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The Contribution of American Sign Language to Sign-Print Bilingualism in Children

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Abstract

Sign languages serve as successful communication, providing access to spontaneous, interactive language for some individuals with a hearing loss. However, for these individuals there is a concern for the development of reading skills in a second language, a bilingual task. Previous studies indicated that a correlation exists between sign language knowledge and written language comprehension for older children and adults. The current study examines the predictive relationship between American Sign Language (ASL) knowledge and the developing English reading skills for children in 1st and 2nd grade. The results of this study indicated that ASL knowledge was a leading indicator of later English reading ability, providing evidence that sign language is a strong predictive factor in enabling young deaf children to acquire reading ability in a second language.

Introduction

This study sought to provide information about the role that sign language knowledge plays in helping young children learn to read in a second language. For children with a significant hearing loss, and whose primary mode of communication is a signed language (L1), the goal of education is to become proficient in that language but also to become proficient in reading another language (L2). In essence, the young child with a hearing loss needs to develop sign-print bilingualism to function academically and in society [1].

Studies that are reviewed in this paper show a correlation between sign language knowledge as L1 and reading acquisition in L2. However, there is a gap in the knowledge about the strength and nature of this relationship, especially with young children who are at a critical stage for developing reading skills. This knowledge would contribute valuable direction for educational programs as well as for future research. Therefore, the purpose of the current study is to determine if ASL knowledge can predict English reading ability for children who are at a critical age for learning to read.

Spoken, Signed, and Written Language Development

Interactive, spontaneous language ability serves as a foundation for the development of literacy skills, and it is commonly accepted that expressive and receptive language skills and reading ability are strongly related for hearing children [2]. Hearing children learn their native language through the auditory modality; they learn to understand and speak the language that they hear. The many different instructional methods used to teach reading all have one factor in common: they rely on the child's auditory knowledge of the spoken language. Thus, for hearing children, the auditory modality allows access to specific language information and serves as a foundation for the development of reading in that same language. Deaf children may also learn an interactive, spontaneous language through sensory exposure but through the visual modality; they learn to understand and use the language that they see. As Chamberlain and Mayberry [3] have indicated, the important question is, does sign language (L1), which does not have an apparent connection to a spoken language, serve as the basis for learning to read in a second language (L2)?

Spoken or signed language, a product of the human brain, is considered an innate ability for both hearing and deaf individuals [4,5]. For spoken or sign language to unfold in a typical manner, children require adequate exposure to the language and interactions with other language users. For deaf infants and children who are exposed to sign language, word comprehension and communicative interactions are accomplished through the visual modality. Language, whether spoken or signed, enables information transfer, which in turn fuels cognitive growth. This cognitive growth is considered by some researchers to be the foundation for later literacy development [4-8]. Reading requires connecting written symbols to meaning and the meaning is derived from language knowledge.

Unlike the spoken or signed language development process, the ability to read does not develop naturally, for either hearing or deaf children. Children with even good spoken or signed language skills cannot usually teach themselves to read [7]. Reading skills need to be directly taught and are considered so important that they are the instructional focus of the early elementary school years.

For hearing children, difficulty in acquiring reading skill is a topic of prominent concern among educators as well as the public, and it is the focus of ongoing research and debate over differing pedagogical philosophies. Acquisition of reading skill is considered even more difficult for deaf students, and low reading levels among deaf children are well documented [9-11]. Learning to read may be challenging for a deaf child because of deficient language skills or because of the complexity of learning to read a second language [10].

Many research studies have investigated best practices in teaching hearing and deaf children to read. There is no doubt that teaching methods have a significant role in the successful acquisition of reading ability. However, for hearing children, success in learning to read their native language depends, in large part, on prior experience with their spoken language. As with hearing children, regardless of the method used for literacy instruction, Padden and Ramsey [7] and Kyle and Harris [10], indicate that deaf children also need prior knowledge of an interactive language to achieve reading facility. Some assume that the development of reading in any language depends upon the prior knowledge of, and the interactive, spontaneous, and conversational use of a first language system, whether the child is hearing or deaf [12,13]. The specific language knowledge that the deaf child brings to the reading task will depend on the language skills that the child has learned and will affect reading success. A question to be answered is, does knowledge of ASL, which does not have a direct correspondence to English, have a significant and positive influence for deaf children in their ability to learn to read English?

