

The Effects of American Sign Language as an Assessment Accommodation for Students Who Are Deaf or Hard of Hearing

Stephanie W. Cawthon*, Samantha M. Winton, Carrie Lou Garberoglio, Mark E. Gobble
University of Texas at Austin

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Students who are deaf or hard of hearing (SDHH) often need accommodations to participate in large-scale standardized assessments. One way to bridge the gap between the language of the test (English) and a student's linguistic background (often including American Sign Language [ASL]) is to present test items in ASL. The specific aim of this project was to measure the effects of an ASL accommodation on standardized test scores for SDHH in reading and mathematics. A total of 64 fifth- to eighth-grade (ages 10–15) SDHH from schools for the deaf in the United States participated in this study. There were no overall differences in the mean percent of items students scored correctly in the standard vs. ASL-accommodated conditions for reading or mathematics. We then conducted hierarchical linear regression analyses to analyze whether measures of exposure to ASL (home and classroom) and student proficiency in the subject area predicted student performance in ASL-accommodated assessments. The models explained up to half of the variance in the scores, with subject area proficiency (mathematics or reading) as the strongest predictor. ASL exposure was not significant with the exception of ASL classroom instruction as a predictor of mathematics scores.

Current educational reforms in the United States focus on high-quality standards and academic assessment of all students, including students who are deaf or hard of hearing (SDHH; Cawthon, 2009). SDHH are a diverse group that includes individuals who are culturally Deaf, wear cochlear implants, and/or have parents who are Deaf. Depending on a number of factors, including access to spoken English and American Sign Language (ASL), SDHH may come to

schooling as fluent users of ASL, as emerging bilingual students, or with a limited first-language base (Marschark, Lang, & Albertini, 2002). For SDHH, meaningful participation in accountability reform may depend on assessment practices that take their linguistic and academic backgrounds into consideration. One way to bridge the gap between the language of the test and a SDHH's linguistic background is to present test items in ASL. Yet, there is very little research on the validity of assessment accommodations used with SDHH (Cawthon & the Online Research Lab, 2006, 2008; Luckner & Bowen, 2006).

The purpose of this study was to measure the effects of an ASL accommodation on standardized test scores for SDHH. There is concern that changing the language of a test item, such as with an ASL accommodation, may invalidate the accommodated test score by changing the meaning of the test content (Crawford & Tindal, 2004). Language translations are rarely exact, and the translation from English to ASL involves different grammatical structures and ways of representing information. As a result, an ASL-translated item may be harder, easier, or simply measure a different construct than the original item. Although there is a tremendous need for such research, the field has not yet systematically measured the effects of an ASL accommodation on standardized test scores, particularly those used in high-stakes decision making within accountability reforms (e.g., No Child Left Behind Act of 2001 [NCLB]). Furthermore, we do not know how test item and student characteristics may interact with the effects

*Correspondence should be sent to Stephanie W. Cawthon, Department of Educational Psychology, The University of Texas at Austin, 1 University Station, MC D5800, Austin, TX, 78712 (e-mail: stephanie.cawthon@mail.utexas.edu).

of an ASL accommodation (Cawthon, Ho, Patel, Potvin, & Trundt, 2009; Sireci, Scarpati, & Li, 2005).

Standardized Assessment and Score Validity Context

Policy

For the past decade, U.S. educational policy has evolved into a system focused on standardized measurement of student knowledge and skills. The NCLB, a reauthorization of the Elementary and Secondary Education Act from the Johnson administration, raised the level of accountability for student performance by placing increased emphasis on results from state-wide standardized assessments. Schools, districts, and states are now “graded” based on the proportion of their students who demonstrate proficiency in core content areas such as reading, mathematics, and science. The high-stakes nature of this process makes it imperative that states develop credible high-quality assessment systems (Linn, 2000). In order for test results to accurately represent what a student knows and how well a school has developed student academic proficiency, significant consideration needs to be paid to the technical quality of the assessments themselves. However, even a quality assessment can be challenging for students with disabilities or those who are English Language Learners to access test content and demonstrate their knowledge and skill (Abedi, 2002; Phillips, 1994).

