Bilingualism and Deafness: Correlations between Deaf Students' Ability to use Space in Quebec Sign Language and Their Reading Comprehension in French

Short title: *Correlations between the use of space in LSQ and reading comprehension in French*

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Abstract

This paper addresses the relation between sign language and literacy development in bilingually educated deaf children. These children are acquiring LSQ (Quebec Sign Language) as a first language and written French as a second language. In the spirit of the "Interdependence Theory" of Cummins (1991), we try to determine whether there is a relation between the mastery of L1 and of L2 despite the modality difference between these languages. In order to examine the relation between the use of space in LSQ and reading comprehension in French, two tests were developed. The use of space in LSQ was measured by an imitation task. Given that in LSQ, as in other sign languages, the use of space is involved in all forms of co-indexation (pronominal reference, verb agreement, etc.) and is the means by which the language establishes relations between different lexical elements, mastery of the use of space was hypothesized as an appropriate indicator of global competence in LSQ. Two aspects of the use of space were looked at, namely, locus assignment and reference. To evaluate reading comprehension, a multi-level reading test was designed to verify specifically the ability to locate and infer information in a text. Statistical analyses (Spearman correlations) show that mastery of LSQ is related to reading comprehension. More specifically, the mastery of locus assignment and reference in LSQ seems consistently related to the ability to make inferences when reading French. However, the mastery of locus assignment in LSQ does not consistently correlate with the ability to locate information in a written text and the mastery of reference in LSQ does not appear to correlated with this ability either.

1 Introduction

Prior to September 1998, no bilingual educational programme for deaf children existed in the province of Quebec. At the request of the deaf children's parents association, the Quebec Ministry of Education authorized the experimentation, under the supervision of a group of researchers, of a bilingual approach over a six-year period (1998-2004) in a special school for the deaf. The implementation and development of the project were supervised by the *Groupe de recherche sur la LSQ et le bilinguisme sourd* (research group on LSQ and deaf bilingualism) from the Université du Québec à Montréal.

The bilingual teaching in LSQ and written French was organised in such a way that from the beginning of preschool onward, children would develop in a setting that would provide them with the possibility of learning LSQ "naturally" through spontaneous interaction with deaf teachers. Starting at grade 1, spontaneous interaction in LSQ was gradually supplemented by explicit teaching of LSQ (by a deaf teacher) and of written French (by a hearing teacher with an excellent command of LSQ). The fact that deaf students have no direct access to an oral language and then can not have a natural input of an oral second language environment, makes them typically different from hearing second language learners. This difference, alike the fact that a lot of deaf children do not learn sign language starting from the birth, justify the necessity of explicit teaching of sign language grammar prior to oral language grammar (see Berent 2000 for a discussion on types of ASL deaf learners). Special attention was put on the cognitive maturity of the children and the attainment of a basic vocabulary in LSQ as requisites for French instruction (For more information on the bilingual program implemented, see Dubuisson & Vercaingne-Ménard 1999 and Vercaingne-Ménard, Parisot & Dubuisson 2005).

Apart from our own academic interest in the concomitant investigation of the bilingual programme, our study was motivated by the fact that the development of the assessment methods necessary for an appropriate evaluation of the bilingual development of deaf children acquiring both a signed and a written language currently represents one of the central issues in the field of sign bilingualism research. However, when the programme began in 1998, no test existed for the assessment of LSQ (neither for production, nor for comprehension), and we thus faced the challenge of developing methods for the assessment of LSQ proficiency in deaf students. Furthermore, the ongoing linguistic description of LSQ imposed constraints on the development

of assessment instruments, as did the lack of studies on the acquisition of LSQ by deaf children of deaf parents. As for the assessment of reading comprehension in French, we also faced the challenge of developing an appropriate tool that would meet the criteria imposed by the research goals.

The paper is organised as follows: after a brief overview of the available hypotheses concerning the interaction of sign language and written language in bilingual development, we will discuss the tests elaborated to assess deaf children's abilities in LSQ and in French reading. We will then present the results of the tests undertaken during 2 years of investigation and discuss them in the light of the available hypotheses.

2 Theoretical framework

One of the central questions in the domain of bilingualism research concerns the relation of both languages in the course of the bilingual development. Regarding the acquisition of literacy, the evidence gathered in studies of hearing bilinguals suggests that knowledge of a first language facilitates literacy development in the second language (Cummins 1991). Given the specific acquisition situation of the participants in this study, which involves the acquisition of a signed language as a primary language and a written language without access to the primary modality it relates to, the question arises as to whether these results would also extend to this type of cross-modal bilingualism. In the course of the last two decades several hypotheses have been proposed in this respect. In the same manner as Niederberger (this volume) and Hoffmeister (2000), we distinguish three main hypotheses (Interference, Double-discontinuity, and Positive relationship). As Niederberger discusses the details of these hypotheses, we will centre here on the shortcomings of the investigations undertaken.