The explicit connection between an interactive sign language and reading in a second language is a promising path of investigation. The knowledge of ASL as an interactive, spontaneous language may fulfill the requirement of a language base for deaf children and serve as a foundation for learning to read. In fact, some researchers have found that language knowledge is a better predictor of reading success than phonemic awareness ability for hearing children [3,14-16] as well as for deaf children [3,17,18]. Other researchers acknowledge that the main problem that impedes a deaf child's ability to acquire literacy skills is weak signed or spoken language skills, not an inability to speak English [17,19].

During the past two decades, several studies that have investigated the relationship between sign language knowledge and reading acquisition consistently report a strong connection between these skills [3,7,13,20]. Strong and Prinz [13] first investigated the relationship between ASL skills and the English literacy development of deaf children. Their study involved 155 children, ranging in age from 8 to 15 years, enrolled at a residential deaf school. Forty students had deaf mothers while 115 students had hearing mothers. They assessed the ASL skills of the students using an evaluative instrument they had developed. The instrument included four tests of comprehension (story comprehension, classifier comprehension, time marker comprehension, and map marker comprehension) and two tests of production (classifier production and story narrative). The performance on all six of the ASL tests was converted to a single composite ASL score. They assessed reading comprehension using selected and adapted subtests of the Woodcock-Johnson Psychoeducational Test Battery, Revised Version (comprehension of vocabulary, sentences, and paragraphs, as well as synonyms and antonyms). The researchers also assessed writing skills utilizing the Test of Written Language (vocabulary, syntax, and narration). The performance on all eight of these tests was also converted to a single composite overall English literacy score. The relationship between ASL skills and English literacy (including writing) was determined by correlations between the two composite scores. The correlation between the two ASL and English literacy composite scores was positive for children between the ages of 8 and 11 years but not for those between the ages of 12 and 15 years. They also found that the students who had deaf mothers had significantly higher ASL and English literacy composite scores than students who had hearing mothers, confirming the findings of earlier studies which suggest that early exposure to ASL facilitates linguistic and literacy achievement [21,22].

Hoffmeister [20] also studied the development of ASL skills as they related to reading skills. He tested the ASL and reading skills of 50 deaf children between the ages of 8 and 16 years; they comprised 14 children who had deaf parents and 36 who had hearing parents. Twenty-one attended a residential school while 29 attended a day school and had more limited ASL exposure. ASL skills were determined by three word knowledge tasks: ASL synonyms, antonyms, and plurals-quantifiers. The students with deaf parents outperformed the other students on the ASL measures. Reading skill was measured with the reading comprehension subtest of the Stanford Achievement Test (SAT-HI), which the author admits has considerable limitations as an in-depth assessment of literacy skills. Multiple correlations, with the effects of age partialed out, were analyzed to determine the relations among the students' SAT performance and the ASL measures. Performance on the ASL tasks was significantly and positively correlated with performance on the SAT reading task.

Padden and Ramsey [7] asked the question of whether and how ASL plays a role in reading development, beyond providing a linguistic and cognitive basis for the development of new language skills. They tested 31 deaf children, some attending a residential and some attending a public school. Eighteen were in 4th grade while 13 were in 7th grade. Five tasks were used to measure ASL skills: sentence order comprehension, verb agreement production, sentence imitation, comprehension of finger spelling in sentences, and comprehension of initialized signs in sentences. Reading skills were measured with the reading comprehension subtest of the SAT-HI. Statistical analyses indicated that performance on the ASL measures was positively correlated with reading scores. The authors acknowledged, however, that age was not controlled and that they only demonstrated that there are relations between ASL and reading, not whether early acquisition of ASL promotes reading development.

Finally, Chamberlain and Mayberry attempted to answer the question of whether ASL (L1) impeded the development of reading English (L2) or if the linguistic basis of reading is abstract and transcends language modality and grammatical form, thus indicating that ASL can serve as the linguistic basis of reading [3]. The authors measured the ASL and reading abilities of 31 deaf adults, 12 women and 19 men, ranging in age from 17 to 53 years. They examined ASL syntactic proficiency by assessing grammatical knowledge of six ASL sentence structures (simple, negative, inflecting verb, wh-questions, relative clauses, and classifier sentences) and two narrative comprehension tasks. Reading measures included the reading comprehension subtest of the SAT-9 as well as the reading comprehension and vocabulary subtests of the Gates-MacGinitie Reading Tests, Second Canadian Edition, which is not normed for deaf readers. They performed a series of regression analyses and found that while nonverbal IQ was not a significant predictor of reading proficiency, skilled reading was predicted by ASL proficiency. Thus, for adults, ASL predicted English reading skill.

