American Sign Language Phonological Awareness and English Reading Abilities: Continuing to Explore New Relationships

Tamara Keck, Keith Wolgemuth

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TAMARA KECK AND KEITH WOLGEMUTH

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Abstract

The present study was conducted to investigate the relationship between American Sign Language (ASL) phonological awareness skills and English reading abilities in both DOD (ASL Early Learners) and DOH (ASL Later-Learners) school-age children. This study evaluated subjects' ASL phonological awareness skills as measured by the ASL Phonological Awareness Test (ASL PAT; McQuarrie and Abbot 2013) and compared those scores to performances on the Test of Early Reading Ability for the Deaf and Hard of Hearing (TERA D-HH; Reid et al. 1991), a standardized test normed on children who are hard of hearing or deaf, and to the Measures of Academic Progress (MAP). Previous research has suggested that Deaf children with Deaf parents (DOD) tend to have stronger English literacy skills than deaf children with hearing parents (DOH), suggesting that early and strong foundational ASL skills may enhance the development of English reading proficiency for Deaf children using ASL as their primary language (Hermans et al. 2008; McQuarrie and Abbot 2013).

Both ASL Early Learners and Later-Learners underwent ASL PAT, TERA-DHH, and MAP reading comprehension testing. All participants were tested using the Test of Nonverbal Intelligence (TONI-4) using nonverbal IQ as inclusionary criteria. Parents com-

Tamara Keck is the director of therapy at the Sensibilities Therapy Group in Riverside, CA. Keith Wolgemuth is an associate professor in the Department of Communication Sciences and Disorders at Loma Linda University in California.

pleted a demographic questionnaire to determine parental hearing status and the age the child was first exposed to ASL.

Positive correlations between all test scores (ASL PAT, TERA-DHH, and MAP) were found for the ASL Early-Exposure Group. For the ASL Early-Exposure Group, a moderately strong positive correlation (** $p \leq .01$) was found between the MAP Reading Assessment and the ASL PAT scores, and a mildly significant correlation between TERA-DDH and ASL PAT scores (**$p \leq .05$). No positive correlations were observed for the ASL Later-Learner group on these measures.

ASL Early-Exposure children (DOD) had overall stronger English literacy skills than ASL Later-Learner children (DOH). Prior studies have established that having a strong foundation in one oral language will help in the development of a second oral language. However, research is now suggesting that this phenomenon can be **cross-modal** (sign language to oral language) in nature. Future studies with larger numbers of children in the ASL Later-Learner group are needed to further examine the relationship between ASL phonological awareness and English literacy skills.

Since the mid-1960s and the publication of William Stokoe's seminal *A Dictionary of American Sign Language on Linguistic Principles* (Stokoe et al. 1965), more Deaf children now have the opportunity to attend a school where American Sign Language (ASL) or some type of manually coded English (e.g., Manually Coded English [MCE] or Signed Exact English [SEE]) serve as the primary instructional language. Schools offering curriculums taught in ASL (bilingual-bicultural educational approach) strive, as all schools do, to provide all necessary and required academic skills to students, including instruction on how to read and write in English. However, existing published research reports that the average student across all deaf and Deaf education programs (i.e., sign language, oral language, total communication) possesses on average a fourth- to fifth-grade English reading level by high school graduation (Allen 2002; Chamberlain and Mayberry 2008; Goldin-Meadow and Mayberry 2001; Hrastinski and Wilbur 2016). Even though these findings included oral-deaf individuals in addition to Deaf subjects, the assumption developed over time that ASL could not possibly serve as a bridge to learning how to read and write English. This assumption was based on knowledge that ASL

signs and grammatical knowledge are so different from the English language that it cannot possibly be used effectively to map knowledge of ASL onto learning English literacy skills.

Ironically, several studies published in recent years have challenged this longstanding assumption, with the results indicating that individuals who possess a strong foundation in ASL phonological awareness, syntactic abilities, or narrative comprehension have higher overall English literacy skills (Chamberlain and Mayberry 2008; Freel et al. 2011; Hermans et al. 2008; McQuarrie and Abbott 2013).

ASL Phonological Awareness and English Literacy

Oral language phonological awareness abilities, or the ability to segment oral words into their individual sounds, is an area that may play an important role in reading development for young hearing readers. However, a meta-analysis performed in this area did not yield a large effect size (Mayberry, del Giudice, and Lieberman 2011). Signed languages, such as ASL, also have their own manual, phonological structure consisting of the hand shape (H), hand movement (M), and hand location (L, in relation to the face or body), which allows signs to be segmented (McQuarrie and Parrila 2014). Sign language phonological units combined with rule-ordered, grammatical structures produce a visual-manual language that can express anything that can be expressed in a spoken language. Within spoken language, one phoneme can be changed to create a new meaning (e.g., pat to hat). In ASL the same phenomenon can occur by changing one parameter of a sign (e.g., changing the location of the hand from the chin [MOM] to the side of the head in the forward temple region [DAD] while retaining the exact same hand shape). ASL phonological processing skills, ASL syntactic comprehension, narrative comprehension, and vocabulary all have been found to be related to Deaf students' ability to learn to read and write English (McQuarrie and Abbott 2013). Developing a strong foundation in a first, oral language typically supports the development of oral and literacy skills in a second language; thus, perhaps learning ASL as a first language will also support more effective learning of English literacy skills even though it is cross-modal language support (Freel et al. 2011; Chamberlain and Mayberry 2008; Hermans et al. 2008; McQuarrie and Abbott 2013). However, stronger ASL skills in

general do not necessarily guarantee that a child who is Deaf or deaf will become an age-appropriate English reader (Chamberlain and Mayberry 2008). Being cross-modal, the child who is Deaf still has to learn the English alphabet and how to make that transfer from ASL to English in terms of vocabulary, syntax, and spelling.

