A Study of the Relationship Between American Sign Language and English Literacy

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This article presents the findings of a study of the relationship between American Sign Language (ASL) skills and English literacy among 160 deaf children. Using a specially designed test of ASL to determine three levels of ASL ability, we found that deaf children who attained the higher two levels significantly outperformed children in the lowest ASL ability level in English literacy, regardless of age and IQ. Furthermore, although deaf children with deaf mothers outperformed deaf children of hearing mothers in both ASL and English literacy, when ASL level was held constant, there was no difference between these two groups, except in the lowest level of ASL ability. The implication of this research is straightforward and powerful: Deaf children's learning of English appears to benefit from the acquisition of even a moderate fluency in ASL.

The acquisition of spoken and written language continues to be a major obstacle to academic achievement and vocational success for deaf individuals throughout the world. Reading and writing levels remain at low levels despite advanced multimedia and computer technology, new methods of detecting hearing loss at an early age, and ever more sophisticated means of amplification (Nelson, Loncke, & Camarata, 1993; Paul & Quigley, 1994). Surveys conducted at the Gallaudet Center for Assessment and Demographic Studies, for example, indicate that approximately half the deaf students in the United States were reading below the fourth-grade level at the time of their graduation from high school (Allen, 1994).

In the United States it is well documented that academic achievement in general is closely connected to English language skills. Deaf students acquire English at a slower pace than hearing students, although along a similar path. According to Paul and Jackson (1993), this slower learning pace results in low achievement levels and restricted annual gains, leading to deaf students averaging six to seven years behind their hearing counterparts by the time they leave high school. Reading levels tend to plateau at the fourth-grade level, and only 7% of deaf high school graduates read at seventh-grade level or above.

The relationship between deafness and low English literacy skills[1] is complex and appears to be related to a variety of factors including academic achievement, language competence, cognitive abilities, and family background. For years, researchers focused on aspects of cognitive ability to explain performance differences between deaf and hearing people. This research may be characterized by three distinct historical phases. In the early part of the century, Pintner et al. claimed that deaf people were intellectually inferior to hearing people and showed specific deficits in various aspects of cognitive functioning (Pintner, Eisenson, &

This study is funded by the U.S. Department of Education, Office of Special Education and Rehabilitation Services, under Field Initiated Grant # 023C30074 and cosponsored by the California School for the Deaf at Fremont. We thank researchers and students who have contributed to this work: Eliot Helman, Missy Keast, Noah Kessler, Lon Kuntze, Daniel Langholtz, Priscilla Poyner Moyers, Nancy Silverman, and Jack Yang. We also thank Nathie Marbury for signing parts of our ASL test and Daniel Veltri for his video magic and, in addition, our consulting linguists who reviewed the first draft of the Test of ASL: Ben Bahan, Lon Kuntze, Ella Lenz, Ted Supalla, and Clayton Valli. Correspondence should be sent to Michael Strong, 927 W. Carmel Valley Rd., Carmel Valley, CA 93924.

Stanton, 1941). However, most of these early investigators used paper and pencil tests as evaluation instruments, often requiring verbal manipulation and verbal responses in English. The second historical phase was most aptly articulated by Myklebust (1960, 1964), who concluded that, when verbal factors in cognitive and intellectual tasks are controlled, there are quantitative similarities but significant qualitative differences between deaf and hearing individuals.

The third and most recent phase embraces the current generally accepted theory first expounded by Furth (1966) and Vernon (1967) that deaf people are intellectually similar to hearing people. Recently, Braden (1994) summarized the research on cognitive performance of deaf people and the link between intelligence and spoken language: "When language demands are minimized, but cognitive demands remain stable, deaf people appear to be somewhat delayed but generally similar to their hearing peers" (1994, p. 8).

Literature regarding the reliability, validity, and predictive power of nonverbal IQ tests suggests that such tests accurately measure the intelligence of deaf people. However, lower scores on verbal IQ (VIQ) scales and an average or above normal score on performance scales (PIQ) could represent a verbal processing defect. Braden (1994) argues that the low VIQ relative to nonverbal or PIQ could result from the deaf child's lack of familiarity with item content (i.e., world knowledge) and because they are unable to use language to solve problems. Therefore, it is difficult to ascertain whether deaf children have deficits in verbal reasoning processes, or simply lack knowledge needed to solve problems. Additionally, Braden points out that motor-free tests consistently yield lower IQ scores than motor-intensive tests.