Education policy at all levels has embraced the practice of using “assessment accommodations” in an effort to “even the playing field” and reduce barriers that are not related to test content (Lazarus, Thurlow, Lail, Eisenbraun, & Kato, 2006). Because many students with disabilities have difficulty with the format of standardized assessments, accommodations can be administered to provide the best opportunity for testing participation and accurate test scores (Bolt & Thurlow, 2004; McDonnell, McLaughlin, & Morison, 1997; Phillips, 1994). Accommodations are meant to make it easier for students with disabilities to gain access to test content without changing the difficulty of the test. Assessment accommodations range from changes to the test format (e.g., into Braille for a student with limited vision), administration format (e.g., extended time for a student with dyslexia), or response

format (e.g., a student who cannot hold a pencil may point to his or her responses or have answers recorded by a scribe; Bolt & Thurlow, 2004). Research on the effects of ASL accommodations for SDHH will provide greatly needed information about their potential effects on score validity within a high-stakes standardized assessment context.

Research

Research on assessment accommodations continues to grow but offers few conclusive findings on whether they facilitate fair and accurate measurement of student knowledge and skill (e.g., Abedi, Hofstetter, & Lord, 2004; Bolt & Thurlow, 2004). Findings differ depending on the type of accommodation, the nature of the student’s disabilities, and the test content. This variability in effect is particularly true for read-aloud accommodations, where test items are presented orally to the student (instead of the student reading the test items). Results range from demonstrating that accommodations are valid and beneficial (e.g., Fletcher et al., 2006; Schulte, Elliott, & Kratochwill, 2001), that they have no effect (e.g., Fuchs, Fuchs, Eaton, Hamlett, & Karns, 2000), or that they may even create an unfair advantage for students who use them (Sireci et al., 2005).

There is very little research on the validity of assessment accommodations used with SDHH (Cawthon & the Online Research Lab, 2006). The majority of teachers of SDHH indicate that their students use a range of accommodations, including extended time, individual or group administration, test directions interpreted via ASL, test items read aloud, and test items interpreted via ASL. State policy on the use of these accommodations varies greatly from state to state (Cawthon, 2007). When asked to name important factors used in their decisions for SDHH, teachers most often ranked student academic level, the subject of the test, and the language used by the student in the classroom (Cawthon & the Online Research Lab, 2008). Although not all-encompassing, these are the considerations noted most often by individuals who make decisions about accommodations use for SDHH.

Test subject. Concerns about ASL accommodations depend, in part, on the subject of the assessment.

For example, ASL accommodations on tests meant to measure reading abilities change the nature of the test. In research on parallel “read-aloud” accommodations for test items, the student may no longer demonstrate decoding and reading comprehension skills but rely instead on listening comprehension skills (Crawford & Tindal, 2004; Fletcher et al., 2006). In contrast, the purpose of a mathematics assessment is to measure a student’s ability to calculate and reason mathematically; accommodations such as read aloud or interpreting the test item (i.e., “through the air”) may still affect the nature of the test but to a lesser extent than for reading assessments. The validity of an accommodation depends, therefore, on the purpose of the assessment. Yet, SDHH typically receive the same set of accommodations for all components of a standardized test (Cawthon & the Online Research Lab, 2008). There are some exceptions with regard to accommodations that change the language of the item, such as using ASL or reading the test question aloud to students. In these cases, teachers sometimes administer the accommodation only for the mathematics assessment. However, this distinction is not a clear one, either in their current use or in recommendations for “best practices” in assessment accommodations for SDHH.