Other authors have also commented on the strong connection between sign language and reading skills [17,23,24]. As has been cited earlier, deaf children who have deaf parents read at a higher level than deaf children of hearing parents [13,20], and this has been attributed to the early access to and development of sign language skills for the deaf children of deaf parents [4,18] and a climate of acceptance and support for deafness [7]. In contrast, it has also been observed that reading problems for deaf children are attributed to deficient language ability, including weak vocabulary skills [25,26]. It may be that the foundational relationship between spoken language ability and reading that is observed for hearing children may also be true for deaf children; that is, a strong interactive language foundation for deaf children may be a key to reading success.

The studies reviewed provide support for the idea that ASL skills are correlated with the development of English literacy ability [3,7,13,20]. It seems evident that language skills, in an interactive, visual modality, may have a positive relationship with reading development for deaf children. However, none of the four research studies reviewed assessed only young children who were at an age when they are first learning to read [3,7,13,20]. Furthermore, most studies report a correlation; the only predictive, or cause-and-effect, relationship between ASL skills and English reading ability was found by Chamberlain and Mayberry [3]. Although this was a much stronger finding than a correlation relationship, their study involved adults and not children. The current study extends this path of research in two important ways. First, we included only young deaf children in 1^{st} and 2^{nd} grade, a time that is formative and critical in the reading acquisition process. Second, we investigated the predictive relationship between sign language knowledge and reading. We sought to provide some evidence that advancing ASL (L1) skills, above and beyond ever-increasing general non-verbal cognitive skills, could serve as a language foundation for deaf children as they learn to read English (L2). This line of research will add information about the strength of the contribution of sign language to the developmental trajectory of reading skills for young deaf children.

Purpose of the Study

The purpose of this study was to investigate the strength of the relationship between ASL knowledge (L1) and English (L2) reading development for children in 1^{st} and 2^{nd} grade. Specifically we wanted to investigate if children's ASL skill level would predict their success in learning to read English beyond that which might be predicted based on ever-increasing general non-verbal cognitive abilities. We hypothesized that ASL (L1) skill level would predict English (L2) reading ability, even when children's general cognitive abilities were statistically controlled.

To test this hypothesis we assessed ASL skills and English reading ability of deaf children enrolled in 1^{st} and 2^{nd} grades and used a longitudinal, cross-lagged panel design. Adult native signers of ASL assessed the 1^{st} and 2^{nd} graders' ASL skills twice, at the beginning and at the end of the school year. English reading skills were assessed with five subtests of the Woodcock Reading Mastery Test – Revised/ Normative Update (WRMT-R/NU) [27] by identifying specific components of early reading and obtaining performance scores for each area. The Raven's Coloured Progressive Matrices (RCPM) [28] was used to obtain a non-verbal measure of general cognitive ability, which served as a statistical control. The RCPM is an analysis of spatial configurations that measures non-verbal intelligence and has been used for this purpose with deaf individuals [29-30].

Method

Participants

There were 25 children enrolled in 1^{st} and 2^{nd} grade at an urban state school for the deaf. ASL was the language of instruction as well as the social language at the school for all participants. Of the 25 participants, there were 14 1^{st} grade children (9 males and 5 females), average age 7 years, 1month and 11 2^{nd} grade children (7 males and 4 females), average age 8 years,1 month. All participants were identified with a hearing loss within three months after birth. The average hearing loss (0.5, 1, 2, and 4kHz) for the better ear was categorized according to the World Health Organization grades of hearing loss [31]. Nineteen participants had profound losses (≥ 81 dB), four had severe losses (61-81 dB), and two had moderate losses (41-60 dB). One child had a cochlear implant and four used hearing aids.

Twenty-one of the 25 participants had deaf parents who were fluent in ASL and used ASL at home as their primary language. Two of the 21 participants with deaf parents used hearing aids. The four remaining participants had hearing parents whose primary home language was English. One of those participants had a cochlear implant, and had parents with conversational ASL ability. Two of the four participants had hearing aids; one had parents with conversational ASL ability and the other participant had parents with limited ASL ability. The fourth participant who had hearing parents did not use amplification and had parents with conversational ASL ability. All participants remained at the residential school during the week and used ASL on a daily basis. Table 1 presents a description of the participants. First and 2^{nd} grade teachers for the participants identified themselves as deaf and conducted classroom instruction in ASL, including reading instruction.