Another area of research regarding deaf children's academic performance was prevalent in the sixties and focused on the differences between deaf children of deaf parents (DP) and deaf children of hearing parents (HP). Parental hearing status was found to be a good predictor of future linguistic and academic success, with DP children typically outperforming HP children, at least in the early years (Meadow, 1968; Quigley & Frisina, 1961; Stevenson, 1964; Stuckless & Birch, 1966).

A number of hypotheses have been advanced to explain this phenomenon: DP children are better adjusted emotionally because of parental attitudes (e.g., Corson, 1973); the etiology of deafness for HP children includes conditions such as RH factor incompatibility, maternal rubella, head trauma, and perinatal anoxia, which are also causes of cognitive problems (Wolff, Kammerer, Gardner, & Thatcher, 1989); DP children are more likely to grow up learning American Sign Language (ASL) than HP children, and this first language exposure is critical in preparing deaf children for future school learning, particularly in English literacy (Lane, 1990). Braden (1994) attributes the DP advantage specifically to the fact that DP have an internal language base, which facilitates their acquisition, storage, and application of academic knowledge. Until now, however, the posited relationship between ASL knowledge and English literacy remains uncorroborated by empirical research.

In recent years, a movement has developed around the fringes of deaf education to explore the potential for bilingual approaches in the schooling of deaf children. The idea that deaf children should be taught first in ASL and later in both ASL and English is predicated to some degree on the notion that DP children outperform HP children because of ASL ability, as well as on the applicability to deaf children of theories of bilingualism among hearing children. These theories stress the "Common Underlying Proficiency" of languages (Cummins, 1981) and the fact that native language proficiency is a consistent and powerful predictor of second language development (Hakuta, 1990). Skeptics of the approach tend to question that ASL is analogous to other first languages because it has no written form, and they rightly point out that no research suggests that knowledge of ASL benefits the learning of English (e.g., Moores, 1992).

Our study was designed to address this and other fundamental issues raised in the above review by posing a question: Is ASL skill related to English literacy development in deaf children? This question can produce information that bears upon the longstanding issue of why DP children tend to outperform HP children in academic and linguistic performance, as well as yield data of critical interest to parents and educators considering the pros and cons of the bilingual education debate.

Methods

The study described here is the second stage of a research project, whose purpose is to examine the relationship between ASL skills and English literacy among residential school deaf children 8 to 15 years of age at the start of the study. During the first stage, or pilot study, we developed test instruments, refined data collection procedures, planned sampling procedures, and tested a small subsample of subjects (Prinz & Strong, 1995). The findings from the pilot study confirmed that the direction of our planned inquiry was legitimate and that the measurement instruments were both reliable and valid. The purpose of this second stage of the study was to address the following research question: What is the relationship between ASL competence and English literacy among Deaf students, ages 8 to 15 years? Additionally, we were interested in a subsidiary question, one that refers back to previous research: Do deaf children of deaf parents outperform deaf children of hearing parents in ASL skills and English literacy skills?

Subjects. One hundred and sixty deaf students were recruited from the pool of students at the school site with no other handicapping conditions who fell within the age parameters defined by the study. The subjects were divided into two age groups, group 1 including ages 8–11 and group 2 including ages 12 and older at the time of testing. Younger children were not selected since it was necessary for them to be able to read and write our tests, and older children were not included because the study was to run for three years, during which we required the subjects to be enrolled at school. We divided the two groups at the critical developmental age of 11, to coincide roughly with puberty. We further determined whether the students had hearing or deaf parents. In only two cases were the parents or guardians of different hearing status (in both instances the mother was deaf and the father hearing). Therefore, for our analysis, we use the hearing status of the mother for grouping purposes. Five students withdrew from school during the academic year before the records were reviewed, and therefore the data on parental hearing status are missing for these subjects. The distribution of subjects by age and maternal hearing status appears in Table 1.