Student proficiency. Some research has indicated that a student’s proficiency level in the subject area may influence the degree to which an accommodation increases demonstrable changes in access to test content. For example, when using an extended time accommodation on a math test, students who had primary difficulties in reading and no documented math difficulties performed differentially better—and thus benefited more from the accommodation—than did students with difficulties in math (Fuchs et al., 2000). Mandinach, Bridgeman, Cahalan-Laitusis, and Tripani (2005) demonstrated that students both with and without disabilities in the “middle” math ability level benefited more from the accommodation on the math section. In the extended time research, students with lower subject area abilities (in mathematics) did not benefit from extended time. However, results supporting effectiveness of accommodations for lower performing students can be found in the

literature on read-aloud accommodations, a test format that parallels administration of test items in ASL (e.g., Bielinski, Ysseldyke, Bolt, Friedebach, & Friedebach, 2001). Studies have shown that students with low reading proficiency demonstrated greater gains when using oral presentation than those who are skilled readers (Meloy, Deville, & Frisbie, 2002). The difficulty of the test items may play a role as well. For example, Bolt and Thurlow (2006) found that the read-aloud accommodation had a greater benefit for student scores on items that were difficult to read. In sum, the read-aloud accommodation may not have an effect for skilled readers who can already access the written form of the assessment but may be beneficial either for poor readers or on more difficult test items. It remains to be seen whether an ASL accommodation acts as a facilitator of test performance for students with different proficiency levels in reading and mathematics.

Language and communication. McKeivitt and Elliott (2003) recommend that those charged with making accommodations decisions should attempt to match the individual student’s needs with the type of accommodation and the content of the test (portions of this section were first published in Cawthon, 2007). For example, SDHH who are children of signing Deaf adults are more likely to have a fully developed use of ASL than those who do not have access to manual communication at an early age (Musselman, 2000). Communication used in instruction is influenced not only by the student’s primary language but also by the resources and communication philosophies of the school or program (Marschark et al., 2002; Ramsey, 1997). As a result, SDHH may be educated in classrooms that use only ASL, some sign language and speech together (total communication), a cueing system such as Cued Speech, English instruction with a sign language interpreter, or speech only (Luetke-Stahlman & Nielsen, 2003). Participants in previous studies of SDHH accommodations use indicate that communication mode is a primary consideration in how SDHH participate in standardized assessments (Cawthon & the Online Research Lab, 2006, 2008). From a teacher’s perspective, evidence as to the efficacy of ASL for SDHH may be

helpful in the accommodations decision-making process.

Purpose of This Study

State assessment policies greatly restrict the use of nonwritten English formats in standardized assessments, including ASL as an accommodation for test items (Clapper, Morse, Lazarus, Thompson, & Thurlow, 2005). How SDHH language background interacts with other aspects of the assessment process, including subject of the test and accommodation used, is unknown (Cawthon et al., 2009). The purpose of this study was to measure the effects of an ASL accommodation on standardized test scores for SDHH. The study design sought to investigate not only the potential change in test scores when students use an ASL accommodation but also the potential differential impact of student language background factors on accommodated test scores. Two main research questions guided this project:

1. Did SDHH scores on mathematics and reading assessments *differ* between standard written English and ASL-accommodated test conditions?
2. Did exposure to ASL and subject area proficiency *predict* student performance on the ASL-accommodated mathematics and reading assessments?

Methodology

Sample

One of the greatest challenges in research with SDHH is the low-incidence nature of the disability. A total of 64 students from six schools for the deaf participated in the main study in fall and winter of 2009–2010. Students with a severe-to-profound hearing loss but without disabilities that required additional test accommodations were included in this sample. Participants were enrolled in fifth through eighth grades and ranged in age from 10 to 15 years. Due to a request by school research boards for anonymous participation, individual student demographics such as the ethnic background, ages, and gender of the students were not provided.

