of this article (who has taken several sign language courses and has a Master's degree in LSE

teaching) developed the questions in a signed manner for the deaf participants and orally for the hearing participants. The answers were taken down for their subsequent analysis.

The texts were rendered into LSE by a highly skilled, certified interpreter, and this interpretation was recorded on video. In order to make sure that passages in the signed version were as similar to the written texts as possible, we carried out a back translation. That is, following the first translation of the written texts into sign language, another interpreter translated the signed version into a written version which was then compared to the original. The result was satisfactory, as both versions coincided in content to a very high percentage (between 95% and 98%). No substitution, additions, or omissions of any part of the passage were produced that could introduce differences in the comprehension of the target groups. The signed version of the passages was presented in video, without supplementary materials (e.g., visual aids). Each lecture was approximately 10 min long. Even though a voice-over actor read the passage during the recording at a speed of 150 words per minute while the interpreter signed, the sound was eliminated for all participants during the video showing.

Although video-based interpreting can eliminate three-dimensional cues and student–interpreter interaction and feedback, Marshark, Pelz, et al. (2005) have demonstrated that no differences appear in comprehension between live and video-based interpreting of college-level lectures. For that reason and in order to avoid the introduction of undesired effects using different interpreters, a video projection of the same interpreter was used for all the participants.

The passages were divided into segments in order to improve their future recall. Each fragment lasted approximately 1 min. Participants were allowed to rewatch the fragments of the passages if they wished it. The number of repetitions was noted.

The comprehension test had two parts. Immediately after viewing each fragment of the passage, the participant was required to tell what he/she had understood so far. The answers given by the participants during this stage were later analyzed, and the following information was collected:

- The number of explicit content ideas the participant was able to mention.
- The number of implicit ideas that the participant was able to extract from the passage rendered. The combination of these two scores was considered a positive indicator of high comprehension.
- The number of ideas the participant invented from the passage.
- The number of comprehension errors the participant had made. These two last measurements, together with the number of repetitions, were taken as indicators of poor comprehension.

After the presentation of the whole passage, and in order to evaluate global comprehension, the participants were required to answer six true or false questions about the passage (closed questions). Each correct response received one point, and the maximum score possible was six. An example of this type of question referred to in the passage found in the appendix is "The main problem the students have when they arrive at the university is registration fees" (True or False).

Participants then answered six open-ended questions about the passage. One point was awarded if the participant fully answered the specifications of the question and used information from the passage in their responses to the questions. A half point was given if the answer contained part of but not all of the information required and zero points if they had not responded to or did not include any of the specifications required by the question. The maximum number of points possible was six. These questions belonged to three groups, depending on the inference required (Manzo, Manzo, & McKenna, 1995):

- Literal questions: they could be answered using only explicit information from the passage. For example, in the passage of the appendix, "Why are students who have brothers or sisters living in Seville luckier?"
- Inferential questions: they required logical sequencing of facts exposed in the passage. For example, in the passage of the appendix, "Why are the walls on the university campus full of apartment rental ads in September?"
- Creative/critical thinking questions: the participant had to make judgments from what was exposed

Table 2 Overall results of the comparison of the signed comprehension between deaf and hearing signers

	Deaf signers	Hearing signers
Explicit	**27.19 (*SD* = 9.26)**	**33.94 (*SD* = 8.84)**
Implicit	**4.58 (*SD* = 3.38)**	**6.50 (*SD* = 3.02)**
Invented	**4.53 (*SD* = 4.16)**	**1.92 (*SD* = 2.26)**
Errors	4.25 (*SD* = 2.07)	3.86 (*SD* = 1.77)
Repetition	2.86 (*SD* = 2.74)	3.19 (*SD* = 2.80)
Closed questions	4.80 (*SD* = 1.14)	5.58 (*SD* = .55)
Open questions	**3.71 (*SD* = 1.29)**	**5.04 (*SD* = .83)**
Title	0.72 (*SD* = .35)	0.69 (*SD* = .34)
Subjective evaluation	**4.36 (*SD* = .83)**	**4.08 (*SD* = .60)**

Note. The significance of the differences is indicated as follows: values in bold, $p < .05$; values not in bold, $p > .05$.

in the passage based on their own experience, personal knowledge, or feelings. For example, in the passage in the appendix, "Why do parents think that students living in residence halls are under more supervision?" There were two questions of each of the three types.