The first hypothesis states that sign language interferes with learning to read and that a manual representation of the oral language is to be preferred in the teaching of the written language. Mayers & Wells (1996), for example, support this hypothesis by arguing that the representational system of sign language is too different from the written system to be useful. The second hypothesis that sign language has no effect on reading and writing development has been contested on methodological grounds. For example, Moores & Sweet (1990), who studied the

relation of conversational skills in ASL and English literacy performance measured by the Test of Syntactic Ability and the Peabody Individual Achievement Test, found no correlations between ASL skills and English literacy performance. However, following Hoffmeister, Moores & Sweet did not, in fact, find any correlations, because the study focussed only on conversational skills and could not, therefore, capture the relation between ASL and school language. In a study concentrating on sophisticated knowledge of ASL lexical and morphological rules, Hoffmeister showed that such knowledge was related more directly to reading and writing than to conversational skills. His conclusion was that a sophisticated knowledge of ASL does correlate with reading skills.

The third hypothesis is that knowledge of sign language is related to reading and writing development. Several North American studies showed for instance that deaf children with deaf parents performed better in English literacy than deaf children with hearing parents. Bebko (1998) observes that, while reading, these children focus on finding meaning instead of decoding specific details of information and therefore do not face the problems children relying on the latter strategy would face given the limitation of the processing mechanisms. Padden & Ramsey (2000) also tested specific ASL skills. For instance, they used the Verb Agreement Production test developed by Supalla *et al.* They found that deaf children with deaf parents have strong reading achievement scores, which may be due to early first language exposure.

Summarising, the preceding overview shows that there are different theoretical strands in the debate on the interaction of sign language knowledge and literacy development. The apparent shortcomings at the methodological level also point to the relevance of a careful development of these, an issue that shall be taken up in section 3.2.1 where we will discuss the development of the assessment procedures used in this study.

3 Method

3.1 Subjects

All of the children who participated in the experimental bilingual classrooms investigated were diagnosed as profoundly or severely deaf. Their level of proficiency in LSQ varied substantially at the time of their admission into the bilingual programme. As was explained earlier, not all children surveyed participated in the programme as of preschool, and therefore some may have had less overall exposure to LSQ than others. Among those who joined the programme later, some had a very basic knowledge of signs. Despite this difference in LSQ proficiency at the children's entrance into the programme, and despite the fact that most children had hearing parents, LSQ was considered to be their L1 because it was the language they had come to know best and used most (see Skutnabb-Kangas (2000, p. 106 and 112) for a discussion on the notion of L1, particularly in relation to the situation of deaf children who have hearing parents). The children had various socio-economic backgrounds. There were no specific selection criteria and all deaf children in the first grade were admitted. Throughout the experimentation of the bilingual approach, the number of children taking part in the project varied because new children were admitted every year, and some children changed schools or were placed in a different educational programme. Therefore, in the 2001-2002 school year, there were 24 children divided into 1st cycle (preschool, 1st and 2nd grade), 2nd cycle (3rd and 4th grade) and 3rd cycle (5th and 6th grade) involved in the study. In 2002-2003, 13 children from the original group continued in the bilingual programme, and 7 children joined the cohort. [i] This variation in the groups of children participating in the study explains the lack of continuity in the data presented below.

Table 1. Number of Students in the Bilingual Classrooms

Year	Students 1st Group	New Students	Total
2001	24	-	24
2002	24	-	24
2003	13	7	20

3.2 Instruments and measures

The following subsections present in detail the development of the assessment instruments for LSQ and French reading comprehension.

3.2.1 Assessment Instruments for LSQ Skills

Because no assessment instruments existed to measure LSQ skills, we drew inspiration from previous research on the assessment of skills in other sign languages in order to develop our own instruments.

Several studies had reported on the use of different assessment methods for sign language proficiency, but they mainly dealt with ASL (e.g. for ASL, Hoffmeister 2000; Padden & Ramsey 2000; Strong & Prinz 1997, 2000; for Australian Sign Language –Auslan-, Schembri et al. 2002). To assess ASL comprehension, Hoffmeister (2000) used a task on synonyms, antonyms and quantifiers. Stimuli consisted in simple lexical items for which frequency, phonological complexity and semantic complexity were controlled. Padden & Ramsey (2000) used a battery of five tests to assess ASL proficiency, among which two assessed finger-spelling and initialization, and the other three assessed more general language skills. Two of these general language skill tests had been developed by Supalla *et al.* in the 1980s (see Singleton and Supalla, 2003) in order to evaluate verb agreement and comprehension of the order of signs. These two tests had also been adapted for Auslan by Schembri et al. (2002). The third general language skill test was developed by Padden & Ramsey (2000) and consisted of an imitation task. Strong & Prinz (1997, 2000) used reception and production tests to assess the ASL proficiency of deaf and hard of hearing subjects. There were two tests on ASL production: one for classifiers and the other for narratives. The reception tests assessed the comprehension of stories, classifier constructions, temporal markers and spatial markers. In the reception test on spatial markers, the subjects had to

watch a video presenting a signed description of eight situations in which objects were located in a specific environment (e.g. cars at an intersection, furniture in a bedroom, etc.). For each signed description, the subjects had to choose the right illustration in a response booklet providing multiple picture choices.