Table 1 Language background inventory descriptive statistics

Item	Responses ($N = 64$)
Is ASL your first language?	Yes: 50%
If ASL is your second language, how many years have you been using it? M (SD)	5.4 (3.3)
What language do you use most often?	ASL: 75% SEE: 6 Spoken English: 16 Other (Spanish): 2
Which language(s) do you like to use? ^a	ASL: 78% SEE: 11 Spoken English: 23 Other (Spanish): 2
What language(s) are used in the classroom? ^a	ASL: 91% SEE: 20 Spoken English: 16 Other: no responses
What language(s) are used at home? ^a	ASL: 53% SEE: 16 Spoken English: 47 Other (Spanish): 3
Do you have Deaf family members?	Yes: 47%
How many Deaf family members do you have?	None: 53% One: 11 Two: 10 Three: 11 Four: 8 Five: 3 Six: 3 Ten: 2

Note. ASL = American Sign Language; SEE = Signed Exact language.

^aStudents could select more than one response.

Participants provided information about their language use and preferences as part of the language background inventory. A summary of student language use is provided in Table 1. The purpose of this measure was to describe the types of language experiences students had both at home and in the classroom. Exactly half of the participants indicated that ASL was their first language or the language that they learned in the home. A similar proportion (47%) indicated that they had Deaf family members, many who were immediate relatives such as parents and siblings. These two characteristics, ASL as a first language and having Deaf family members, were not exact correlates in this population. Ten of the 32 students who had ASL as a first language did not have Deaf family members at

home. In contrast, 8 of the 32 students who had Deaf family members at home did not have ASL as a first language. Both characteristics are therefore important to consider when understanding these students' exposure to ASL.

Students who learned ASL as a second language, either at home or at school, had been using it for an average of just over 5 years. The students in this study were in fifth to eighth grades; it is likely, then, that these students were exposed to ASL after they entered formal schooling. All the students attended schools for the deaf where ASL was used in instruction almost all the time (91% of students reported ASL used in instruction). Students reported lower rates of Signed Exact English (SEE; 20%) and spoken English (16%) in the classroom, consistent with instructional practices at many schools for the deaf. Finally, students reported relatively high levels of ASL use overall, with 75% using ASL most often and 78% preferring ASL over other communication modes. Students in this study therefore were likely to have had some exposure to ASL, either at home or at school, and showed a strong dominance in its use over spoken English or SEE.

Procedures

Two students participated in a pilot study in the spring of 2009 in an effort to test the protocol for the main study. In the pilot, two Deaf research assistants (the DVD creators, described below) administered the assessments "live" with the two students in three after-school sessions. The pilot resulted in a refinement of the test administration procedures to allow for more breaks if students needed them, but the test procedures remained the same. For the main study, individual parent permission forms were disseminated and collected using the designated research recruitment procedures at each school site. When requested by the school site, teachers were given a block of code numbers to use so that individual student information was not retained and student participation was anonymous. Local teachers and administrators were provided with a test administration guide and checklist to maintain a standard set of procedures (see supplementary materials for administration guide and checklist).

Depending on the school schedule and length of time blocks available for testing, students participated in two or three 60- to 90-min test sessions spread out over the course of a week. All students received a token of appreciation such as a bracelet or an engraved pencil.

The study was administered via a DVD that was shown to students either on individual computers or as a group with an LCD projector screen (a copy of the administration guide is included as part of the supplementary materials). Only one site (three students) completed the study on individual computers. The DVD was created by two Deaf research team members who are native ASL users, are fluent in both ASL and English, and have backgrounds in bilingual education methodology. ASL components were translated using ASL structure while following the structure of the text as closely as possible, not English word order (as defined in Livingston, Singer, & Abrahamson, 1994). Although there were some instances of fingerspelling, particularly in cases where the ASL sign would provide information about the definition of the targeted word, it was not a primary component of the translation. An example of an ASL-accommodated test item sequence is provided in supplementary materials for this article. The DVD creators were present at the pilot and at implementation at one test site and did not detect significant linguistic or cultural issues in the translations.