Participants then proposed a title for the passage. The maximum possible score was 1 because each response received one point if the title content made reference to the key aspects of the passage. A half point was awarded if the title content included part of the key aspect of the passage but was incomplete. Zero points were given if no title was given or if the content did not include any reference to the passage.

Finally, participants rated their own comprehension (subjective evaluation) following a 1–5 scale: 1 rating very low comprehension, 2 low, 3 medium, 4 high, and 5 very high. This subjective evaluation was used to contrast the scores obtained in comprehension with the perception that the participant had of his/her own performance.

Testing was done individually. The instructions and each question were signed by the same interpreter of the video and in the same passage-recording order.

Results

In order to respond to the initial question of just how much of sign language interpreting deaf people really understand, the comprehension of the signed passages of this group was examined and their performance was then compared to that of the hearing signers.

Unless otherwise indicated, all those results reported were reliable at the .05 level. Because the data do not follow a normal distribution, nonparametric tests were used for the statistical analysis (Kendall's Tau b for correlations and Kolmogorov–Smirnov Z value for differences between means).

Deaf Participants' Comprehension

Signed comprehension of the deaf participants was characterized in the following way (Table 2). Deaf participants recalled on average somewhat more than half of the explicit contents from the passages, 63.23% of the total ($X = 27.19$; $SD = 9.26$). On average, deaf participants inferred 4.58 implicit ideas from the passages ($SD = 3.38$), invented 4.53 items ($SD = 4.16$), and made 4.25 mistakes ($SD = 2.07$). In other words, for every six explicit items, one implicit idea was inferred, another was invented, and a mistake was made.

As for the questions about the passage, deaf participants obtained an average score of 4.80 out of 6 ($SD = 1.14$) on the true or false questions and a score of 3.71 out of the same maximum score on the open-ended questions ($SD = 1.29$), that is, an average correct percentage of 80% and 62%, respectively. Higher scores were obtained in the proposal of titles: an average score of 0.72 on a maximum of 1 ($SD = .34$).

The average number of repetitions requested was 2.86 ($SD = 2.74$); however, there were certain deaf participants who did not require any repetitions and others who needed up to 12 repetitions to complete the passages. Even so, no significant correlation was found between scores on explicit contents and the number of repetitions needed ($\mathcal{J} = -.124$, $p = .319$, $N = 36$).

Table 3 Sociodemographic and communication variables examined in the sample

Deaf signers	Hearing signers
Educational level of the participant and parents	Educational level of the participant and parents
Degree of hearing loss	Profession
Hearing loss age onset	Presence of other deaf family members
Use of hearing aid	Active participation at (a) deaf association(s)
Cultural identity	
Presence of other deaf family members	
Active participation at (a) deaf association(s)	
Most frequent communication system used	
Age of learning sign language	Age of learning sign language
Number of years of experience with LSE	Number of years of experience with LSE
Where they learned sign language	Where they learned sign language
Interpreting services used	Do they know the interpreter in the video?
Have participants previously met/seen the interpreter?	Have participants previously met/seen the interpreter?

Subjective evaluation of deaf participants' own comprehension performance was high ($X = 4.36$; $SD = .83$). The subjective scoring correlated in this group of participants with the results obtained in the open-ended questions ($\mathcal{J} = .311$, $p = .026$) and had a negative correlation with the number of repetitions ($\mathcal{J} = -.450$, $p = .001$), although in all cases the correlations were not very high.

No significant differences were obtained between the two passages ($Z = 0.667$, $p = .766$ for explicit content; $Z = 1.333$, $p = .057$ for implicit content; $Z = 0.500$, $p = .964$ for invented content; $Z = 0.500$, $p = .964$ for erroneous content; $Z = 1.333$, $p = .057$ for the title invention; $Z = 0.667$, $p = .766$ for the short questions; $Z = 0.667$, $p = .766$ for open-ended questions; and $Z = 1.333$, $p = .057$ for the number of video repetitions).