Table 1 Distribution of subjects according to age group and mother's hearing status

	8–11 years	12–15 years	Total
Deaf mother	14	26	40
Hearing mother	42	73	115
Total	57	103	155

Measurements. There are two sets of language-related tests, one set for ASL and one set for English Literacy. Nonverbal IQ was measured using the Matrix Analogies Test (MAT) (Naglieri, 1985). In addition, parents or guardians completed a questionnaire regarding language use at home, and other background information was collected from school records. These sources provided information on the existence of deaf relatives at home, standardized test scores, date of birth, and details of hearing loss.

ASL tests. Students' ASL skills were assessed using a set of production and comprehension measures we developed (Prinz & Strong, 1994). A draft of the test was sent to five nationally recognized deaf linguists who were hired as consultants to review the test and suggest improvements. The final version incorporates their feedback. ASL production was evaluated with the following tests:

1. *Classifier production test:* Each student watched a five-minute cartoon movie. The movie was then presented again in 10 segments, and the students were required to sign in ASL the actions from each segment in turn. This procedure minimized the effects of memory. Responses were videotaped and then scored for the presence of different size, shape, and movement markers known as classifiers.

2. *Sign narrative:* Students looked at pictures from a children's story book that has no text and then signed the story in ASL. Stories were videotaped and later

scored, using a checklist, for the presence of ASL grammatical and narrative structures.

ASL comprehension was assessed with the following tests:

1. *Story comprehension:* Students watched a videotaped story told in ASL by a deaf native ASL signer. Ten questions about the events in the story were interlaced throughout the videotape. Students signed responses to these questions as they appeared and their responses were videotaped. In this way, memory requirements were reduced to a minimum.

2. *Classifier comprehension test:* Students were shown pictures of objects with a variety of features. They watched a native ASL signer describe each object in five ways. Using an answer sheet that contained printed video freeze frames of each description, students were required to mark the one that provided the best ASL description of the picture.

3. *Time marker test:* Students were shown, on video, six representations of specific times or periods of time. Using an answer sheet containing calendars, the student was required to find the corresponding dates.

4. *Map marker test:* Students were shown, on video, eight descriptions of the way objects are located in a given environment such as vehicles at a crossroads or furniture in a bedroom. For each description, students had to select the correct representation from a selection of photographs in an answer booklet.

English literacy tests. Both comprehension and production were assessed using selected and revised subtests from the Woodcock-Johnson Psychoeducational Test Battery, revised Version (WJ-R), and the Test of Written Language (TOWL).

1. *Comprehension:* Comprehension of English vocabulary, sentences, and paragraphs was tested using the vocabulary subtest of the WJ-R. Stimulus items were presented either by pictures or words, and the student marked the correct response on an answer sheet.

2. *Production:* Productive vocabulary was tested using the synonyms and antonyms subtest of the WJ-R. Stimulus words were presented in writing and the subject was asked to find another word that either means the same or the opposite of the stimulus word.

3. *Syntax:* English syntax skills were assessed using a sentence writing subtest of the TOWL.

4. *Written narrative:* Students were shown pictures from a children's story book that has no text (the same stimulus used in the ASL narrative subtest) and asked to write a story about the pictures.

Procedures. Students were taken to a testing room during the school day for two sessions of one hour each. The ASL tests were conducted during one hour and the English literacy tests and the MAT during the other hour. Testing order was randomized so that some subjects received the ASL tests first and others the English tests first. Instructions were given on videotape in ASL, and the researcher answered further questions in person if necessary. The ASL tests were conducted by deaf researchers fluent in ASL, the English tests by hearing researchers who were also highly proficient in ASL. No hearing persons were present during the ASL testing. All signed responses were videotaped and subsequently scored from the videotape. Subjects were given a small remuneration for their participation.

The ASL tests were scored by deaf researchers and the English test by hearing researchers who were also fluent in ASL. Interrater reliability was established for each subtest that required subjective decisions by having raters score the same set of 10 protocols, reviewing and resolving disagreements, and then scoring a second set of 10 protocols. Eventual agreement was better than 96% in all cases.

Results

Once all tests were scored and background information collected, data were entered into a working file using a commercially available statistical software program (Systat, 1992). In order to address the first research question regarding the relationship between ASL skills and English literacy, we performed the following analysis. In the first step, all subtests of ASL and of English were standardized (i.e., assigned z-scores) and combined to form two composite scores of overall ASL and overall English literacy, with all subtests receiving equal weighting. Secondly, the correlation between total ASL scores and total English literacy scores was calculated for all subjects combined, separately for each of the two age groups, 8–11, and 12–15-year-olds, separately for those with deaf mothers (DM) and hearing mothers (HM), and finally within each age group according to maternal hearing status. The results can be seen in Table 2.