Age of ASL Acquisition: Effect on English Reading Abilities

Approximately 90 to 94 percent of deaf/Deaf children are born to two hearing parents who do not know ASL, as most genetically induced hearing loss is transmitted recessively (Goldin-Meadow and Mayberry 2001). This often results in a delay in early sign language exposure for the child with hearing parents who do not sign during the critical language-learning period, e.g., birth to 3 to 5 years (Mounty et al. 2013). The advent of cochlear implantation has strengthened the initial use of the oral-auditory or auditory-verbal approaches for the majority of hearing parents who have deaf children; however, Deaf parents who are fluent in ASL are typically the opposite, and their children are exposed to ASL from birth. Most Deaf parents also choose the bilingual-bicultural educational approach for their children as they enter preschool and school (Lederberg et al. 2013). If critical learning periods for ASL exposure within the toddler and preschool years are missed, and sign language is introduced later, it will potentially have an impact on the child's overall ASL foundational skills and subsequently their English reading abilities (McQuarrie and Abbott 2013). As with hearing bilingual individuals, Deaf children using ASL appear to learn and understand words in English within the context of their preexisting language and conceptual system. The stronger the first language, the greater the potential the individual has for learning a second language; although, in this case it is a cross-modal language transfer from sign language to a different, written language (Hermans et al. 2008). Hall, Ferreira, and Mayberry (2012) obtained results consistent with those of Hermans et al. (2008), finding that non-native or ASL Later-Learners (ASL-LL) attempted to use oral phonological similarities to choose ASL target words that were semantically similar and not phonologically related, while ASL Early-Learners (ASL-EL) were able to focus much more on ASL phonological similarities (hand shape, hand movement, and hand location) to select correct target

words. ASL-EL children have also been found to be able to distinguish between phonological similarities in signs to a larger extent than ASL-LL children (Mayberry and Witcher 2005). Early meaningful communication during the critical language-learning period is just as important for Deaf children learning ASL as it is for hearing children learning English.

ASL-EL children are exposed to ASL from birth, so parents are able to communicate effectively with their children from the earliest days of the critical learning periods for language, and these children typically acquire a strong foundation in ASL (Hermans et al. 2008; Hrastinski and Wilbur 2016; Mounty et al. 2013; Mounty et al. (2013) studied 251 deaf children, with 59 having two Deaf parents, 65 having two hearing parents who signed, and 35 having two hearing parents who did not sign. Children who received early exposure to sign language from either Deaf or hearing parents who signed had higher overall English literacy skills than children who had later exposure to ASL (Mounty et al. 2013). Supporters of the bilingual-bicultural approach claim that if a first language is well established, even a signed language (e.g., ASL), then children who are Deaf and use ASL as their primary language can develop English literacy without using English in its primary, oral form, which contradicts a long-held view that ASL will hinder English literacy development (Hrastinski and Wilbur 2016; Mounty et al. 2013). It is assumed that most hearing parents do not typically introduce sign language soon after receiving the diagnosis of deafness or severe-to-profound hearing loss for their child. This is not surprising, given that ASL is not their primary language. Furthermore, with the advent and increased use of cochlear implant devices, there is an increased expectation among hearing parents that their child has the potential to be an oral speaker. Thus, the central issue here is not the hearing status of parents per se, but the age of exposure to ASL and the ability of having a strong foundation in ASL skills to assist in the learning of how to read in the English language.

Studies have examined ASL age of acquisition and its relationship to development of ASL phonological, syntactical, and narrative structures. The findings suggest that Deaf children of Deaf parents have an advantage in the development of both ASL phonological and English literacy, based on early and consistent exposure to ASL as a first

language (Chamberlain and Mayberry 2008; McQuarrie and Abbott 2013). Lieberman, Borovsky, Hatrak, and Mayberry (2014) divided deaf participants into two groups based on age of exposure to sign language: (1) an early ASL exposure group (exposed to sign language from birth to five years), and (2) a later ASL exposure group (exposed to sign language after the age of five years). A difference was found between the groups, with the later ASL exposure group exhibiting a greater number of ASL phonological errors. Phonological features in ASL, as in English, appear very early in development, which supports that early exposure to ASL for Deaf/deaf children typically results in stronger ASL phonological skills that can then be used in learning a second language. A delay in ASL exposure and development has been found to have a negative impact on syntactical development in both ASL and English, thus confirming that delayed acquisition of a first language will typically result in delayed second language acquisition (Boudreault and Mayberry 2006). Mayberry (2006) and Mayberry and Lock (2003) also concluded that ASL-EL children tended to show near-native levels in second language proficiency, including a spoken language in written form. McQuarrie and Abbott (2013) studied the impact of ASL phonological awareness skills (hand shape [H], hand movement [M], and hand location [L]) on English reading skills for 50 students between the ages of seven and eighteen, all attending dual-language (ASL-English) classes. They found a significant positive correlation between ASL phonological awareness and English word reading and reading comprehension skills. Dammeyer (2014) assessed 117 deaf students who attended an ASL/bilingual school and found that 68 percent of the students with higher ASL proficiency demonstrated literacy skills no more than one academic year behind that of typical, normal hearing children (Dammeyer 2014).