The analysis of the influence of sociodemographic variables on comprehension (displayed in Table 3) produced the following significant differences.

The number of years attending mainstream schools moderately correlated with recall of the explicit content ($\mathcal{J} = .306$, $p = .018$), the open-ended questions ($\mathcal{J} = .366$, $p = .006$), and the closed questions ($\mathcal{J} = .300$, $p = .034$), all of which are comprehension measurements specifically used in the educational context. For that reason, it is no wonder that the more years of school a person had (especially in integrated contexts), the more explicit content was recalled and more open-ended and closed questions were correctly answered.

Familiarity with the interpreter signing the messages also introduced significant differences ($Z = 1.494$, $p = .023$), in that the deaf participants, who stated knowing the interpreter, obtained higher scores ($X = 32.77$; $SD = 4.95$) than those who had never seen the interpreter sign before ($X = 24.04$; $SD = 9.72$).

Identical to what happened in previous studies (e.g., Marschark et al., 2004, 2005a; Marschark, Pelz, et al., 2005), variables such as the degree of hearing loss, the age of hearing loss onset, the use of hearing aids, the presence of other deaf family members, and the age of learning sign language were not related to comprehension or to the rest of the variables that appear in Table 3.

Hearing Participants' Comprehension

Identical to what happened in the deaf group, the hearing group did not demonstrate any significant differences between the two passages ($Z = 1.000$, $p = .270$ for explicit content; $Z = 0.667$, $p = .766$ for implicit content; $Z = 0.667$, $p = .766$ for invented content; $Z = 0.667$, $p = .766$ for erroneous content; $Z = 0.667$, $p = .766$ for the title; $Z = 0.667$, $p = .766$ for the short questions; $Z = 1.333$, $p = .057$ for the open-ended questions; and $Z = 1.167$, $p = .131$ for the number of repetitions).

With respect to the comparison between the groups, we can see from Table 2 that the hearing signers group surpassed the deaf group in explicit and

implicit content, open-ended questions, and in true and false questions. That is, superior performance by this group is seen in almost all of the positive comprehension indexes. The only exception to this is with the points obtained in assigning a title, where the deaf participants slightly outperformed the hearing participants, but without reaching a statistically significant difference.

Regarding explicit content, whereas hearing signers obtained an average score of 33.94 ($SD = 8.84$), or 78.93%, the deaf participants' average score was 27.19 ($SD = 9.26$) or an equivalent of 63.23%. These differences were statistically significant ($Z = 1.532$, $p = .018$). Hearing signers also outperformed deaf participants on the implicit idea content with scores of 6.50 ($SD = 3.02$) and 4.58 ($SD = 3.38$), respectively ($Z = 1.532$, $p = .018$) and on open-ended questions with a score of 5.04 ($SD = .83$) by the hearing signers compared to 3.71 ($SD = 1.29$) obtained by the deaf participants ($Z = 2.239$, $p = .000$). The correct answers in percentage equivalents are 84% and 62%, respectively, for the open-ended ones.

Deaf participants had higher scores than hearing signers regarding the number of invented content items ($X = 4.53$ and $SD = 4.16$ as opposed to $X = 1.92$ and $SD = 2.26$, respectively) ($Z = 1.414$, $p = .037$). Deaf participants also significantly outscored the hearing signers on the subjective assessment ($Z = 1.414$, $p = .037$); however, these differences were much smaller ($X = 4.36$ and $SD = .83$ as opposed to $X = 4.08$ and $SD = .60$, respectively).

Contrary to what occurred with the deaf participants, the hearing signers' group subjective score did not correlate in a significant way with any of the comprehension measurements because in their case, they tended to underestimate their performance. These data differ from those found in Marschark et al. (2004) where they observed the difficulties that the deaf students had when asked to predict their performance of the comprehension tests from the interpreted lectures and this did not happen with the hearing group. The absence of correlation between the subjective score and the comprehension measurement of the hearing signers seems to be due to the tendency to underestimate their performance.