Hearing Status of Participants						
Time of Hearing Loss Identification	Categorization of Hearing Loss			Use of Amplification		
	Moderate	Severe	Profound	Hearing Aids	Cochlear Implant	None
Birth-3 mos						
25	2	4	19	4	1	20

Home Language Status of Participants						
Parental Hearing Status		Parental ASL Ability			Home Language	
Hearing	Deaf	Limited	Conversational	Fluent	English	ASL
4	21	1	3	21	4	21

Table 1: Hearing status and home language status of the 25 participants.

Assessment instruments

Three assessment instruments were used to obtain the measures of ASL skills, English reading ability, and general cognitive ability. All test instructions and responses were in ASL, the participants' preferred communication method.

1. The American Sign Language (ASL)Assessment is an instrument designed by this state school for the deaf to assess signing skills of students enrolled at the school. For the participants of this study, the ASL Assessment followed stages of ASL development for children 6–8 years and generally considered the following skills for this age group: clear and consistent use of complex handshapes and movement; frequent use of fingerspelling; use of complex sentences including relative clauses and conditionals; use of verb modifications to show intensity, manner, number, and distribution; use of abstract

referencing to talk about people and things not present; use of adult-like storytelling with frequent self-corrections; ability to assume a variety of roles in conversation and storytelling; and clear and consistent expression, body shifts and eye gaze.

The ASL Assessment evaluated 12 items each for both expressive and receptive skills. Specific aspects of ASL expression and reception that were assessed included:

- Basic sentence types (3 items): question mark wiggle, rhetorical questions, and topicalization
- Fingerspelling (2 items): names and places, lexicalized signs
- Location identification (2 items): people, objects
- Body shifts (2 items): eye gaze to show role playing, slight shoulder movement
- Morphology of location in ASL (1 item): noun to show plural
- Pre-linguistic aspects of deaf culture (2 items): begins conversation after eye contact, looks at face, not hands, of signer.

Each of the 12 items was rated on a scale of 1-5, with 5 = Superior. Scores for both expressive and receptive skills were summed for a total score, for a total possible score of 60 on the expressive and 60 on receptive portions. The two raters used ASL as their primary language and identified themselves as deaf. The raters were teachers employed at the deaf school who routinely administered the ASL Assessment instrument to evaluate the ASL skills of the children enrolled at the school. The alpha reliability of the composite scores for expressive and receptive ASL skills were .94 and .97 respectively. The scores on the expressive and receptive ASL Assessment served as the primary predictor variables for this study.

2. Five subtests of the Woodcock Reading Mastery Test – Revised/Normative Update (WRMT-R/NU), Form G, were modified for presentation in a non-standardized manner. All participants received the same test instructions in ASL, and all responses from the participants were in ASL. Raw scores were used for purposes of data analysis; percentiles and scaled scores were not computed since the modified WRMT-R/NU is not normed for administration in ASL. Six examiners completed the testing of participants on the subtests of the modified WRMT-R/NU and the RCPM. All examiners had ASL skills at a level required for test administration. To ensure accuracy and uniformity of test instructions, examiners completed training in administration and scoring of the RCPM and the WRMT-R/NU.

The five subtests administered included:

- Letter Identification assessed alphabetic knowledge. This subtest presents single letters in both lower and upper cases and various font types. When the child was shown a letter, he was expected to respond with the matching alphabet letter using conventional finger-spelling in ASL.
- Word Identification assessed ability to read single words. When the child was shown a printed word, he was expected to respond with the matching word in ASL.
- Word Comprehension-Antonyms assessed ability to read single words. When the child was shown a printed word, he was expected to respond with the opposite word in ASL.
- Word Comprehension - Analogies assessed ability to read two words in sequence and complete the next sequence, analogous to the first, such as "dog – walks", "bird – ____", using ASL.
- Passage Comprehension assessed the ability to read a partial sentence or passage and complete it in ASL, such as "The cat is playing with a ______(accompanied by a picture of a cat playing with a ball)".

Scores on the modified WRMT-R/NU subtests, as well as a composite measure, served as the primary outcome measures for this study.