Goldin-Meadow and Mayberry (2001) stated that learning how to read requires two related, but separate, capabilities: (1) a familiarity with a language, and (2) understanding the mapping between that language and the printed word. Additionally, Goldin-Meadow and Mayberry stated that the child who is Deaf/deaf is at a disadvantage on both counts unless they have a strong foundation in one language so that they can map that language to the printed, English word and its grammar. Goldin-Meadow and Mayberry then conclude that ASL

does not hinder deaf children from learning how to read English; on the contrary, they report that stronger ASL skills appear to facilitate significantly higher English literacy skills. Their findings are consistent with the other aforementioned studies.

While relatively small in number, the studies in this area offer some support for the idea that early ASL exposure resulting in a strong foundation in that language appears to be related to higher English reading comprehension skills. The purpose of this study was to determine if ASL phonological awareness skills, as assessed by the ASL Phonological Awareness (ASL-PAT) PC-based test would be significantly related to early reading skills as measured via the Test of Early Reading Development for the Deaf and Hard of Hearing (TERA-DHH) and to a host of reading-related and reading abilities assessed by the Measures of Academic Progress (MAP).

Research Questions

1. Are there positive correlations: (A) between ASL phonological awareness skills (as measured by the ASL PAT) and the MAP Reading Fluency subtests, and (B) between the ASL PAT and English reading skills as measured by the Test of Early Reading Ability–Deaf or Hard of Hearing (TERA-DHH)?
2. Is there a difference between early ASL exposure and later ASL exposure in terms of ASL phonological awareness skills, and does this correlate with higher scores on tests of reading abilities?

Methods and Procedures

Participants

The Loma Linda University Institutional Review Board (IRB) approved all aspects of this investigation. Participants consisted of thirty-nine children who are Deaf, ranging in age from 4.7 to 13.7 (M = 8.25 years, SD = 2.49 years) with seventeen males and eleven females in the ASL-EL group and seven female and four male participants in the ASL-LL group. In addition, fifteen additional potential participants were excluded due to being too young for the ASL-PAT and TERA-DHH test norms, or having had an extensive period of oral language exposure and usage (and hearing aid or cochlear implant use) as compared to the average student at this state Bilingual-Bicultural

school. Of the 39 participants included in this study, all attended a state school for the Deaf using ASL as the primary instructional language, and all were being taught the reading and writing of English as a second language. Twenty-seven participants had two deaf parents and there was one set of parents where the father was Deaf and the mother self-reported as HOH, although their child was first exposed to ASL (thus, an ASL-EL). Ten participants had two hearing parents and one participant had two HOH parents (this single participant was exposed to both Spanish and English as a first-language). No participants had one deaf parent and one hearing parent. The participants' parents completed a demographic questionnaire that included information regarding:

- the parent's self-reported overall hearing level category (Deaf, hard of hearing),
- what grade level the parent believed their child's English reading level to be,
- when their child was first diagnosed as Deaf/deaf (age/year),
- the child's degree/type of hearing loss,
- the age the child was first exposed to ASL,
- the child's exposure to any other languages during childhood, and
- if the parents themselves wore hearing aids or cochlear implant(s).

Participants and parents were categorized as "Deaf" if they reported a bilateral, profound sensorineural hearing loss. The school staff audiologist on campus provided the overall degree of hearing loss classification of the student participants. All student participants were classified as being either deaf or severe-to-profound in terms of degree of sensorineural hearing loss in both ears, according to school audiometric records.

Materials

Test of Nonverbal Intelligence (TONI, 4th edition).

File reviews were conducted on all participants, and those who had not participated in a nonverbal IQ test within the past year were given the Test of Nonverbal Intelligence (TONI) Screening Tool, 4th edition (Brown et al. 2010).

This test was administered to each potential participant to determine that nonverbal IQ was within + or - 1 standard deviation of the test mean (Standard scores; $M = 100$; $SD = 15$) prior to admitting them as a participant in the study. In this way nonverbal IQ was controlled for by being identified as age-appropriate, thereby excluding all children as participants who tested outside the ± 1 standard deviation range so as to not have lower cognitive abilities affecting overall reading proficiency or ASL phonological awareness skills. This test was normed using an age range of 6:0–8:11and typically takes 15–20 minutes to administer. Standardized instructions were given in ASL, and the TONI requires participants to point, nod, or blink in order to respond. The TONI is considered a reliable and valid measure of a nonverbal intelligence quotient (Brown et al. 2010). Nonverbal IQ scores previously obtained within one year of the study date were accepted as a valid determination that participants met IQ inclusion criteria. Reading skills were measured using two tests, the Test of Early Reading Ability–Deaf or Hard of Hearing (TERA-DHH) and the reading comprehension subtest of the MAP.