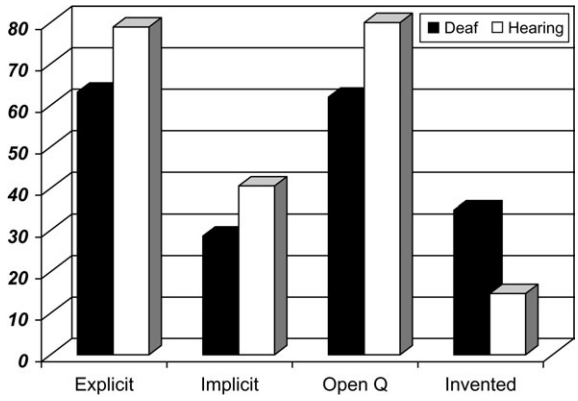

Figure 1 Significant differences (shown in percentages) of the signed comprehension between deaf and hearing signers.

Figure 1 shows significant differences between both groups in percentages.

No statistically significant differences were found regarding other comprehension measures. However, not only did the deaf participants invent more ideas from the passages but they also made more mistakes that the hearing signers ($X = 4.25$ and $SD = 2.07$ as opposed to $X = 3.86$ and $SD = 1.77$, respectively).

As for the number of repetitions, no statistically significant differences were found between the two groups; however, the hearing signers group needed an average of 3.19 repetitions ($SD = 2.80$) (a minimum of 0 and a maximum of 10) to reach comprehension of passages, whereas average number of repetitions for the deaf participants was 2.86 ($SD = 2.74$) (a minimum of 0 and maximum of 12). At a first glance, one might think that this higher number of repetitions requested by the hearing signers group was responsible for their better scores; however, no correlation was found between the number of repetitions requested and explicit contents elicited ($\mathcal{J} = -.069$, $p = .579$) or between these repetitions and implicit contents ($\mathcal{J} = -.014$, $p = .911$).

In short, comprehension of the hearing signers was significantly higher than that of the deaf participants in that the first group bettered than the second one on almost all of the positive indicators of high comprehension, while the opposite occurred with the indicators of poor comprehension.

One might think that within the hearing signers group, the participants working as interpreters should obtain higher scores on all the comprehension

measurements than the rest of the professionals. This was not reflected in the results, however, as no significant differences were found between groups (Table 4).

Taking the hearing signers group as a whole, the sociodemographic variables (displayed in Table 3) that manifest a relationship with the signed comprehension are sign language learning age, the number of years of experience with this language, and knowing the interpreter who signed the videos.

Regarding LSE learning age, a negative correlation was observed with explicit content ($\mathcal{J} = -.258$, $p = .033$) and with subjective scores ($\mathcal{J} = -.342$, $p = .014$). The years of sign language experience showed the same relationship but in the inverse sense; that is, there was a positive relationship not only with the explicit content ($\mathcal{J} = .372$, $p = .002$) but with the subjective content as well ($\mathcal{J} = .387$, $p = .005$).

Lastly, knowing the interpreter ahead of time also introduced significant differences ($Z = 1.414$, $p = .037$). This is identical to what happened in the deaf signers group. Those participants who knew the interpreter who signed the videos scored higher on the comprehension measurement ($X = 36.91$; $SD = 6.47$) than those who had not seen the interpreter sign before ($X = 29.29$; $SD = 10.23$).

In short, the results coincide with those found by Marschark, Pelz, et al. (2005) where they compared signed lecture comprehension of a group of interpreters with that of deaf students, finding that the first group performed higher. In our case, although the comparison group included interpreters as well as other hearing signers of a more heterogeneous group with respect to their LSE communication abilities, the same results were found.

Discussion and Conclusions

The response to the initial question of how much deaf people understand academic information presented to them in LSE at the secondary level coincides with the findings of other studies (e.g., Jacobs, 1977; Marschark et al., 2004, 2005a). The results described above suggest that, in general, the deaf participants extract less information than hearing people do from academic lectures, even when both groups use the same means of accessing academic information: sign language.