Based on these results, the only subgroup with a nonsignificant correlation coefficient, that of older children with DMs, was excluded from subsequent analysis. The third step was to create three levels of ASL skill by dividing the range of ASL scores into thirds, resulting in low, medium, and high levels of ASL ability, as measured by our test of ASL. Subjects were distributed across the levels as seen in Table 3.

We developed the following research hypotheses to address the relationship of ASL skill and English literacy: H1: Subjects in the high ASL group will outperform students in the low ASL group in English literacy. H2: Subjects in the medium ASL group will outperform subjects in the low ASL group in English literacy. H3: Subjects in the high ASL group will outperform subjects in the medium ASL group in English literacy.

We planned a series of eight analyses of covariance (ANCOVA[2]) to test these hypotheses for the whole sample and the various subgroups, with the composite English literacy score as the dependent variable, the ASL level as the independent variable, and the MAT score (performance IQ) and age (measured in months) as covariates. (See Table 4 for probability values for independent variable covariate interactions.)

The fourth step in the analysis was to run ANCOVAs for each of the selected groupings, together with post hoc Bonferroni pairwise comparisons to test for significance among the three levels of ASL. The ANCOVA results for the sample as a whole are displayed in Table 5. Summary results for all the subgroupings are displayed in Table 6.

As can be seen in Table 5, the F ratio is significant at the .000 level, showing a positive relationship between ASL level and performance on tests of English literacy. For the sample as a whole, H1, H2, and H3 are all accepted. Bonferroni pairwise comparisons among ASL levels were significant for high versus low (p = .000), medium versus low (p = .001), and high versus medium (p = .002).

Table 6 shows the summary results for the subgroups of similar analyses. For students ages 8–11 the F ratio is significant at the .003 level, showing a positive relationship between ASL level and English literacy for students in the younger age group. H1 was accepted (p = .004), H2 was accepted (p = .017), and H3 was rejected.

For the subgroup of students ages 12–15, the F ratio is significant at the .000 level. H1, H2, and H3 are all accepted. For the subgroup of subjects with DMs, the relationship between ASL level and English literacy was not significant, while for those with hearing

Table 2 Pearson correlation coefficients for total ASL scores with total English literacy scores among all subjects and subgroups according to age and maternal hearing status

Group	*n*	Pearson *r*	Probability
All subjects	145	.580	.000
Ages 8–11	52	.663	.000
Ages 12–15	93	.500	.000
DM	36	.603	.000
HM	104	.507	.000
8–11, DM	13	.742	.000
8–11, HM	38	.660	.000
12–15, DM	23	.219	NS
12–15, HM	66	.391	.001

DM = deaf mothers; HM = hearing mothers.

Table 3 Distribution of subjects by age group, maternal hearing status, and ASL level

	8–11			12–15			
ASL level	DM	HM	MD	DM	HM	MD	Total
Low ASL	03	21		01	24	02	51
Medium ASL	05	11		05	30	01	52
High ASL	05	09	01	19	14	01	49
Total	13	41	01	25	68	04	152

DM = deaf mother; HM = hearing mother; MD = missing data.

Table 4 Probability values for the independent variable by covariates interactions for the eight planned ANCOVAs on research question 1

Group	Age	IQ
All subjects	.630	.507
Ages 8–11	.579	.941
Ages 12–15	.598	.336
DM	.963	.590
HM	.178	.979
8–11, DM	.940	.565
8–11, HM	.722	.351
12–15, HM	.242	.659

DM = deaf mother, HM = hearing mother.