In the assessment of LSQ skills, we did not use tests of initialization, finger-spelling and sign order because these phenomena are less frequent in LSQ than in ASL (Dubuisson et al. 1996; Bouchard et al. 1999[ii]). Tests using synonyms and antonyms were not considered either, because we wanted to assess morpho-syntactic knowledge in LSQ rather than lexical knowledge. Prior to the present study, the LSQ narrative skills of the children in the experimental classrooms had been evaluated (Vercaingne-Ménard et al. 2001; Vercaingne-Ménard 2001). This type of data collection was found to provide an accurate evaluation of a) children's comprehension of a story (presented on video without signs and speech), b) their capacity to retell the story in a coherent manner and c) their mastery of the production of narrative structures. The material used for data collection (an animated movie of *Félix le chat*) was chosen because it allows the production of a classic narrative schema, providing clues about children's ability to use linguistic elements in LSQ such as spatial marking. The use of spatial narrative markers had been previously shown to play a central role regarding cohesion in the narrative structures of native adult LSQ signers (Dubuisson et al. 2001). However, this kind of test did not permit a structured evaluation of the use of space, since the absence of certain types of spatial markers in the productions could not be interpreted as a lack of mastery, given the spontaneous nature of the data. Due to this shortcoming it was decided to use an imitation test to assess the participants' skills regarding the use of space, in particular, verb agreement and classifier constructions. Our test placed special emphasis on the assessment of verb agreement structures, for these often involve a grammatical use of space. Items assessing classifier constructions were also included in the test. The test

developed takes into account a distinctive feature of signed languages, including LSQ: the use of space to express syntactic and semantic relationships between the elements of a sentence (Pettito & Bellugi 1988), including all forms of coindexation (pronominal reference, verb agreement, noun determination, etc.) (Parisot, 2003). Given fundamental role played by the use of space in LSQ grammar, it was hypothesized that the degree of mastery of this property would be an indicator of global proficiency in this language.

The form of the test was based on the third test used by Padden & Ramsey (2000): an imitation task in which the participants had to reproduce a series of sentences as accurately as possible. This type of task is often used in studies on language acquisition to verify the mastery of particular language structures. For example, Mayberry & Fischer (1989) used this type of test and found a correlation between the results of the imitation task and the ability of children to predict upcoming signs using syntactic structure and contextual cues. In more general terms, it has been shown that the ability to repeat a sentence is linked to the subjects' understanding of the language (Pearson 1990) and their knowledge of the grammatical properties involved. On the one hand, if a sentence is understood, but the signs or the syntactic structures used are not mastered, children will tend to replace them by signs or by syntactic structures they know and intuitively consider as equivalent (Brown & Brewer 1996), which shows that the errors in imitation tasks can be used as an indirect measure of language acquisition. On the other hand, it has also been shown that children are able to repeat sentences that they would not produce spontaneously (Gallimore & Tharp 1981). Therefore, imitation tests seem to be an adequate way to assess children's mastery of language.

3.2.1.1 Development of the First Version of the LSQ Test

As mentioned previously, our test focussed primarily on the phenomenon of verbal agreement. More specifically, it aimed at assessing the two linguistic devices used for verbal agreement in LSQ: locus assignment (the act of attributing a locus in space to a particular noun) and spatial reference (the act of referring to a locus previously assigned). For this purpose, in the analysis of the data, only spatial markers were examined, and only those that were identical to the model were considered to be correct answers[iii].

The examples below show the type of spatial markers investigated in the present study and were included in the stimulus material. In example (1), a locus x is assigned to the noun GRENOUILLE (‘frog’) through the adjective GROS (‘big’). The locational verb ATTENDRE (‘to wait’) refers to the pre-established locus x, and the final index is a pronoun that assigns a locus *y* to the noun MOUCHE (‘fly’).

In example (2), a locus *x* is assigned to the noun MARY by signing it at a specific point in space, while a locus *y* is assigned to the noun GIRL be means of the determiner INDEX3(by). The plain verb TO-LOVE is followed by two indexes which act as pronouns referring to the loci y and *x*.

(1) GRENOUILLE(a) GROS(ax) MOUCHE(b) 3a-ATTENDRE-3b(x) INDEX3(by)
‘*The big frog is waiting for the fly*.’

(1) MARIE(ax) FILLE(b) INDEX3(by) AIMER INDEX3(by)-INDEX3(ax)
‘*The girl loves Mary*.’

Although non-manual components play an important role to consider in the use of space in LSQ, we decided to investigate only manual spatial markers. A pilot study we carried out previously had shown that while reproducing a signed sentence children tended to look at the deaf

experimenter for feedback, and this visual contact was found to interfere with their production of non-manual components. The types of spatial markers investigated in the present study were chosen from those found in spontaneous narrative productions of native signers (Dubuisson et al. 2001). The frequency of the spatial markers chosen for the test was matched to the frequency of the same markers in the narratives of native signers. The number of spatial markers included in each stimulus sentence was varied because it was hypothesized that the level of difficulty of a sentence would be related to the number of spatial markers it contained. Finally, there was substantial variation in the number of signs contained in the stimulus sentences because of the varying number of spatial markers.