Nevertheless, in this study, the differences in comprehension of the deaf participants compared to the hearing signers seem to be less than those found in previous research on the same topic (Marschark, Pelz, et al., 2005). This could be due to several reasons. Firstly, this study, different from previous ones, evaluated participants individually. Secondly, diverse measurements of sign comprehension were used (not only answers to the multiple-choice test but also the number of explicit contents, implicit contents, invented contents and errors mentioned, the answers to open-ended questions, and the proposal of a title as well). Thirdly, the texts used corresponded to secondary level of education and not to college level. Lastly, the participants could go back and see video fragments of the signed message if they felt it would help increase their comprehension.

Aside from these variances, significant differences were still found between both groups with respect to

Table 4 Overall results of the comparison of the signed comprehension between the interpreters and the rest of the hearing signers

	Interpreters	Other hearing signers
Explicit	36.91 ($SD = 6.46$)	29.29 ($SD = 10.23$)
Implicit	6.14 ($SD = 3.15$)	7.07 ($SD = 2.81$)
Invented	1.59 ($SD = 1.53$)	2.43 ($SD = 3.08$)
Errors	3.82 ($SD = 1.62$)	3.93 ($SD = 2.06$)
Repetition	3.45 ($SD = 3.40$)	2.79 ($SD = 1.42$)
Closed questions	5.63 ($SD = .49$)	5.50 ($SD = .65$)
Open questions	5.02 ($SD = .96$)	5.07 ($SD = .62$)
Title	.72 ($SD = .30$)	.64 ($SD = .41$)
Subjective evaluation	4.14 ($SD = .56$)	4.00 ($SD = .68$)

Note. The significance of the differences is indicated and as follows: values in bold, $p < .05$; values not in bold, $p > .05$.

the amount of explicit content remembered, the implicit ideas taken from the lecture, and the open-ended questions that were answered. In all the above, the deaf participants scored lower than their hearing peers. The deaf participants, on the other hand, tended to compensate for their lower comprehension of explicit information from the message by inventing content for it. The explanation for the differences between both groups could be attributed to the different educational level acquired. However, this variable was not related to the comprehension scores for either one of the groups or for the whole study sample.

The educational level attained can influence results through the previous academic knowledge acquired. Nevertheless, the role of previous knowledge was ruled out because even though Marschark, Sapere, Convertino, and Seewagen (2005b) and Marschark, Pelz, et al. (2005) confirmed that deaf students enter classrooms with less previous knowledge than their hearing peers, when the effects of previous content knowledge are removed (via an analysis of covariance), hearing students still outperformed their deaf peers. On the other hand, the differences found in our study cannot be attributed to previous knowledge of a specific topic. A topic from daily life was chosen that did not demand a high degree of knowledge, and thus, it was familiar to both groups. Therefore, the influence of previous knowledge is insufficient for explaining the different comprehension of the messages by hearing and deaf participants.

Maybe what is really influencing comprehension of the signed lecture (rather than knowledge of the subject matter) is the way of organizing the information that is received; this organization could be different for both groups. In fact, Banks, Gray, and Fyfe (1990) found that although deaf and hearing participants remembered equal amounts of the text read, the deaf students demonstrated a more scattered recall of information instead of taking out the main ideas of the text. The latter, discourse-based strategy was more used by the hearing participants. Although this finding was obtained with text reading, we believe that it could be used to explain the differences in signed comprehension between deaf and hearing participants.

Most of the deaf participants examined (and deaf people in general) have hearing parents. This fact leads to less language exposure during childhood and a later acquisition of spoken language. The combination of these two potentially limits a deaf person to lower development in comprehension abilities than his/her hearing peers.

Auditory deprivation itself limits the quantity of information that a person receives through his/her life, and if in addition to this reading and writing problems are apparent, the seed for functional illiteracy is planted. This circumstance not only leads to a smaller amount of previous knowledge available but also less organization of such knowledge and possibly a deficient use of the strategies that are used to make the most of it. Exploring the influence of these variables should direct future studies on comprehension of a signed message.