Table 5 ANCOVA table for the relationship of English literacy with ASL level, adjusted for cognitive ability (PIQ) and age, for all subjects

Source	Sum of squares	Degrees of freedom	Mean squares	*F* ratio	Significance
ASL level	359,687.97	2	179,843.99	21.619	0.000
PIQ	53,408.84	1	53,408.84	6.420	0.013
Age	50,974.23	1	50,974.23	6.128	0.015
Error	1,014,887.62	122	8,318.75		

Table 6 Summary ANCOVA results and post hoc comparisons of ASL level on English literacy

Group	*F* ratio	*p* value	High versus low	High versus med	Medium versus low
All	21.6	.000	.000	.001	.002
8–11	6.7	.003	.004	.017	NS
12–15	17.2	.000	.000	.048	.001
DM		NS			
HM	14.5	.000	.000	.002	.042
8–11, DM		NS			
8–11, HM	7.5	.002	.003	.013	NS
12–15, HM	9.8	.000	.000	.051	.026

DM = deaf mother; HM = hearing mother; NS = not significant.

Table 7 Probability values for the independent variable by covariates interactions of the six planned ANCOVAs on research question 2

	English		ASL	
Group	Age	IQ	Age	IQ
All subjects	.963	.414	.423	.614
Ages 8–11	.464	.331	.346	.844
Ages 12–15	.982	.964	.734	.694

mothers the *F* ratio is significant at the .000 level. H1, H2, and H3 are all accepted for this group.

For the subgroup of students in the younger age group who had DMs, the relationship between ASL level and English literacy was not significant, while for the younger group with hearing mothers the *F* ratio was significant at the .002 level. H1 and H2 were accepted and H3 was rejected for this group.

For the subgroup of students ages 12–15 with HMs, the *F* ratio of 9.844 was significant at the .000 level. H1, H2, and H3 were all accepted.

In order to test the second research question, whether DP children outperform HP children in ASL and English literacy, we ran two more sets of ANCOVAs with English literacy scores and ASL scores as the dependent variables, maternal hearing status (MHS) as the independent variable, and PIQ and age as the covariates. The research hypotheses are as follows: H4: Subjects in the DP group will outperform subjects in the HP group in tests of English literacy. H5: Subjects in the DP group will outperform subjects in the HP group in tests of ASL.

Each set comprises a test of all subjects taken together, and the younger and older age groups were analyzed separately. The homogeneity of slopes assumption was tested by measuring the independent variable by covariates interactions for the six planned ANCOVAs. In every instance acceptance of the assumption is plausible. Results are displayed in Table 7. The ANCOVA results for the sample as a whole are displayed in Tables 8 and 9. The summary results for all the subgroupings are displayed in Table 10.

Table 8 shows the comparison of the DP and HP children on English literacy for the whole sample. H4 was accepted, with the DP group significantly outperforming the HP group at the .000 level of probability (*F* ratio = 22.127).

Table 9 shows a similar analysis but with ASL scores as the dependent variable. H5 was accepted with the DP students significantly outperforming the HP group at the .000 level of probability (*F* ratio = 19.278).

Table 8 ANCOVA table for the relationship of English literacy with maternal hearing status, adjusted for cognitive ability (PIQ) and age, for all subjects

Source	Sum of squares	Degrees of freedom	Mean squares	F ratio	Significance
MHS	206,920.42	1	206,920.42	22.127	0.000
PIQ	200,204.23	1	200,204.23	21.409	0.000
Age	105,892.18	1	105,892.18	11.324	0.001
Error	1,140,878.25	122	9,351.46		

Table 9 ANCOVA table for the relationship of ASL skill with maternal hearing status, adjusted for cognitive ability (PIQ) and age, for all subjects

Source	Sum of squares	Degrees of freedom	Mean squares	F ratio	Significance
MHS	208.31	1	208.31	19.278	0.000
PIQ	218.94	1	218.94	20.261	0.000
Age	52.32	1	52.32	4.842	0.030
Error	1,296.68	120	10.81		

Table 10 Summary ANCOVA results of maternal hearing status on English literacy and ASL skill

Group	F ratio	MHS and English literacy P value	F ratio	MHS and ASL P value
All	22.1	.000	19.3	.000
8–11	14.6	.000	19.3	.000
12–15	10.9	.001	16.4	.000

MHS = maternal hearing status.

Table 10 shows the results for the subgroups. For the students in the younger age group, DP students outperformed HP students in English literacy at the .000 level of probability, thereby confirming H4. H5 was also confirmed, with DP students outperforming HP students in ASL also at the .000 level of probability. For students in the older age group, both H4 and H5 are also confirmed.