All students received the test items in the same sequence. The content of the study was divided into three parts: (a) the language background inventory, (b) the standard test condition, and (c) the ASL-accommodated test condition. All participants were included in both the standard and ASL conditions of the project to act as their own control. In the standard condition sections of the study, the directions were translated into ASL but the reading passages, reading test items, and math test items were provided only in written English (in test booklets). In the ASL condition of the study, the reading passages, reading test items, and mathematics test items were provided both in ASL on DVD and in the written version in the test booklet. For reading passages, the translation occurred on the DVD and the print version was in the booklet. For reading and math items, the item was first

presented in print on the screen, then in ASL, and then again in print on the screen. After the second print exposure on the screen, the students were given time to respond to the items in their booklets.

Measures

Background assessments. Students were provided test booklets for both background and study measures. The background assessments were included to provide standardized measures of student proficiency in reading and mathematics as well as an inventory of their language experiences. These tests included the following measures:

- Standardized measure of reading proficiency: Iowa Test of Basic Skills (ITBS) Survey Battery, Reading Parts 1 and 2 (Hoover, Dunbar, and Frisbie 2001). The ITBS reading test is a widely used assessment of a student's proficiency in vocabulary and reading comprehension. Students complete a short 30-min block of 10 vocabulary items, four reading passages, and 17 reading comprehension items. Student scores can be converted into grade equivalencies based on norms provided by ITBS.

- Standardized measure of mathematics proficiency: ITBS Survey Battery, Mathematics Parts 1 and 3 (Hoover et al., 2001). The ITBS mathematics tests used in this study included the problem-solving and computation sections. Students first completed a 30-min block of 19 items that ranged from interpreting charts and graphs, logic problems, algebra word problems, number sense, and visual rotation problems. Finally, students completed eight computation problems that focused on addition, subtraction, multiplication, and division. Student scores can be converted into grade equivalencies based on norms provided by ITBS.

- Language background inventory: The language background inventory was a questionnaire that includes items such as what language(s) the student uses at home and at school (see Table 1 for all items).

Study measures. In order to compare the effect of standard versus ASL administration on test performance, it was necessary to develop two tests that were

reasonably identical without being the same test (to control for practice effects). Between 2007 and 2009, the study team developed and piloted two forms of the mathematics and reading assessments in an item equivalency study to meet this need. Test items were matched for difficulty and task demands across the standard and ASL conditions.

- Mathematics items: Released practice problems from the fifth- and sixth-grade 2003 and 2004 Texas state mathematics assessments. There were a total of 16 items for each condition (standard and ASL). These items were short word problems similar in nature to the ITBS mathematics problem-solving items on the test of mathematics proficiency.

- Reading passages and items: Released practice problems from the fifth- and sixth-grade 2003 and 2004 Texas state mathematics assessments. There were a total of two passages and 16 items for each condition (standard and ASL). The passages were three to four paragraphs in length and covered topics such as how scientists monitor penguins in the Arctic, panda bears visiting the United States, training elephants in Africa, and weaving lace in Paraguay.

Results

Reading and Mathematics Proficiency

Students completed reading and mathematics sections of the ITBS as part of the study. The purpose of ITBS tests was to have a standardized normed score of student proficiency in these areas. The overall ITBS reading scale scores ranged from 145 to 225 ($M = 181$), reflecting a grade-equivalent reading level of grades 1.5–6.6 ($M = 3.6$) in this sample. The overall ITBS mathematics scale scores ranged from 152 to 236 ($M = 191$), a grade-equivalent math level of 1.9–7.6 ($M = 4.2$). As a point of reference, the test items in the accommodations comparison portion of the study were selected to target fifth- and sixth-grade reading and mathematics skills. Although there was a strong correlation between grade-level performance on the ITBS reading and mathematics assessments ($r = .774, p < .01$), there was no significant relationship between academic grade level (i.e., grade enrolled at school) and the ITBS grade-level

Table 2 Mean percent correct in standard and ASL-accommodated test conditions

Subject	% Correct, <i>M</i> (<i>SD</i>)	
	Standard	ASL accommodated
Reading (<i>n</i> = 61)	41 (23)	45 (17)
Mathematics (<i>n</i> = 60)	47 (19)	47 (16)

Note. ASL = American Sign Language.

performance in either reading ($r = .193$, *ns*) or mathematics ($r = .125$, *ns*).