The Test of Early Reading Ability–Deaf or Hard of Hearing (TERA-DHH)

The Test of Early Reading Ability-Deaf or Hard of Hearing (TERA-DHH) is a norm-referenced test that provides standard scores and percentile ranks for children with hearing loss ages 3:0 to 13:11 (Reid et al. 1991). It is designed for children with moderate to profound hearing loss and provides standard scores, percentile rankings, and normal growth curve equivalents. The TERA-DHH is the only individually administered test of reading designed for children with moderate to profound sensorineural hearing loss (i.e., ranging from 41 to beyond 91 decibels, corrected). The TERA-D/HH is also the only individually administered reading test designed for children younger than age eight who are deaf or hard of hearing. The TERA-DHH assesses a child's ability to attribute meaning to printed symbols in the following areas: relational vocabulary (selecting two words that are "related" to a stimulus word), knowledge of the alphabet and alphabet functions, and knowledge of print conventions. Each question is asked in ASL and has a corresponding visual prompt. The child is expected

to either point to the response or sign the response depending on the prompt given. The TERA-D/HH was standardized on a national sample of more than 1,000 deaf or hard of hearing students from twenty states. Normative data are given for every six-month interval from 3:0 through 13:11.

The Measures of Academic Progress (MAP)

The MAP is a comprehensive assessment that has assessed and been normed on more than 8 million students. This program is a state-aligned, computerized, adaptive assessment program that assesses not only the grade level at which a student is performing for math and reading skills, but also measures academic growth over time (month to month and year to year). Being an adaptive test, it efficiently measures oral reading fluency, reading comprehension, and foundational reading skills. Participant scores on the MAP reading comprehension subtest used in this study were accessed via school records upon receipt of IRB-approved written parental and school consents. The MAP reading comprehension subtest assesses reading phonological awareness (rhyming, blending, identifying number of syllables in words), reading phonemic awareness (phoneme identification), reading phonemic awareness (manipulation of sounds), reading letter identification, reading phonics (matching letters to sounds), reading syllable types (digraphs and diphthongs), reading syllable types (CVC-CVCe-E-Controlled), and three decoding tasks involving consonant blends with diagraphs, multisyllabic words, and word pattern families. The MAP reading assessment is computer-based and adaptive in nature and measures the precise performance level of the student regardless of the student's ability or grade level (*Measures of Academic Progress Comprehensive Guide*, Northwest Evaluation Association, 2013). The MAP assessment is also designed to identify the student's areas of strength and what they are ready to learn next in areas related to reading abilities, and it provides a consistent longitudinal measure of student growth. For each of the MAP reading comprehension subtests, a Rasch unit (RIT) score is generated that represents the level of test item difficulty at which the student is capable of answering correctly 50 percent of the time (*MAP Comprehensive Guide*, NWEA, 2013).

ASL Phonological Awareness Test (ASL-PAT)

The ASL-PAT instrument used in this study was developed and is being normed as a standardized ASL phonological awareness assessment tool for use with young Deaf children ages four through thirteen (McQuarrie 2013. It is a computer-based test designed to assess knowledge of the phonological properties of sign formation (i.e., handshape [H], hand location [L], and movement [M]). The ASL-PAT measures the child's ability to identify phonological similarity relations in signs under three comparison conditions: (1) signs with three shared parameters (H + M + L); (2) signs with two shared parameters (H + M; L + M; and H + L); and (3) signs that share a single parameter (H, M, or L). The test begins with a vocabulary check in the form of a picture dictionary presented on a 5 by 5 grid picture display. Children are required to sign (name) each picture. If a child is uncertain or unable to generate a sign for a picture item, a video prompt of the sign is available by clicking on the picture. Prompted items are subsequently added to the end of the picture display and retested without the video prompt prior to beginning the test. It is essential that children know the vocabulary associated with the test pictures prior to taking the test. For this testing, a deaf native adult signer presented video instructions in ASL, followed by Part 1 (four practice trials and twelve test items) and then a Part 2 segment (three practice trials and twelve test items). Feedback is provided on the practice items; however, no feedback is provided on test items. Each practice and test item consists of a signed cue (video) with three picture items below representing the target/phonological match and two distracter items. Test-takers are required to select the picture that matches the cue along the phonological parameter(s) tested.

For scoring, the online database records accuracy (correct match -1; incorrect match - 0) and error response choice for each test item used. Overall test performance is determined by the number of correct responses out of 24. All tests were administered by a group of fluent ASL assessors (three Deaf, three hearing), children were instructed and tested individually, and the participants were tested in two or three sessions that lasted between twenty and forty minutes each.