Discussion

From the analysis and results presented in the previous section, a clear, consistent, and statistically significant relationship between ASL skill and English literacy is evident. The present data show that, when controlled for age and PIQ, the subjects perform at a higher level of English literacy if their ASL skills are well developed than if those skills are lacking. This is true for all ages taken together and for students in each of the two age groups considered separately. The post-hoc analyses reveal that English performance improves even with a moderate-level ASL skill. In other words, membership in the intermediate ASL group is associated with significantly higher English literacy scores than obtained by those in the lowest group. Similarly, members in the highest of the three ASL groups tended to achieve significantly higher English scores than members in the lowest ASL group and, in most cases, than those in the intermediate ASL group.

There were some exceptions among certain of the subgroups, notably, those involving students with DMs. As we saw earlier, the only Pearson correlation coefficient between ASL skill and English literacy that was not statistically significant was for the older group with DMs. This is almost certainly explained by the distribution of ASL test scores being skewed towards the high end for this subgroup. Table 3 shows that only one out of 25 of the older students with DMs fell in the lowest ASL group, and only five in the intermediate group. In all likelihood this skewed distribution affected the ANCOVA for the entire subgroup with DMs, which failed to reach significance at the 95%

level. The younger group of maternally deaf students also failed to show a statistically significant ANCOVA relationship between ASL and English literacy, however. This finding was predicted by our pilot study (Prinz & Strong, 1995) and may be partly a result of the small size of the subsample, but may also indicate that, for children with DPs, other factors (such as those discussed below) are influencing the relationship between ASL and English literacy acquisition, particularly during the early years.

The generally very strong relationship between ASL skill and English literacy demonstrated by these data may be interpreted in three ways. First, ASL skill allows for better acquisition of English literacy. Second, English literacy ability promotes increased ASL skill. Third, some other factor is intervening to influence both ASL skill and English literacy.

Let us consider these interpretations in reverse order. Two of the factors most likely to influence both the acquisition of English literacy and of ASL are chronological age and IQ, both of which were controlled in the present analysis. Other potential factors known to affect school performance in general are socioeconomic level, quality of teaching, location of school, and, for deaf children, cause, degree, and age of onset of hearing loss. In this study, all the students in a single participating school within the target age-range were included, omitting only students with other conditions such as those who attended the special unit. Thus, the effects of teacher differences, school type, and location are eliminated. All students in the study were described as having at least a severe hearing loss, all incurred in early childhood, mostly prelingually. Thus, any effects of these variables on English literacy acquisition are either minimized, controlled, or neutralized by the size of the sample. Sampling bias is itself ruled out by our inclusion of the total available population, although, of course, one would wish to collect corroborating findings from other settings before generalizing with confidence.

One potential factor whose influence is untested by our data concerns the effect of the quality of parent-infant communication (as distinct from the language of communication) on language acquisition of any kind, either English or ASL. Work by Schlesinger (1988) and Schlesinger and Acree (1984), for example, indicates that mother-child interaction might be associated with the later reading levels of deaf children. Also, a study by Lou, Strong, and DeMatteo (1991) indicates the possible importance of consistent linguistic input (regardless of language type) on various academic and cognitive outcomes.

A second interpretation for the findings is that English literacy skills affect ASL ability. This would mean that the students in the study are acquiring English and that this skill then enhances their acquisition of ASL. Such an explanation would be plausible in a setting where deaf children were not exposed to ASL until they had acquired some skills in English, and then they subsequently learned ASL to a level influenced by their knowledge of English. However, we know, from earlier studies, that when deaf children are exposed to both English and ASL in the same environment, their spontaneous language overwhelmingly reflects the ASL rather than the English input (Strong, 1985; Livingston, 1983). Since the present data were collected in a school for the deaf where ASL is the primary language of social interaction, the conditions that would be necessary for this interpretation to be correct are lacking.

Given the setting, we suggest that the first interpretation for the findings is the most plausible. That is, expertise in ASL influences the acquisition of English literacy. This interpretation is further supported by the results pertaining to the comparisons of DP with HP children. Since, at home, the HP children are more likely than the DP children to be exposed to some form of English than to ASL, then, for the interpretation that English literacy affects ASL to be correct, one would expect the HP children to outperform the DP children in both English and ASL. However, the reverse turns out to be true, since DP children outperformed the HP children in both English and ASL at both age levels, confirming the findings from earlier studies.