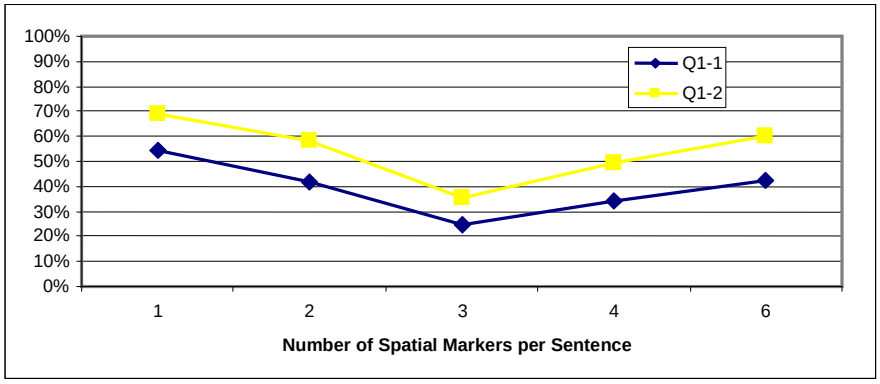
The stimulus sentences were created and produced by a native signer of LSQ who uses this language as her primary mode of communication. The vocabulary used was basic and familiar to the youngest children (5 years old). The stimulus sentences were pre-recorded on video, ensuring that all children saw identical sentences in the testing sessions. The recorded sentences were presented using the software MultimediaFusion ™ and were shown one at a time to the children on a laptop computer.[iv] The children's productions were recorded on video by a native deaf signer of LSQ in order to make sure the children were in an LSQ stimulating linguistic setting encouraging spontaneous production in this language, for it has been shown that in conversational settings, speakers adapt to the language of their interlocutors. Thus a deaf signer will tend to sign differently when in presence of a deaf than when a hearing interlocutor is present (Lucas 1996).

3.2.1.2 Modifications of the First Version of the Test

Following the analysis of the data collected with the first version of the test (Q1), it was noted that certain elements had to be modified. After two test sessions, our measure was validated and appeared accurate. The children's progress showed that they performed better during the second

test session, but the inter-item level of accuracy was comparable in both tests (test-retest reliability). However, the hypothesis that the level of difficulty was a function of the number of spatial markers in a sentence was not supported. For example, certain sentences containing up to six spatial markers were reproduced by the children with greater accuracy than some sentences containing only one or two spatial markers. Figure 1 shows that the stimulus sentences that were reproduced least accurately were those containing three spatial markers. The sentences containing six spatial markers were reproduced with equal or greater accuracy than those containing two spatial markers.

Figure 1: Percentage of Accurate Reproduction of Spatial Markers as a Function of their Number in a Sentence



A closer look at the data showed that level of accuracy was linked to the type of spatial marker rather than to the number of spatial markers involved in the stimuli. The sentences that were most accurately reproduced contained semantic classifiers, verbs used in classifier constructions (see example 3), and involved a topographic use of space.[v]

(3) SALON(ax) CUISINE(by) CHAMBRE(cz) CHAT(d) ALLER(xyz)
'*The cat goes from the living room towards the kitchen and the bedroom.*'

Because of this finding, we decided to elaborate a second version of the test, with new stimulus sentences. The lexical items were selected on the basis of the same criteria used for Q1 (i.e. basic and familiar vocabulary) but unlike in Q1, all the stimulus sentences had the same number of signs and the same number of spatial markers. The sentences in Q2 also differed from those in Q1 in that they only involved the use of syntactic space and not topographic space. Table 2 summarizes the differences between the first (Q1) and the second version (Q2) of the LSQ test.

Table 2: Summary of the Differences between Both Versions of the LSQ Test

	Q1	Q2
Number of sentences (items)	22	26
Number of signs/sentence	3 to 7	5 or 6
Number of spatial markers/sentence – topographic space	1 to 4	0
Number of spatial markers/sentence – syntactic space	1 to 4	3 or 4
Total number of spatial markers/sentence	1 to 6	3 or 4
Total number of locus assignment markers	44	54
Total number of reference markers	33	42

Table 3 presents the distribution of locus assignment and reference markers in both versions of the test. In Q1, eight types of assignment markers and five types of reference markers were included. In Q2, we removed any stimuli involving the use of topographic space, and we also eliminated possessives and locational verbs which would assign a locus (see example 5). [vi] In Q2 we kept the locational verbs that also function as reference markers, as illustrated in example (6).

(5) PÈRE(a) LIVRE(b) POSS(ax) ÉCRIRE(y) INDEX3(ax)
‘*My dad is writing his book.*’

(6) GÉRANT(a) PTÉ3(ax) ENTENDANT(b) PETIT(by) 3b-CONNAÎTRE-3a(y) PTÉ3(ax)
‘The short hearing-person knows the manager.’