Table 1. Descriptive Statistics for the ASL-PA Total Correct, TERA Percentile, and MAP Reading Fluency Measures

		N	Mean	S.D.	Range
ASL-PAT	ASL Early-Learners	25	19.26	2.27	23–15 = 8
	ASL Later-Learners	9	16.22	2.24	22–10 = 12
	Total	34			
TERA PC	ASL Early-Learners	28	52.85	22.05	91–15 = 76
	ASL Later-Learners	9	41.11	11.90	71–23 = 48
	Total	37			
MAP Reading	ASL Early-Learners	19	180.94	14.79	214–155 = 59
	ASL Later-Learners	4	167.25	7.87	183–156 = 27
	Total	23			

Results

See table 1 for the descriptive statistics of the participants' ASL PAT total score, TERA-DHH percentile, and MAP Reading Fluency score. The primary purpose of this study was to further explore previous findings that ASL phonological awareness skills are significantly related to English reading abilities as assessed by the TERA-DHH and the reading comprehension subtests of the MAP. Both of these reading assessments have been used to assess deaf and Deaf students. The MAP assessment is unique in that, in addition to determining where a child is academically compared to their peers, it provides a growth estimate so that one can observe how much growth or improvement a child accomplishes in a single school year. The ASL phonological awareness measure used in this study was developed and is being normed for use as a standardized assessment instrument of ASL phonological awareness in young children ages four through thirteen (McQuarrie and Abbott 2013). Reading abilities were assessed using the TERA-DHH and MAP Reading Assessment reading comprehension subtests, and data analyses included comparing these results with age of acquisition of ASL and ASL phonological awareness abilities.

The first question posed in this investigation examined the relationships between participant performance on the ASL-PAT, TERA-DHH, and MAP Reading assessments as well as the relationship between test performance and hearing status of the parents (Deaf,

Table 2. Pearson Correlation Table for ASL Early-Language Learners Comparing Results from the ASL PAT, TERA Percentile and Quotient, and MAP Composite Scores

		MAP Reading	TERA PC	TERA Qt	ASL PAT24
MAP Reading	Pearson Correlation	1	.74**	.71**	.75**
	Sig. (2-tailed)	.000	.000	.000	.000
	N	24	39	39	35
TERA PC	Pearson Correlation	.74**	1	.98**	.35*
	Sig. (2-tailed)	.000	.000		0.34
	N	24	39	39	35
TERA Qt	Pearson Correlation	.71**	.74**	1	.34*
	Sig. (2-tailed)	.000	.000		.043
	N	24	39	39	35
ASL PAT 24	Pearson Correlation	.75**	.35*	.34*	1
	Sig. (2-tailed)	.000	.000	.000	.000
	N	24	39	39	35

*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

hard of hearing, normal hearing) and age of first exposure to ASL (Early Exposure, Later Exposure). Pearson correlation coefficients were performed for all Deaf and deaf subjects, regardless of language first learned. The results are displayed in table 2. A strong positive correlation was found between the ASL-PAT and the MAP Reading Assessment ($r = 0.75$, $p < 0.01$ level, 2-tailed, $n = 24$), and a mildly significant positive correlation was found between the ASL-PAT and the TERA-DHH percentile scores ($r = 0.37$, $p < 0.05$ level, 2-tailed, $n = 39$) and the TERA Quotient scores ($r = 0.37$, $p < 0.05$, 2-tailed, $n = 39$). It is an interesting finding that even without controlling for language first learned (ASL or English), a strong relationship appears to exist between the ASL-PAT and the MAP Reading Assessment, suggesting that stronger ASL phonological awareness skills can predict higher MAP reading scores.

Figure 1 displays a correlation scatterplot showing the strong, positive relationship between the MAP reading assessment subtest and the TERA-DHH percentile scores ($r = 0.75$, $p < 0.01$, 2-tailed) for the participants in the ASL-EL group, indicating that individuals with stronger ASL phonological awareness skills tended to perform at a similar performance level on the two reading measures that assess

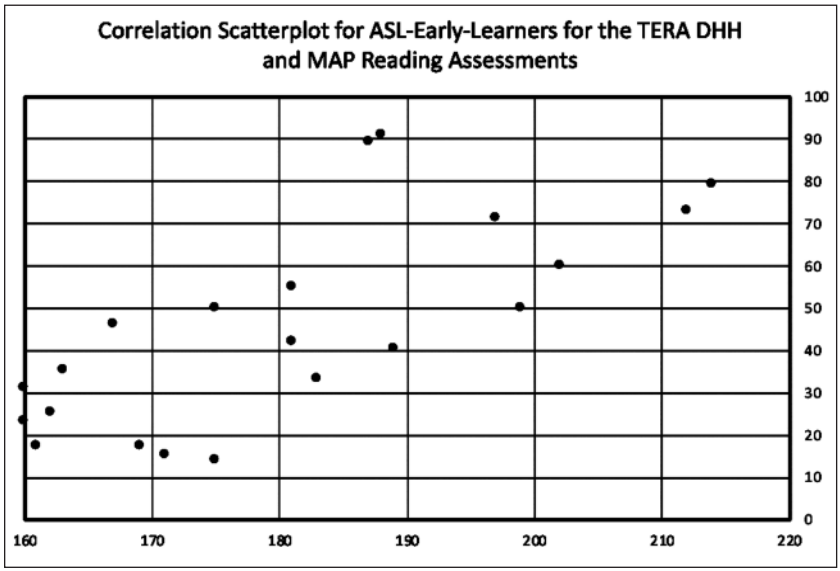

FIGURE 1. Correlation Scatterplot displaying the relationship between the TERA-DHH and MAP reading assessments for the participants who were early or native ASL language speakers.