3. The Raven's Coloured Progressive Matrices (RCPM) was used as an assessment of non-linguistic general cognitive ability. On the RCPM, participants simply identify, from a selection of four items, the piece that is the "best fit" for the item missing in the presented matrix. This test was selected for two reasons. First, the test required minimal use of language in presenting the instructions. Children quickly learned what to do in the task based on the presentation of sample items. In this way, deaf children could respond easily without spoken language or ASL. All participants received the same limited instructions in ASL, and only pointing responses were required. Second, the test is thought to be language-free and provides an assessment of general cognitive ability that is independent of language ability [28].

Schedule of testing

All three assessment procedures were administered at two different times of the school year, once in the Fall and once in the Spring, six months apart. All tests were administered during the school day, and usually three orfour sessions per child were required to complete the test battery at each testing period.

Results

Gender, grade level and time of testing effects

Scores on the predictor measures (expressive and receptive ASL scores) and the outcome measures (WRMT-R/NU subtests) were analyzed in a series of 2 (Gender) X 2 (Grade Level) X (2) (Time of Testing) mixed design ANOVAs to look for differences across these factors. Before conducting these analyses, two 2 (Gender) X 2 (Grade) X (2) (Time of Testing) MANOVAs were performed on the predictor (Expressive and Receptive ASL) and outcome variables (WRMT-R/NU subtests) separately. These analyses confirmed the validity and consistency of the pattern of results across the univariate ANOVAs presented and were not reported here for brevity. These analyses revealed no significant gender differences nor did gender interact with Grade Level or Time of Testing on any of the variables involved in this study. We therefore eliminated gender as a factor from all subsequent analyses.

Means (and standard errors) for the predictor variables (expressive and receptive ASL scores) broken down by Grade Level and Time of Testing (Fall versus Spring) are presented in Table 2. As shown, there were no significant grade differences on the measures of expressive and receptive ASL nor were there any Grade Level by Time of Testing interactions. These analyses revealed significant Time of Testing effects only with children showing significant growth in both expressive and receptive ASL Skills between the Fall and Spring semesters.

Means (and standard errors) for the outcome measures (the WRMT-R/NU subtests) are presented in Table 3. As can be seen, 2nd graders scored higher than 1st graders on every subtest of the WRMT-R/NU. Additionally, children showed significant growth on the WRMT-R/NU subtests between the Fall and Spring testing sessions.

Finally, two small but statistically significant Grade Level by Time of Testing interaction effects were found. In both cases (for the Letter and Word Identification subtests), 1st graders' improvement between the Fall and the Spring testing sessions was slightly larger than that of the 2nd graders (Table 3). Because ASL skills and linguistic progress for both grade levels was generally very consistent, we combined the two samples (1st and 2nd graders) for the test of the primary hypothesis that ASL skill level would predict English reading ability.

	Grade				
	1st Grade		2nd Grade		
	Fall	Spring	Fall	Spring	Notes
Expressive-ASL Score	34.0 (2.1)	47.9 (2.2)	41.1 (2.3)	55.1 (2.5)	a
Receptive ASL Score	36.6 (2.2)	49.5 (2.1)	41.6 (2.5)	56.1 (2.3)	b

Table 2: Mean (and standard errors) of expressive and receptive ASL scores broken down by grade and time of testing. [a]Time of Testing $F(1,23) = 106.8$, $p < .001$; [b]Time of Testing $F(1,23) = 90.9$, $p < .001$

	Grade				
	1st Grade		2nd Grade		
	Fall	Spring	Fall	Spring	Notes
Letter ID	31.4 (1.7)	36.1 (1.2)	38.7 (1.9)	39.6 (1.3)	a,f,k
Word ID	14.4 (3.5)	27.8 (3.6)	38.3 (4.0)	45.1 (4.1)	b,g,l
Antonyms	1.1 (0.8)	2.6 (0.9)	4.9 (0.8)	6.4 (1.0)	c,h
Analogies	3.1 (1.6)	7.0 (2.6)	14.1 (1.8)	17.7 (3.0)	d,i
Passage Completion	3.1 (1.4)	5.3 (2.5)	10.7 (1.6)	17.6 (2.8)	e,j