The second version of the test also contained more spatial markers overall than the first version

that were better distributed across the different types of verbs, and either involved a modification of the initial and/or final place of articulation of a verb or the addition of pronouns. [vii]

Table 3: Distribution of Assignment and Reference Markers in Q1 and Q2

		Q1	Q2
Assignment Markers	Noun localization	16	16
	Determiner Index	8	13
	Directional Verb (Final Place of Articulation)	2	7
	Semantic Classifier	5	0
	Pronominal index	5	3
	SASS[†]	2	15
	Possessives	4	0
	Locational verb	2	0
Reference Markers	Pronominal Index	8	19
	Locational verb	4	8
	Directional verb (Initial Place of Articulation)	7	6
	Directional verb (Final Place of Articulation)	6	9
	Classifier Verb	8	0
Total		77	96

[†] Size and shape specifiers (SASS) correspond to signs such as SMALL or BIG which are used to specify the size or shape of a referent.

3.2.2 Assessment of Reading Comprehension in French

Part of our supervision mandate for the implementation of the bilingual programme involved carrying out an assessment of the children's comprehension in the comprehension of written French. We had to take into consideration both the particular situation of the experimental approach and to comply with the requirements of the Quebec Ministry of Education.

There is a long tradition in the assessment of the reading comprehension of deaf children (for an analysis on the relevance of different types of reading tests for deaf children, see Dubuisson & Bastien 1998), which has often relied on normalized tests such as *the Woodcock-Johnson Psychoeducational Battery* (Strong & Prinz, 1997) and the Stanford Achievement Test-Hearing Impaired (SAT-HI). While biases related to the modality have been eliminated (e.g. the use of

speech or the presence of lengthy questions with complex syntactic structures, etc. (see Strong & Prinz 1997, 2000)), the SAT-HI remains subject to criticism. Hoffmeister (2000), for example, highlights the fact that the SAT-HI has considerable limitations which make it unsuitable for a thorough assessment of reading comprehension because it only uses decontextualized, and often unfamiliar, reading passages or sentences.

It is important to point out that in the province of Quebec, no reliable standardized reading test comparable to the SAT exists. In the test we developed, we took into account the criticism mentioned above. The text presented to the children was about topics specific to their reality (e.g. Halloween), most of the vocabulary was familiar to them and the syntactic structures were rather simple. Assessment questions were also formulated simply, in written French, and if necessary, the instructions and the questions could be given in LSQ.

In order to ensure that the test would comply with the requirements of the Quebec Ministry of Education we developed it on the model of existing tests administered in elementary schools in the province of Quebec to assess children's reading comprehension. These tests are designed in such a way that in order to answer the questions, children have to use four mental operations that play a role in the comprehension of written texts: locating, grouping, selection and inference. The children are asked to locate information clearly expressed in the text (locating); a question relating to this type of mental operation would be, for example: *What is the color of the princess's dress*? The correct answer would involve the location of the relevant information in the text sentence: *The princess has a pink dress.* Further, children are required to group together different elements in the text; for example, they have to identify all costumes appropriate for Halloween (grouping). To demonstrate their ability at the level of 'selection' they must choose among many pieces of information and classify them in two or more sets; for example, they have to put together articles of clothing that make up a princess's costume or that of a sorcerer. Finally,

they have to find out information that is not expressed in words but is suggested in the text and needs to be deduced from contextual clues (inference). For example, following a text in which the story begins on Saturday morning, one of the test questions asks: *Why are the children not going to school today?*

We elaborated a multilevel reading comprehension test (L1 – 1) which was to be used with children from grade 1 to grade 3. The difficulty level of the questions had to be graded in order to distinguish the reading levels of the children from grade 1 to grade 3. However, the vocabulary and the sentence structures had to be simple enough for the children in the 1st grade to be able to take the test.

As we were aware from previous studies that children did not perform adequately if the same test was administered twice during the same school year, a second version of the test was developed (L1 – 2). In order for us to better assess progress in reading comprehension, we ensured that both versions of the test would be of same the linguistic level, i.e. the two different stories involved similar sentence structures, and in both cases, the vocabulary was familiar to the participants.

Additionally, it was also deemed necessary to develop a third, more difficult version of the test, for the children who achieved nearly perfect scores during the second testing session. This new version (L1 – 3) assessed the same mental operations (locating, grouping, selection and inference), was longer, used more complex sentence structures and contained a more advanced vocabulary.

For L1 – 1, L1 – 2 and L1 – 3, a scoring template was developed, in which each of the four abilities tested (locating, grouping, selection and inference) was listed and used for the grading of each answer on the basis of the following scale: *not acquired* (0 points), *partly acquired* (1 point) and *acquired* (2 points).

Table 5 presents the number of mental operations relating to 'locating' and 'inference' assessed in the three test sessions along with the number of items used in each test. Since only a few questions assessed these mental operations, the scores associated with grouping and selection did not have a sufficient weight to be used as categories for statistical analyses. Thus, these categories do not appear in table 5, but are taken into account in the global mark. The global mark, as will be explained later on, is therefore the sum of the results obtained for locating, grouping, selection and inference.

Table 5 shows that the number of questions assessing the ability to locate information in a text was reduced in the L1 – 3 test because the assessment of this ability was no longer necessary as the results indicated that it was already mastered by the children at the end of the 2002-2003 school year.