different aspects of reading skills. A relationship exists in that higher MAP Reading scores predict higher scores on the TERA-DHH for the ASL-EL subjects. Correlations were then repeated by looking at the relationships between ASL phonological awareness and reading skill proficiencies for only the nineteen ASL first language subjects. These are shown in table 3. For the ASL-EL users, a strong significant correlation coefficient was obtained ($r = 0.86$, $p < 0.01$ level, 2-tailed) between the ASL-PAT test results and the MAP reading comprehension assessment, and it was a slightly stronger relationship than existed between these two measures when examining both subject groups. The correlations between the ASL-PAT and the TERA percentile score ($r = 0.41$, $p < 0.05$ level, 2-tailed) and quotient score ($r = 0.40$, $p < 0.05$ level, 2-tailed) were mildly significant, consistent with the results found for all subjects (ASL-EL and ASL-LL groups). None of the Pearson correlation coefficients performed for the ASL-LL subjects were significant in comparing ASL phonological awareness performance with the two reading skills assessments (table 4). However,

Table 3. Pearson Correlation Table for ASL Later-Language Learners (English as First Language) Comparing the Results from the ASL PAT, TERA Percentile and Quotient, and MAP Composite Scores

		MAP Reading	TERA PC	TERA Qt	ASL PAT24
MAP Reading	Pearson Correlation	1	.62	.60	.13
	Sig. (2-tailed)		.37	.39	.86
	N	4	4	4	4
TERA PC	Pearson Correlation	.62	1	1**	.10
	Sig. (2-tailed)	.37		.000	0.78
	N	4	9	9	9
TERA Qt	Pearson Correlation	.60	.1**	1	.10*
	Sig. (2-tailed)	.39	.000		.78
	N	4	9	9	9
ASL PAT 24	Pearson Correlation	.13	.10	.10	1

**Correlation is significant at the 0.01 level (2-tailed)

Table 4. Mann-Whitney Test Results for ASL Early-Learner and ASL Later-Learner Groups for the ASL PAT24, TERA DHH, and MAP Assessments

		N	Mean Rank	Sum of Ranks
MAP Reading	ASL Early-Learners	19	12.84	244.00
	ASL Later-Learners	4		
	Total	23		
TERA PC	ASL Early-Learners	28	20.18	565.00
	ASL Later-Learners	9	15.56	138.00
	Total	37		
TERA Qt	ASL Early-Learners	28	20.11	563.00
	ASL Later-Learners	9	15.56	140.00
	Total	37		
ASL PAT 24	ASL Early-Learners	25	19.04	476.00
	ASL Later-Learners	9	13.22	119.00

Test Statistics	MAP Reading	TERA PC	TERA QT	ASL PAT24
Mann-Whitney U	22.00	93.00	95.00	74.00
Wilcoxon W	32.00	138.00	140.00	119.00
Z	–1.299	–1.170	–1.099	–1.515
Asymp. Sig. (2-tailed)	.194	.242	.272	.130
Exact Sig. [2*(1-tailed Sig.)]	.218[a]	.255[a]	.286[a]	.140

Note: Grouping Variable: First language (ASL Early Learners versus ASL Later Learners)
a. Not corrected for ties

only four ASL-LL subjects were used in calculating these correlations between the MAP reading comprehension assessment and the ASL-PAT. For the correlations obtained between the ASL-PAT and the TERA-DHH percentile and quotient scores, only nine ASL-LL subjects were used in these analyses.

Given the correlation coefficient results, and given the fact that the number of ASL-LL subjects ranged from four to eleven as compared to nineteen to twenty-eight subjects in the ASL-EL group, a Mann-Whitney U nonparametric test was performed to assess group mean differences on test performance for the ASL-PAT, MAP reading comprehension subtest, and the TERA-DHH. No significant mean rank differences were observed when comparing the ASL-EL group to the ASL-LL group on performance for these assessments. However, a trend in the data was noted in that the ASL-EL group mean ranks were consistently greater than the mean ranks for the ASL-LL group mean ranks. These findings could be due, in part, to the uneven number of subjects in the two groups and the low number of ASL-LL subjects. A Levene's Test for Equality of Variances was also performed and indicated unequal variances between the ASL-EL and ASL-LL groups on TERA-DHH test performance ($p < 0.016$); however, here too the unequal number of subjects in the two groups makes it difficult to draw firm conclusions from the analysis.

Discussion and Conclusions

The purposes of this study were to examine the relationship between ASL phonological awareness skills and specific English literacy skills in Deaf children whose first language was either ASL (ASL-EL) or spoken English (ASL-LL), and whether there was a difference between the ASL-EL and ASL-LL groups in terms of the relationship between ASL and English literacy skills. Scores on the ASL-PAT, TERA-DHH, and the MAP reading comprehension assessments were examined to determine if significant correlations existed between these measures. The results of this study overall were consistent with prior investigations that have established a relationship between strong foundational skills in ASL and English literacy skills (Chamberlain and Mayberry 2008; Freel et al. 2011; McQuarrie and Abbott 2013; Hrastinski and Wilbur 2016). The participants in this study who were ASL-EL tended to have higher ASL phonological awareness (ASL-PA) and English

reading skill scores as compared to the ASL-LL participants. For the ASL-EL group, phonological awareness skills were highly correlated with their test scores on the MAP reading comprehension subtests and the TERA-DHH. These findings are consistent with the findings of McQuarrie and Abbott (2013), who found significant relationships between ASL-PA skills and English reading and reading vocabulary skills for early ASL learners.