There are two other possible explanations to account for the differences in signed comprehension between both groups. On the one hand, hearing signers had taken LSE courses in which formal vocabulary and structures were learned. Most of the deaf participants, however, had learned LSE at school among peers; that is, they had an informal exposure to it in a nonadult environment. It is worth mentioning that in Spain, most schools attended by deaf people have an oralist tradition. In this country, bilingual schools are only about a decade old and there are no more than 10 of these schools in the whole country. Taking into account the age of the participants participating in the study, we are certain that none of them attended any of these bilingual schools.

On the other hand, the hearing signers were also late learners of a second language. According to Mayberry's (1993) observations, these late learners usually obtain higher scores in comprehension and production of signed passages than those participants who are late learners of a first language (as was the case of most of the deaf participants of our sample). This also coincides with Fleischer's observations (1975): The higher the bilingual level of a participant, the more information he/she receives from the interpreter.

The deaf participants and hearing signers in this study, aside from the obvious difference in measures

of comprehension, coincide in two aspects worth mentioning. First, they were influenced by the degree of familiarity they had with the interpreter, and second, they required several repetitions to reach an acceptable comprehension of the signed messages.

With respect to the degree of familiarity they had with the interpreter, both deaf and hearing signers have better comprehension if given the opportunity to see the interpreter work beforehand. This fact has obvious, practical implications as it suggests that the more regular the contact an interpreter has with the deaf student, the more likely it is that the student will achieve high levels of comprehension.

Regarding the elevated number of repetitions necessary to comprehend the signed messages occurring in both groups, we are inclined to think that this could be an inherent need in sign language and should be further analyzed in more specific research. In any case, we believe this finding should be taken into account in the training of LSE interpreters and in their professional development. If their clients need more repetitions of the passage in order to understand it, this should be taken in consideration during the interpreting process.

In short, the importance that the obtained findings has lies in the fact that for many deaf people sign language interpretation is practically the only means of participating in the different aspects of society, from education to work and even to leisure activities. According to the data found, LSE interpretation of the academic lectures (corresponding to secondary education level) does not offer deaf students the same educational opportunities as their hearing peers. In conclusion, providing an interpreter for the deaf individuals is often an insufficient means to get them to reach the same educational level as their hearing peers if the interpretation is not accompanied by complementary means, such as guaranteeing an early and complete learning of LSE and appropriate access to literacy.

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Appendix

Text Corresponding to the Typical Comprehension Level of Secondary Education

Starting with the month of September, many students begin a new and challenging time in their lives: entrance to the university. Almost half of the students at the University of Seville come from towns within the province and other Andalusian cities. The first and main problem that these students encounter is the search for housing.

Where to live is the question that does not allow students to sleep night after night. The lucky students are the ones who have brothers or sisters or friends who already live in Seville and can help them look for an apartment. Nevertheless, many are those who arrive lost and frightened and have no idea where to begin to look. These students can be found all over town looking for an apartment to live in for the rest of the year.

When considering moving out for the first time, there are many alternatives that one can welcome. The most widely used alternative is perhaps that of renting an apartment with various friends. This is the solution that students prefer and has the following advantages: if the apartment is rented among friends, housing is cheaper; students have the freedom to come and go as they please; and the apartments are usually close to the different faculties on campus, and therefore, students save money by not having to take the bus.

On the other hand, one must keep in mind that renting an apartment also has some disadvantages. For example, students have to prepare their own food, wash and iron their clothes, and clean the apartment.

To find an apartment, you only need to walk around campus and look on walls because when September arrives, they are full of rental advertisements of various prices. These prices vary depending on the neighborhood where the apartment is located.

A different alternative to apartment renting is the university residence hall. This is the solution preferred by parents of university students. Parents feel more at ease with a residence hall because they think that students are watched more and in addition receive education and a good and healthy diet. These are some of the advantages to residence hall living, but other

advantages are that many different types of residence halls exist in Seville, for example, women only, men only, or mixed; there are residence halls all over the city and students can choose the hall that is closest to their campus; you can meet a lot of people and make new friends in the residence halls; and some residence halls offer tutoring classes to help students in their studies.