Table 5 Mental Operations Assessed and Global Marks for the French Reading Tests

	Locating	Inference	Global
L1-1	8	8	20
L1-2	8	8	20
L1-3	3	7	14

3.3 Test sessions

Table 6 summarizes the test sessions and the periods of assessment for both languages.

Table 6. Test sessions for LSQ and French

	LSQ Tests		French Reading Tests	
2001	Q1-1		L1-1	
2002	Q1-2		L1-2	
2003	Q1-3	Q2-1		L1-3

Since our study was conducted in a school setting involving authentic situations of Quebec deaf school reality, we had to deal with a small number of subjects and the circumstance that from one year to the next new students joined the bilingual programme while others left.

Table 7 shows the number of subjects that participated in language testing sessions. All the children participating in the bilingual programme at the time took the first LSQ test in 2001 (Q1-1: 24 children), and the same children took the test again in 2002 (Q1-2: 24 children). In 2003, the LSQ test (Q1-3) was administered to 20 children (13 from the preceding year and 7 new ones, see table 1) and the new revised LSQ test (Q2) was administered to 18 children (several children were absent at different moments and five of the students took only one of the two tests).

Since the preschool children were too young to participate in the French reading test sessions, in 2001-2002, 15 out of the 24 children took the L1-1 and L1-2 tests. In 2003, only 11 of those children attended the bilingual classes and 9 took L1-3 (two were absent).

Table 7 Number of subjects for each test session

	LSQ Tests		French Reading Tests	
2001	24		15	
2002	24		15	
2003	20	18		11

To verify that the tests reflected the students' progress, we compared, on the one hand , the results of the four LSQ testing sessions and, on the other hand, the first and the third French reading test sessions (because of a probable bias, we could not take the results of L1-2 into account). To establish correlations between the results in LSQ and those in French reading, we used the results of subjects involved in each pair of tests that we compared (see the grey boxes in table 7). As shown in table 8, for the LSQ testing sessions, 24 subjects were the same in 2001 and

2002, 13 in 2002 and 2003, and 15 for the two tests of 2003. For French reading comprehension, 8 children were given both L1-1 and L1-3. For comparison of LSQ and French tests, 15 students took both tests in 2001 and 9 in 2003. Here again, the variation in the number of subjects is explained by the instability of the cohort and by the exclusion of the preschool students for the LSQ/French comparison.

Table 8 Number of subjects for the correlation analysis

Between LSQ test sessions		Between reading test sessions		Between LSQ and reading test sessions	
Q1-1 vs Q1-2	24			Q1-1 vs L1-1	15
Q1-2 vs Q1-3	13				
Q1-3 vs Q2	15	L1-1 vs L1-3	8	Q2 vs L1-3	9

4 Results and discussion

We will first present the results of the LSQ tests and the results of the French reading tests. We will then compare the successive test sessions. Finally, we will show the correlations between the mastery of LSQ and French reading comprehension.

4.1 Results from the LSQ test

Altogether, the results of Q1-1 Q1-2 and Q1-3 show that children became better at using spatial markers in LSQ, either when assigning a locus or when referring back to it.[viii]

A paired Student t-test shows a significant improvement in the scores obtained in the second testing session compared to those of the first one, for locus assignment ($p = 0.009$) and for reference ($p < 0.0001$). Likewise, a paired Student t-test shows a significant improvement in the scores obtained in the third test session compared to those of the second one for locus assignment ($p = 0.0454$) and for reference ($p = 0.0251$). Modifications to the first version of the test (Q1)

made the second version (Q2) more difficult, and a ceiling effect was therefore avoided for the more advanced children. The average score obtained for assignment markers in the Q2 test was 51.3 (SD = 20.7), whereas it was 61.1 (SD = 21.6) in Q1-3. Furthermore, the average score obtained for reference markers in Q2 was 44.1 (SD = 28.4), whereas it was 61.5 (SD = 26.4) in Q1-3. However, the Pearson correlations between the scores in Q1-3 and in Q2 are highly significant ($p < 0.01$) for assignment markers as well as for reference markers. These correlations are presented in Table 9.

Table 9: Correlations between Q1-3 and Q2 (Pearson correlation)

N=15	Q2 Assignment	Q2 Reference
Q1-3 Assignment	0.85**	0.75**
Q1-3 Reference	0.81**	0.70**

**$p < 0.01$

Table 10 compares the results for assignment markers and reference markers for the tests Q1-1, Q1-2, Q1-3 and Q2. The scores for assignment markers are significantly higher than the scores for reference markers ($p < 0{,}0001$ for Q1-1, $p = 0{,}0170$ for Q1-2 and $p = 0{,}0044$ for Q2). However, in the case of the Q1-3 test, scores for assignment markers and for reference markers do not differ (61.1% and 61.5% respectively).