Hermans et al. (2008) investigated the relationship between the reading and signing skills of eighty-seven Deaf children enrolled in bilingual education programs, and they found strong, positive correlations between the scores obtained in a signed vocabulary assessment and an English reading vocabulary test with age and nonverbal IQ scores controlled. Their findings are consistent with the results of our investigation. Chamberlain and Mayberry (2008) found that skilled Deaf readers demonstrated higher levels of ASL syntactic and narrative comprehension abilities as compared to less-skilled Deaf readers. Hrastinski and Wilbur (2016) found that Deaf students highly proficient in ASL "outperformed" their less ASL-skilled Deaf peers on nationally standardized assessments of English language use, English comprehension, and mathematics. Hrastinski and Wilbur concluded that ASL proficiency was the single variable that significantly predicted results for all outcome measures.

The common thread across all of these studies is that a strong foundation in ASL, as with a strong foundation in any first language, can lead to stronger English reading abilities. A large body of research has shown the effectiveness of using a well-developed first language to support and facilitate the learning of a second language (Hakuta 1990). The findings of McQuarrie and Abbott (2013), Freel et al. (2011), and Chamberlain and Mayberry (2008) provide evidence that this principle holds true even when it is a cross-modal arrangement (ASL being a visual language) serving as a foundation or bridge for Deaf children to learn how to read and write in the English language (oral language). Hrastinski and Wilbur (2016) state that perhaps these findings call for a paradigm shift in our thinking about deaf education by focusing on characteristics shared among successful deaf signing readers—specifically, ASL fluency—in the hopes we can develop more effective methods of teaching English literacy to children who are both ASL-Early Learners and ASL-Later Learners.

Limitations and Conclusions

A major limitation of the present study is that we were only able to recruit eleven subjects total in the ASL-LL group as compared to twenty-eight subjects in the ASL-EL group. For ASL phonological awareness comparisons to MAP reading comprehension results in the ASL-LL group, we also only had available MAP data on four of the eleven participants. The lack of a significant correlation coefficient between ASL PAT, TERA-DHH, and MAP reading scores for the ASL-LL participants was affected by the low number of subjects in this group. Both an Independent Samples T test for Equality of Means and a Mann-Whitney nonparametric test were performed to assess differences, and no significant differences were found between the means of the ASL-EL and ASL-LL participants. Overall, however, the ASL-EL subjects outperformed the ASL-LL subjects on all measures and, again, the four to eleven ASL-LL subjects used in the analyses limited the generalization of results. The highest correlation coefficient obtained for the ASL-EL group was between the ASL PAT and MAP reading comprehension scores, with the correlation between the ASL PAT and the TERA-DHH scores being mildly significant for the ASL-EL group. However, it is important to note that the MAP and TERA-DHH reading skills performances were highly significantly correlated with each other and that the MAP reading comprehension subtests assess a wider range of different reading abilities as compared to the TERA-DHH. ASL-EL participants tended to have higher ASL phonological awareness scores and higher scores on both the MAP and TERA-DHH assessments. Further research with larger sample sizes for both groups is needed to further investigate the nature of the relationships between strong foundational ASL skills and the development of English reading skills.

Further research to determine the ASL phonological awareness abilities of ASL-LL children, and whether these abilities can be improved upon and strengthened to facilitate better English literacy skills, would be of immense practical use. There is also a scarcity of formal, standardized measurement tools to assess ASL skills, and children who are DOD are just as prone to specific language impairment or language delay as are hearing children. The ASL PAT continues to be developed and standardized by Dr. Lynn McQuarrie and colleagues at

the University of Alberta and will offer important diagnostic value in the evaluation of ASL skill level. The ASL PAT results of Deaf students appear to be moderately related to MAP reading comprehension skills. However, what specific ASL skills are used, and how are they used to apply sign language knowledge to the reading and writing of English?

Another limitation involved the mean age of the participants in this study (M = 8 years; 5 months). Therefore, the children who had attended the state school for the deaf since kindergarten could have been immersed in ASL for a minimum of three years or more, depending on their home language. It would be useful for further research in this area to obtain larger groups of kindergarten and older deaf children who are ASL-EL and more ASL proficient than those who are ASL-LL, to study how each group of children applies specific ASL skills to learning English. A growing number of studies have provided reasonable evidence that native ASL users or those who are ASL-EL tend to have higher abilities in written English comprehension (Chamberlain and Mayberry 2008; Freel et al. 2011; McQuarrie and Abbott 2013). The results of this study are consistent with prior studies in that children with stronger foundational skills in ASL (ASL-EL group) tended to achieve higher scores on the MAP reading comprehension subtests and the TERA-DHH. Future research would benefit from not only larger numbers of subjects, but also from longitudinal studies that follow children from the preschool years through late elementary school years to identify how Deaf children using ASL as their primary language map these skills onto written English. Such research could lead to new and improved methods to teach ASL in a manner that would facilitate using it maximally as a bridge from Deaf children's sign language to the competent acquisition of written English. Further research is also needed to develop additional ASL standardized assessments to better identify those children who use ASL who may have a language delay or disorder. In conclusion, the longstanding assumption that the nature of ASL is what limits Deaf children from becoming competent readers and writers of English has been challenged by several studies (Chamberlain and Mayberry 2008; Freel et al. 2011; Hermans et al. 2008; McQuarrie and Abbott 2013). Strong ASL skills appear to lead to better English reading comprehension skills, and it is important that this line of research continue so that we can further develop and enhance the effectiveness of

bilingual-bicultural educational programs for the Deaf, and potentially also benefit oral-deaf children learning to read English.