Table 3: Mean (and standard errors) of WRMT-R/NU subtests scores broken down by grade and time of testing. [a]Grade Level $F(1,23) = 7.3$, $p < .05$; [b]Grade Level $F(1,23) = 15.5$, $p < .001$; [c]Grade Level $F(1,23) = 9.6$, $p < .005$; [d]Grade Level $F(1,23) = 13.0$, $p < .001$; [e]Grade Level $F(1,23) = 16.2$, $p < .001$; [f]Time of Testing $F(1,23) = 9.7$, $p < .005$; [g]Time of Testing $F(1,23) = 68.2$, $p < .001$; [h]Time of Testing $F(1,23) = 16.6$, $p < .001$; [i]Time of Testing $F(1,23) = 8.5$, $p < .01$; [j]Time of Testing $F(1,23) = 6.8$, $p < .05$; [k]Grade Level X Time of Testing $F(1,23) = 4.4$, $p < .05$; [l]Grade Level X Time of Testing $F(1,23) = 7.5$, $p < .05$

Correlations between predictors, outcomes, and control variables

Table 4 and Table 5 present the intercorrelations between all the predictor and outcome variables employed in this study (including the non-linguistic general cognitive index RCPM) for the Fall and Spring testing sessions respectively. As can be seen in the tables, expressive and receptive ASL scores were highly intercorrelated (.92 in the Fall, and .90 in the Spring). Because of this near linear association, expressive and receptive ASL scores were combined into a single ASL Skills measure.

Likewise, as can be seen in Table 4 and Table 5, the five subtests of the WRMT-R/NU that make up the predictor variables were highly and significantly intercorrelated, ranging from a low of .45 to a high of .91 for the Fall testing and between .48 and .91 in the Spring. A principal components factor analysis of these subtests revealed them to be unidimensional (the one factor accounting for 76% and 82% of the total matrix variability for the Fall and Spring respectively), so the WRMT-R/NU subtests were combined into a composite English Reading Ability score with an overall alpha reliability of .84 and .89 for the Fall and Spring testing sessions respectively.

Finally, as shown in Table 4 and Table 5, the outcome variables were significantly correlated with the non-linguistic general cognitive measure RCPM (correlations ranging from .47 to .73 across the various subtests and the two testing sessions). RCPM was significantly correlated with the combined English Reading Ability score $r = .76$, $p<.001$ in the Fall and $r = .73$, $p<.001$ in the Spring, suggesting its importance as a control measure to test the primary hypothesis.

	Express-ASL	Recep-ASL	Letter ID	Word ID	Antonyms	Analogies	Passage Comp.	RCPM
Express-ASL	1.0	.92**	.72**	.78**	.63**	.65**	.51**	.65**
Recep-ASL		1.0	.62**	.60**	.48*	.48*	.38	.51**
Letter ID			1.0	.69**	.52**	.62**	.45*	.65**
Word ID				1.0	.91**	.91**	.70**	.73**
Antonyms					1.0	.83**	.62**	.63**
Analogies						1.0	.65**	.70**
Passage Comp.							1.0	.62**
RCPM								1.0

Table 4: Correlations of predictor, outcome and control variables at the fall testing session. *$p< .05$; **$p< .01$

	Express-ASL	Recep-ASL	Letter ID	Word ID	Antonyms	Analogies	Passage Comp.	RCPM
Express-ASL	1.0	.90**	.69**	.67**	.50*	.44*	.32	.42*
Recep-ASL		1.0	.75**	.62**	.50*	.43*	.30	.41*
Letter ID			1.0	.67**	.64**	.58**	.48*	.47*
Word ID				1.0	.91**	.88**	.81**	.69**
Antonyms					1.0	.89**	.81**	.69**
Analogies						1.0	.94**	.72**
Passage Comp.							1.0	.70**
RCPM								1.0

Table 5: Correlations of predictor, outcome and control variables at the spring testing session. $^{*}p< .05$; $^{**}p< .01$