Table 10: Accuracy of Assignment Markers versus Reference Markers in LSQ

	Assignment	Reference
Q1 – 1st testing session	+	−
Q1 – 2nd testing session	+	−
Q1 – 3rd testing session	=	=
Q2 testing session	+	−

These results suggest that assignment markers are easier to acquire than reference markers, an assumption that would have to be further verified in longitudinal studies on the acquisition of LSQ by deaf children of deaf parents in a naturalistic acquisition situation. A possible

explanation of the equal scores for Q1-3 may be a ceiling effect on assignment markers in the first version of the test (Q1).

4.2 Results of the French Reading Comprehension Tests

The data analysis in this domain focused on the global scores and on the scores for the ability to locate and infer information when reading. A two-sided paired Student t-test comparing the results from the L1-1 and L1-2 tests shows a significant improvement in the reading test scores between the beginning and the end of the school year ($p = 0.0155$). No improvement was found for the ability to locate information in a text ($p = 0.6209$), however the scores were already quite high in the L1-1 test (75%). The general improvement was essentially due to the children's ability to infer information from the text ($p = 0.0054$), but a confounding factor was later uncovered which may have biased the scores (the experimenter was a newcomer to the team and, without realizing it, partly gave the answers to the children of one of the groups while he was giving them LSQ instructions for L1-2). The observed progress in the children's performance could therefore not be taken into account and it was not possible to verify the children's progress between the spring of 2002 and the spring of 2003. Nevertheless, it was possible to compare the results of the L1-1 and L1 – 3 tests. This comparison only involved the ability to make inferences, since the L1 – 3 test did not include many questions targeting the ability to locate information in a text. A one-sided paired t-test shows that the children's ability to make inferences improved between L1-1 and L1 – 3 ($p = 0.0470$).

4.3 Relationship between the use of space in LSQ and French Reading Comprehension

In this section we present the results of statistical analyses that show how, on the basis of the tests presented above, mastery of the use of space in LSQ is related to reading comprehension.

As summarized in Table 11, the tests taken into account in the analyses are the LSQ and reading tests administered in 2001 and the LSQ[ix] and reading tests administered in 2003.

Table 11: Summary of the correlations between the ability to use space in LSQ and French Reading Comprehension

	LSQ Tests		French Reading Tests	
2001	Q1-1	⟷	L1-1	
2002	Q1-2		L1-2	
2003	Q1-3	Q2	⟷	L1-3

Because the compared groups were small, Pearson and Spearman correlation tests were performed in order to verify that the results of both tests showed the same tendencies. However, in the present paper, only the results of the Spearman tests are presented.[x]

The Spearman test (for the tests taken in 2001) shows a highly significant correlation between global reading comprehension in French (locating, grouping, selection and inference) and global ability to use space in LSQ (assignment and reference). More specifically, there is a correlation between the ability to assign loci in LSQ and the ability to infer information in reading, and also between assignment in LSQ and global reading skills. Furthermore, there is a correlation between the ability to refer to a pre-established locus in LSQ and the ability to infer information in reading, as well as between reference in LSQ and global reading comprehension. There is no correlation between locus assignment in LSQ or reference in LSQ and the ability to locate information in a text when reading. Finally, there is a correlation between the level of global ability in the use of space in LSQ and the ability to make inferences in reading. Table 12 shows the correlations for the tests taken in 2001.

Table 12: Correlations between the LSQ test (Q1-1) and the reading test (L1-1) (2001)

2001 (n=15)	Assignment	Reference	Global score
Locating information	0.41	0.34	0.43
Inference	0.68**	0.76**	0.77**
Global score	0.66**	0.62**	0.71**

** $p < 0.01$

For the tests administered in 2003, the results of nine children who took both tests (L1 – 3and Q2-1) were also analyzed using a Spearman correlation test. The results of eight out of nine of these children were included in the analysis of the results for the tests taken in 2001. As seen in Table 10, the significant correlations that were found are the same as those found in 2001 (see Table 9). However, Table 13 also shows two new significant correlations between locus assignment in LSQ and locating skills in reading, and also between the global skill level in LSQ and locating skills in reading.

Table 13: Correlations between the LSQ test (Q2) and the reading test (L1 – 3) (2003)

2003 (n=9)	Assignment	Reference	Global score
Locating information	0.79**	0.52	0.67*
Inference	0.59*	0.75*	0.64*
Global score	0.70*	0.92**	0.84**

*$p < 0.05$ and ** $p < 0.01$

Because the groups were small and because the correlation coefficients were too close to one another, particularly in the case of the data from the 2001 test sessions, the confidence intervals were too wide to allow us to determine whether there was any difference between them (for instance, whether the correlation between reference in LSQ and inference in the reading of French was more significant than assignment in LSQ and inference in the reading of French). However, the overall analyses we conducted show consistent correlations between the level of global ability in using space in LSQ and the level of global comprehension in the reading of

French. Furthermore, the analyses also show that proficiency in the use of space in LSQ is correlated to the ability to make inferences rather than to the ability to locate information in a text. In particular, no correlations were found between the ability to locate information in a text, which is used very early by learners, and the ability to refer to a pre-established locus in LSQ, which is learned later. It would be interesting, in a future study, to test the correlations found here and to determine to what extent the mastery of locus assignment and of spatial reference in LSQ are related to higher-level processes in reading (e.g. inference).