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References

Allen, B. M. (2002). ASL-English Bilingual Classroom: The Family's Perspective. *Bilingual Research Journal* 26(1): 149–68.

Brown, L., R. J. Sherbenou, and S. K. Johnsen. 2010. *Test of Nonverbal Intelligence*, 4th ed. Austin, TX: PRO-ED.

Boudreault, P., and R. I. Mayberry. 2006. Grammatical Processing in American Sign Language: Age of First-Language Acquisition Effects in Relation to Syntactic Structure. *Language and Cognitive Processes* 21 (5): 608–35.

Chamberlain, C., and R. I. Mayberry. 2008. American Sign Language Syntactic and Narrative Comprehension in Skilled and Less Skilled Readers: Bilingual and Bimodal Evidence for the Linguistic Basis of Reading. *Applied Psycholinguistics* 29: 367–88.

Dammeyer, J. 2014. Literacy Skills among Deaf and Hard of Hearing Students and Students with Cochlear Implants in Bilingual/Bicultural Education. *Deafness & Education International* 16(2): 108–19.

Freel, B. L., M. D. Clark, M. L. Anderson, G. L. Gilbert, M. M. Musyoka, and P. C. Hauser. 2011. Deaf Individual's Bilingual Abilities: American Sign Language Proficiency, Reading Skills, and Family Characteristics. *Psychology* 2:18–23.

Goldin-Meadow, S., and R. I. Mayberry. 2001. How Do Profoundly Deaf Children Learn to Read? *Learning Disabilities Research & Practice* 16(4): 222–29.

Hall, M. L., V. S. Ferreira, and R. I. Mayberry. 2012. Phonological Similarity Judgments in ASL. *Sign Language & Linguistics* 15(1): 104–27.

Hermans, D., H. Knoors, E. Ormel, and L. Verhoeven. 2008. The Relationship between the Reading and Signing Skills of Deaf Children in Bilingual Education Programs. *Journal of Deaf Studies and Deaf Education* 13(4): 518–30.

Hrastinski, I., and R. B. Wilbur. 2016. Academic Achievement of Deaf and Hard-of-Hearing Students in an ASL/English Bilingual Program. *Journal of Deaf Studies and Deaf Education* 21: 156–70.

Lederberg, A. R., B. Schick, and P. E. Spencer. 2013. Language and Literacy Development of Deaf and Hard-of-Hearing Children: Successes and Challenges. *Developmental Psychology* 49(1): 15–30.

Lieberman, A. M., M. Hatrak, & R. I. Mayberry, R. I. 2014. Learning to Look for Language: Development of Joint Attention in Young Deaf Children. *Language Learning and Development* 10(1). doi:10.1080/15475441.2012.760381

———. 2006. Learning Sign Language as a Second Language. In *Encyclopedia of Language and Linguistics*, 2nd ed., vol. 6, ed. K. Brown, pp 743–46. Amsterdam: Elsevier.

Mayberry, R. I., and E. Lock. 2003. Age Constraints on First versus Second Language Acquisition: Evidence for Linguistic Plasticity and Epigenesis. *Brain and Language* 87: 369–84.

Mayberry, R. I., and P. Witcher. 2005. What Age of Acquisition Effects Reveal about ASL Foundational Skills as Assessed by the ASL PAT? Nature of Phonological Processing. *CRL Technical Reports* 17(3): 1–9.

McQuarrie, L., and M. Abbott. 2013. Bilingual Deaf Students' Phonological Awareness in ASL and Reading Skills in English. *Sign Language Studies* 14(1): 80–100.

McQuarrie, L., and R. Parrila. 2014. Literacy and Linguistic Development in Bilingual Deaf Children: Implications of the 'And' for Phonological Processing. *American Annals of the Deaf* 159(4): 372–84.

Mounty, J. L., C. T. Pucci, and K. C. Harmon. 2013. How Deaf American Sign Language/English Bilingual Children Become Proficient Readers: An Emic Perspective. *Journal of Deaf Studies and Deaf Education* 19(3): 333–46.

Northwest Evaluation Association. 2013. *Measures of Academic Progress (MAP): Reading Assessment Subtest*.

Reid, D., W. Hresko, D. Hammill, and S. Wiltshire. 1991. *Test of Early Reading Ability: Deaf or Hard of Hearing*. Austin, TX: PRO-ED.

Stokoe, W. C., D. Casterline, and C. Croneberg. 1965. *A Dictionary of American Sign Language on Linguistic Principles.* Washington, DC: Gallaudet College Press.

Traxler, C.B. 2000. The Standford Achievement Test, 9th Edition: National Norming and Performance Standards for Deaf and Hard-of-Hearing Students. *Journal of Deaf Studies and Deaf Education* 5(4): 337–48.