Relationship of ASL knowledge to English reading ability

In order to test the primary hypothesis, that ASL (L1) skill level would predict deaf children's future learning of written English (L2), we used a longitudinal, cross-lagged panel design between the composite measure of ASL Skills and the composite measure of English Reading Ability. For this analysis, we combined the samples of 1st and 2nd grade children to examine the relationship between ASL Skills and English Reading Ability at two points in time (Fall and Spring semesters). Combining Grades 1 and 2 was considered appropriate here because grade level at the school is based on child age and not performance on any of the measures included in the study. Following the recommendations of Finkel and others, we included a time-varying covariate in our model to help control for the effects of general cognitive ability on language learning,and also to reduce some of the known limitations of cross-lagged panel designs including the possible biases of both low test-retest stability and autoregressive correlations between measures at two or more points in time [32]. Additionally, we conducted the cross-lagged panel analysis generally following the recommendations of Campbell and Kenny [33] by conducting the analysis in three ways. The first analysis uses the traditional approach for estimating directional effects in a longitudinal context by examining the difference in the relationships between two variables at two points in time (the cross-lag correlations) [34]. These results are presented in Figure 1. The presented coefficients in the model are the part-correlations between the relevant variables after correcting for RCPM scores on English Reading Ability. As can be seen in Figure 1, both ASL Skills and English Reading Ability (corrected for RCPM scores) were relatively stable across the testing sessions, and ASL Skills were correlated with corrected English Reading Ability both in the Fall and the Spring. Most important for testing the primary hypothesis are the cross-lagged panel correlations. As shown in Figure 1, Fall ASL Skills were a significant predictor of corrected English Reading Ability scores, but corrected Fall English Reading Ability scores were not a significant predictor of Spring ASL scores. As described by Campbell and Kenny [33], this analysis was followed up by two additional tests: the Rogosa [35] multiple regression test and the Kenny and Campbell [36] time-reversed test. The Rogosa multiple regression test includes a more explicit test for directionality than the traditional test [35]. When applied to these data, the Rogosa model revealed a significant directional path from Fall ASL Skills to Spring English Reading Ability scores (t=2.64,p=.014 but the path from Fall English Reading Ability to Spring ASL Skills was not significant (t=1.146,p=.262). The second test, the Kenny and Campbell time-reversed test, is a re-analysis of the original data, only this time with the temporal ordering reversed (i.e., Spring being used to predict Fall data) [36]. This test examines the possibility that the results of the traditional analysis are a simple artifact of regression to the mean (Campbell and Kenny [33]). The traditional analysis revealed a significant directional relationship between Fall ASL Skills and Spring English Reading Ability (beta=.418,SE=.21,p=.028), but the relationship was effectively nil in the time-reversed (Spring to Fall) direction (beta=.021,SE=.11,p =.643). Across the set of three cross-lag analyses, we found consistent evidence that Fall ASL Skills were a significant predictor of corrected English Reading Ability scores, but corrected Fall English Reading Ability scores were not a significant predictor of Spring ASL scores. The pattern of results across these analyses was taken as support for the proposed model that ASL knowledge is an important leading indicator of deaf children's later learning of written English.

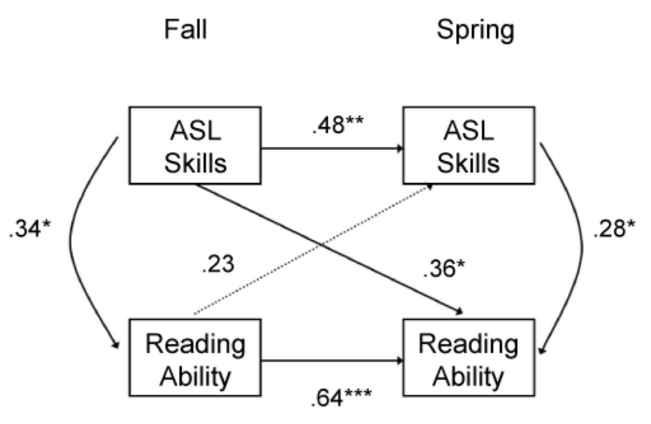

Figure 1: Cross-lagged panel analysis of ASL skills and English literacy proficiency at the fall and spring testing sessions.

Discussion

The purpose of this study was to investigate whether ASL (L1) skills would predict deaf children's English (L2) reading ability. Although many factors contribute to the development of reading ability, this study focused on the contribution of sign language, specifically ASL, and how knowledge of this language influenced the development of reading ability for young deaf children. We built into this study several key features that make it both unique and innovative. First, we studied a population of young children (in 1st and 2nd grade) with significant hearing losses who used ASL as their primary language. No other research of ASL and reading ability has exclusively studied children at this young age. This allowed us to look at reading skills at an age when sign-print bilingual ability is at an early stage of development. Second, we employed an instrument to measure ASL skills that was already in use by the school and had proven utility as an assessment tool for teachers. Third, we employed a measure of reading skills that tested different components of English reading skills but that as expected, could be combined to form a reliable global index. Fourth, we used an assessment of non-verbal cognitive ability to help serve as a control for differences in general non-linguistic cognitive ability. Fifth, we tested children at two points in time, at the beginning of the school year and again at the end, to specifically look at how ASL skill level might facilitate the development of reading skills over time. Sixth, we ensured that the administration and response format of the relevant measures were done in ASL, the primary language of the participants. Finally, we used an analysis to determine if ASL knowledge could predict English reading ability.