The comparison data between DP and HP children may also shed further light on the question of why the relationship between ASL level and English literacy was not statistically significant for the DP children. It is possible to test the speculation that something other than ASL fluency is positively affecting the performance of DP children by holding the ASL level constant. That is, one can make a comparison of DP and

Table 11 Summary ANCOVA results of maternal hearing status on English literacy within three ASL levels

Group	*F* ratio	*P* value
ASL low	4.49	.041
ASL medium	3.12	NS
ASL high	1.96	NS

HP children within ASL skill levels. Thus, if some factor other than ASL skill were enhancing the performance of DP children, they would continue to outperform HP children in English literacy, even when ASL level was controlled.

To address this question, we performed three additional ANCOVAs with English lteracy as the dependant variable, MHS as the independent variable, and age and IQ as covariates, one for the high ASL group, one for the medium ASL group, and the third for the low ASL group. The hypotheses were as follows: H6: In the high ASL group, subjects with DMs will outperform those with HMs in English literacy. H7: In the medium ASL group, subjects with DMs will outperform those with HMs in English literacy. H8: In the low ASL group, subjects with DMs will outperform those with HMs in English literacy.

Table 11 summarizes the results of these analyses. As can be seen, H6 and H7 were rejected, whereas H8 was accepted ($p = .041$). In other words, these data suggest that, if you have a medium or a high level of ASL skill, as measured by our test of ASL, then English literacy performance is not positively affected by having a DM. However, if you have low ASL skills, then it is advantageous to have a DM, suggesting that other factors such as emotional stability, good parent-child communication, and parental acceptance may play a role in academic performance until moderate skills in ASL are acquired, at which point their benefits are apparently superseded by the advantages of ASL.

Together, the findings from this study strongly point to the importance of ASL skills in the acquisition of English literacy.[3] Of particular interest is the fact that ASL is related to English literacy not only among deaf children of DPs but also, and in fact even more consistently, among deaf children with HPs.

Children from deaf families do outperform their peers from hearing families in both English literacy and ASL, as earlier research had indicated. In our study, however, this advantage persists even among the older children. Furthermore, our data suggest that the advantage of being from a deaf family is likely to result largely from fluency in ASL, for, when ASL ability is held constant, DP children's superiority in English literacy almost disappears. Thus, the longstanding question of why DP children tend to outperform HP children academically may be resolved.

These findings do not suggest that ASL knowledge is the only path to successful acquisition of English literacy for deaf children, and, indeed, they may not generalize beyond an environment such as the school for the deaf studied here, where ASL is in common use. Nevertheless, the implication of this research for parents and educators is straightforward and powerful. Deaf children's learning of English appears to benefit from the acquisition of even a moderate fluency in ASL. Since, given the right input, any deaf child (without significant neurological impairment) can acquire ASL, this information should be of interest to parents, particularly hearing parents, who are attempting to choose an educational environment for their deaf child. As for those pondering the value of bilingual education for deaf children, even the skeptics now have some research findings to draw upon that strongly suggest the value of an approach using ASL as the language of instruction.

Notes

1. We use the term "English literacy" to describe the reading and writing skills we measure in order to distinguish it from a more generalized "English knowledge" or "English fluency" or "English proficiency," which would typically include skills related to speaking.

2. ANCOVA tests the hypothesis that there is no difference in the means of two or more groups, once the variation explained by the covariates(s) is accounted for. In other words, in this analysis, we test the additional amount of variation in English literacy scores among the three levels of ASL beyond that explained by age and cognitive ability. Before conducting ANCOVA, it is necessary to determine that there is no significant interaction between the covariate(s) and the independent variable. This assumption of no interaction is often known as "homogeneity of slopes." The probability values for the interaction of the covariates age and PIQ with the independent variable of ASL level across the different subgroups are shown in Table 4. The probabilities range between .178 and .963, so the assumption of homogeneity of slopes in all cases is plausible.

3. The question of how long one can wait to expose a deaf child to ASL before it ceases to be of value is not addressed by our data. However, we are collecting longitudinal data over a period of three years, with which we will be able to study the relative improvement in ASL and English literacy skills of the students. These data will provide further information on the relationship between ASL and English literacy, as well as a possible insight into the important of age of acquisition of ASL.

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