Standard Versus ASL-Accommodated Assessments

The first set of assessments consisted of one reading and one math test under standard conditions. In the standard condition, the directions were presented via ASL, but the students read the items alone and responded in their test booklets. In the second set of tests, also one on reading and one on mathematics, both the test directions and the test items were each presented in ASL. A summary of student performance across the two conditions, for reading and mathematics, is provided in Table 2. Overall performance was essentially flat across the standard and ASL conditions. There were no differences in the average percent of items students scored correctly in the standard versus ASL-accommodated conditions for reading ($M = 41\%$ vs. 45%) or mathematics ($M = 47\%$ vs. 47%). To assess the impact of ASL on student performance, we ran two separate paired *t* tests, one for reading and one for mathematics. There was no statistically significant difference for either reading, $t(60) = 1.37$, $p = 1.77$, or mathematics, $t(61) = .013$, $p = .989$.

As a follow-up analysis, we checked to see if there was a relationship between a student's ITBS score (i.e., subject area proficiency) and the change in performance between standardized and accommodated test conditions. The correlation table below indicates

that, with one exception, there was no relationship between a student's ITBS scores and a positive increase in the ASL-accommodated condition (Table 3). A student's reading ITBS score was significantly correlated with a drop in performance on the ASL-accommodated reading assessment ($r = -.289$, $p < .05$). Although not a large effect size, the direction of the change will be important to consider when interpreting these data. As a further analysis, we conducted analyses on the change in performance from the standard to the accommodated conditions (in reading) for three student groups: the top, middle, and bottom third of students in their performance on the reading ITBS. There were no significant differences between the groups, $F(2, 54) = 2.38$, $p = .102$, though potentially because this was underpowered with no more than 20 participants per group.

Predictors of Test Performance

The purpose of the second set of analyses was to explore whether a student's exposure to ASL, in conjunction with proficiency in reading (and math, for mathematics items), had an influence on student performance on an ASL-accommodated assessment. With a sample size of 64 participants, we had sufficient power to include up to four variables in our regression analyses (Stevens, 1996). However, because we had a smaller sample size than recommended by Tabachnick and Fidell (2001), we used the adjusted R^2 values in interpreting the amount of variance explained by our models. The reason for including reading proficiency in both models is that students must use literacy skills to read and understand word problems in the mathematics assessments. We first performed a series of checks in the data to identify potential sources of measurement error. These checks included test form equivalence, student grade, school, and ceiling effects

Table 3 Correlations between ITBS grade equivalent scores and change in performance on ASL accommodated tests

	ITBS mathematics grade equivalency (<i>n</i> = 61)	ITBS reading grade equivalency (<i>n</i> = 61)
Mathematics assessment change from standard to ASL	-.233	-.190
Reading assessment change from standard to ASL	-.230	-.289 ^a

Note. ASL = American Sign Language; ITBS = Iowa Test of Basic Skills.

^aCorrelation is significant at the 0.05 level (two-tailed).

Table 4 Summary of hierarchical regression analysis for variables predicting student performance on ASL-accommodated assessment in reading

Variable	<i>B</i>	<i>SE B</i>	β
Step 1			
Home ASL	.035	.046	.104
Classroom ASL	.035	.084	.057
Step 2			
Home ASL	.00005	.033	.000
Classroom ASL	-.005	.06	-.008
ITBS reading grade-equivalent score	.096	.013	.713*

Note. ASL = American Sign Language; ITBS = Iowa Test of Basic Skills. Adjusted $R^2 = -.016$ for Step 1 ($p = .593$); $\Delta R^2 = .481$ for Step 2 ($p < .001$).