But university residence halls also have their inconveniences. For example, students feel watched because closing hour at the residence is very early, and each time they leave for the weekend they have to fill out a special form stating they will be gone. In addition, residence halls are also more expensive that apartment renting.

References

Banks, J., Gray, C., & Fyfe, R. (1990). The written recall of printed stories by severely deaf children. *British Journal of Educational Psychology, 60,* 192–206.

Fernández-Viader, M. P., & Fuentes, M. (2004). Education of deaf students in Spain: Legal and educational politics developments. *Journal of Deaf Studies and Deaf Education, 9,* 327–332.

Fleischer, L. R. (1975). *Language interpretation under four interpreting conditions*. Ph.D. dissertation, Brigham Young University, Provo, UT.

Jacobs, L. R. (1977). The efficiency of interpreting input for processing lecture information by deaf college students. *Journal of Rehabilitation of the Deaf, 11,* 10–14.

Jones, K. H. (1993, December). *Analysis of readability and interest of home economics textbooks for special needs learners.* Paper presented at the American Vocational Associations Convention, Nashville, TN.

Livingston, S., Singer, B., & Abramson, T. (1994). A study to determine the effectiveness of two different kinds of interpreting. In *Proceedings of the Tenth National Convention of the Conference of Interpreter Trainers—Mapping our course: A collaborative venture* (pp. 175–197). Sacramento, CA: Conference of Interpreter Trainers (CIT).

Manzo, A. V., Manzo, U. C., & McKenna, M. C. (1995). *Informal reading-thinking inventory. An informal reading inventory (IRI) with options for assessing aditional elements of higher-order literacy.* Orlando, FL: Harcourt Brace College Publishers.

Marschark, M., Leigh, G., Sapere, P., Burnham, D., Convertino, C., Stinson, M., et al. (2006). Benefits of sign language interpreting and text alternatives for deaf students' classroom learning. *Journal of Deaf Studies and Deaf Education, 11,* 421–437.

Marschark, M., Pelz, J. B., Convertino, C., Sapere, P., Arndt, M. E., & Seewagen, R. (2005). Classroom interpreting and visual information processing in mainstream education for deaf students: Live or Memorex®? *American Educational Research Journal, 42,* 727–761.

Marschark, M., Sapere, P., Convertino, C., & Seewagen, R. (2005a). Access to postsecondary education through sign language interpreting. *Journal of Deaf Studies and Deaf Education, 10,* 38–50.

Marschark, M., Sapere, P., Convertino, C., & Seewagen, R. (2005b). Educational interpreting: Access and outcomes. In M. Marschark, R. Peterson, & E. Winston (Eds.), *Sign language interpreting and interpreter education* (pp. 57–83). New York: Oxford University Press.

Marschark, M., Sapere, P., Convertino, C., Seewagen, R., & Maltzen, H. (2004). Comprehension of sign language interpreting: Deciphering a complex task situation. *Sign Language Studies, 4,* 345–368.

Mayberry, R. I. (1993). First-language acquisition after childhood differs from second-language acquisition: The case of American Sign Language. *Journal of Speech and Hearing Research, 36,* 1258–1270.

Murphy, H. J., & Fleischer, L. R. (1977). The effects of Ameslan versus Siglish upon test scores. *Journal of Rehabilitation of the Deaf, 11,* 15–18.

Napier, J., & Barker, R. (2004). Access to university interpreting: Expectations and preferences of deaf students. *Journal of Deaf Studies and Deaf Education, 9,* 228–238.

Rodríguez Ortiz, I. R. (2005). *Comunicar a través del silencio: las posibilidades de la Lengua de Signos Española*. Sevilla, Spain: Universidad de Sevilla. Vicerrectorado de Investigación.

Rodríguez Ortiz, I. R., & Mora Roche, J. (in press). The efficiency of information transmission for sign and spoken language. *American Annals of the Deaf.*

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