The most significant finding from this study was that, even with a control for cognitive growth, not only were the ASL skills of children in this study significantly related to their performance on English reading tests, but their ASL (L1) skills, measured in the Fall, were a leading indicator of English (L2) reading ability later in the Spring. This finding provides evidence that sign language knowledge is a strong predictive factor for the reading development of young deaf children. This study highlights the importance of language knowledge as a foundation for learning to read, even when the relationship is bilingual.

The present study provides evidence that ASL skills facilitated English reading ability for young deaf children at time when learning to read is critical. Chamberlain and Mayberry [3] concluded that sign language skills have a predictive role in reading ability, but their study was limited to an adult deaf population. The current study provides evidence for the critical role that ASL skills have in the development of early reading skills for young deaf children. The results of this study are consistent with the observed relationship between language and literacy for hearing children in that children with stronger language skills later develop better reading skills [2].

These results also help explain why deaf children of deaf parents often have English reading ability that is significantly higher than that of deaf children of hearing parents. The one factor that is often different between these two groups is the age at which ASL is acquired. For deaf children of hearing parents, ASL is often not introduced until the child has had a history of difficulty with spoken English. For deaf children of deaf parents, as exemplified by the majority of the participants in this study, ASL is most often introduced in infancy or early childhood. As our results suggest, early ASL knowledge could well enable deaf children to develop written language skills at an early age. Literacy studies consistently point to the importance of acquiring language skills early, whether spoken or signed; children who acquire language skills at an early age have stronger language ability, including the ability to read [37].

The question of the contribution of ASL knowledge to reading development in English is a particularly interesting one because of the differences between the two languages. At first glance there is no apparent reason why ASL should contribute to English reading development. However, although the structure of signed languages differs from spoken languages, the cognitive requirements are similar; only the modalities are different, which may not actually be an important difference [10]. The specific cognitive task that underlies all language competence is for the brain to assign meaning to abstract symbols, whether those symbols are signed, spoken, or written. The results of this study indicate that ASL skills were a leading indicator of later English reading ability. This was true even though ASL and English are not similar in structure or form, and even though most participants did not have auditory access to spoken English. The findings of this study support the conclusions of other researchers that language skill for deaf children is critical for success in learning to read in another language [3,7,10,12,13].

It should be noted that the primary assessment instruments used in this study were either non-standardized or used in a non-standardized manner. The ASL Assessment has not been normed, and standard scores were not obtained from the WRMT-R/NU because administration of the test was modified to accommodate the use of ASL for instructions and responses. Our use of these scales was not normative but developmental in nature in order to examine how the specific population under study changed over time and the role that ASL skills might play in that. Indeed, the distributions of the raw scores for both of these instruments did evidence ranges of scores that were useful for the purpose of this study. For our purposes, the reading subtests were employed strictly to determine if there was a relationship between ASL and English reading ability. Standard scores and grade- or age-levels for either ASL or English literacy were neither computed nor used in this study. Further, it is acknowledged that the participants in this study were a select group of children who, for the most part did not use amplification, who were exposed to ASL at an early age, and who used ASL as their primary language. However, with this population and with these instruments and test administration methods, we were able to determine the effect of ASL knowledge on the development of English reading ability.

The results of this study suggest that strong ASL (L1) skills facilitate the development of L2 reading ability and that language knowledge, in sign language form, is a predictive factor of reading success. These results broaden the research of others who report that sign language supports the development of reading in a second language [3,7,13,20,38]. Future research endeavors should include the investigation of specific aspects of ASL that facilitate a connection between ASL and English print. McQuarrie and Abbott, for instance, have suggested that a visual ASL Phonological Awareness (ASL-PA), a specific aspect of sign language knowledge, is related to English reading ability [39]. Although the construct of ASL-PA is not yet well defined, determination of a predictive relationship between ASL-PA and reading ability would be significant. Research could also investigate the universal aspects of any sign language as an L1 that contributes to reading success in any L2. Finally, research endeavors could focus on the design of reading programs that maximize a strong language contribution, thus enabling deaf individuals to develop effective sign-print bilingualism.

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