5 Conclusion

In a bilingual education setting, the assessment of sign language proficiency is an essential aspect of the curriculum for determining the level of acquisition of certain components of sign language structure. However, an evaluation can only be carried out on elements of the language for which a linguistic description is available. LSQ grammar has not yet been fully described, and we therefore chose to consider the use of space as representative of the degree of proficiency in LSQ. Because the description of LSQ is ongoing, there is a constant back and forth movement between descriptive research and language assessment, whence the need for caution in the interpretation of what may be considered a global measure of language skills in sign language.

The study presented in this paper contributes to a better determination of the elements to be considered in the assessment of language skills in LSQ. It also shows that there are correlations between deaf children's mastery of spatial elements of LSQ and their reading comprehension level. We cannot assert, from a bilingual acquisition perspective, that there is a unidirectional link between mastery of LSQ and French reading. Nonetheless, the results of our analysis have shown that there is a relation between specific LSQ structures and cognitive tasks implied in the reading

process. As this relation involves specific skills at different linguistic and non-linguistic levels, an adequate interpretation will only be possible once a more comprehensive model of bilingualism becomes available. Existing hypotheses on the facilitating effects of the knowledge in the L1 for the acquisition of the L2 do not sufficiently expand on the origins of such effects. It would be interesting to conduct further research to examine the question of directionality in the relationship between signing and reading proficiency.

Despite the many methodological and descriptive limitations of this study, the results lead to a new stage in the development of evaluation instruments and the analysis of the language skills of deaf children in Quebec. The study was conducted in a school setting, which implied real-life factors such as the coming and going of students from one year to another. Despite these conditions, however, the results provide interesting leads for further research, particularly on the relationship between a specific aspect of sign language proficiency (spatial reference) and a specific aspect of reading comprehension (inference). It seems, as Hoffmeister (2000) suggests, that sophisticated measures of sign language skills such as spatial reference are related to reading skills. Furthermore, it is interesting to note that in our study, a specific ability in LSQ (referring to a pre-established locus) is explicitly correlated to a higher-level reading process (making inferences). This brings us a step farther in our efforts to understand the interaction of both languages.

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[i] We use the terms “cycle” and “grade” because these terms correspond to those used in the standard school system. However, in the case of schools for special communities, the homogeneity implicit in such terms does not always correspond to reality because the children vary considerably in their levels of acquisition of knowledge.

[ii] Studies on sign order have shown that grammatical relations in LSQ are established spatially rather than by linear order. This explains why there are many possible orders for signs in LSQ. The same has been described for French sign language in different frameworks (Cuxac, 2000; Millet, 2005).

[iii] This first-pass analysis was a "strict" analysis. A second, more lenien analysis was also applied to the data from the first testing session with Q1; half the points were given when a child had produced a spatial marker equivalent to the one produced by the experimenter instead of reproducing the model. A comparison of both types of analyses showed that the children produced very few acceptable substitutions.

[iv] The sentences could be seen repeatedly at the child's request or if there was a technical problem (a frozen computer or a discontinuous video flow). In order to be able to distinguish memory processes (recall of the entire target to be reproduced) from linguistic processes (production of morpho-syntactic structures), a child was allowed to view a video as many times as needed before reproducing it.

[v] Topographic space in sign languages consists in a transposition of real-life scenes in order to provide a detailed description of spatial relationships or of the spatial arrangement of elements. Syntactic space is an abstract use of space to establish a setup for the realization of reference in a discourse (Emmorey 1996; Emmorey, Corina et Bellugi 1995).

[vi] There was much variation in the children's ability to reproduce 3rd-person possessives in the first two test sessions of Q1 (Q1-1 and Q1-2). This variation may be explained by the fact that when a sign expressing possession is present in a sentence, a constraint is imposed on the order of signs (Bouchard *et al.*, 2000). This constraint appears to interact with the degree of difficulty in using space while signing.

[vii] The agreement of directional verbs is generally expressed by the modification of the signs' initial and final place of articulation, whereas the agreement of locational verbs is expressed by the modification of the signs' place of articulation and by the addition of a pronoun. Finally, the agreement of plain verbs does not involve the modification of the place of articulation (compared to the citation form of the verb), but instead the use of one or two pronouns is required. For more details on verbs in LSQ, see Parisot (2003).

[viii] For the comparative analysis presented in this section, statistics were computed from the results of subjects who had taken two tests: either Q1-1 and Q1-2 (n=24), Q1-2 and Q1-3 (n=13), or Q1-3 and Q2 (n=15).

ix For the 2003 test session, only the second version of the LSQ test (Q2) is included in the analysis. Because of the possibility of a ceiling effect on the performance for the assignment markers category (as discussed above), the Q1-3 test (1st version and 3rd testing session) was removed from the analysis.

[x] The statistical analyses were performed by the SCAD, a service offered by the University to assist researchers in the analysis of their data. Only the results of the Spearman correlation tests are presented because the analyses are based on the rank of the children rather than on their scores. Such a test avoids putting too much emphasis on the great variation between scores, and also allows getting around the influence of outliers.

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