* $p < .001$.

(students who score 100% in either condition) as well as multicollinearity and singularity of the test variables. Hierarchical linear regressions were performed on the percent of items students answered correctly in the ASL-administered conditions. Predictor variables were entered in three steps. Step 1 consisted of measures of a student's exposure to ASL in the classroom and at home. Steps 2 and 3 consisted of the ITBS grade equivalency scores (reading and mathematics). These results were run in both directions, with ASL exposure both as the initial step and as the final step; results were the same in either case. Summaries of results are shown in Tables 4 and 5.

The first overall regression model significantly predicted performance on the ASL-accommodated

assessment in reading, adjusted $R^2 = .481$; $F(60) = 19.561$, $p < .001$. As a block, the ASL exposure variables, ASL at home and ASL in the classroom (Step 1), did not significantly predict performance on the ASL-accommodated reading assessment, adjusted $R^2 = -.016$; $F(2) = 0.527$, $p = .593$. Performance on the ASL-accommodated reading test was significantly predicted by the ITBS standardized measure of reading proficiency (Step 2), $\Delta R^2 = .497$; $\Delta F(1, 57) = 56.617$, $p < .001$. (We did not enter mathematics ITBS scores into the model for performance on the ASL-accommodated reading test.) ITBS reading score was the only significant predictor of ASL-accommodated reading scores in the final model ($\beta = .713$, $p < .001$).

The second overall regression model significantly predicted performance on the ASL-accommodated assessment in mathematics, adjusted $R^2 = .381$; $F(60) = 10.246$, $p < .001$. When entered alone, the ASL exposure variables, ASL at home and ASL in the classroom (Step 1), did not significantly predict performance on the ASL-accommodated math assessment, adjusted $R^2 = .042$; $F(2) = 2.328$, $p = .107$. We then added the ITBS measure of reading proficiency (Step 2) because the items on the test were word problems that did require some level of English literacy skills, even in the ASL-accommodated version. The ITBS reading scores did significantly predict performance on the ASL-accommodated

Table 5 Summary of hierarchical regression analysis for variables predicting student performance on ASL-accommodated assessment in mathematics

Variable	<i>B</i>	<i>SE B</i>	β
Step 1			
Home ASL	.084	.044	.264
Classroom ASL	-.116	.079	-.195
Step 2			
Home ASL	-.062	.038	.189
Classroom ASL	-.144	.069	-.242*
ITBS reading grade-equivalent score	.067	.014	.511**
Step 3			
Home ASL	-.040	.036	.122
Classroom ASL	-.145	.064	-.244*
ITBS reading grade-equivalent score	.025	.019	.191
ITBS mathematics grade-equivalent score	.066	.021	.460*

Note. ASL = American Sign Language; ITBS = Iowa Test of Basic Skills. Adjusted $R^2 = .042$ for Step 1; $\Delta R^2 = .248$ for Step 2 ($p < .001$); $\Delta R^2 = .091$ for Step 3 ($p \leq .05$).

* $p < .05$, ** $p < .001$.

mathematics assessment, $\Delta R^2 = .248$; $\Delta F(1, 57) = 21.175$, $p < .001$. Finally, having controlled for ASL exposure and literacy skills, we added student performance on the ITBS mathematics assessment into the regression model (Step 3). ITBS mathematics scores significantly increased the explained variance, $\Delta R^2 = .091$; $\Delta F(1, 56) = 9.459$, $p < .01$. In the final model, classroom exposure to ASL ($\beta = -.244$, $p < .05$) and the mathematics ITBS scores ($\beta = .460$, $p < .05$) remained the two significant predictors of performance on the ASL-accommodated math assessment (after removing overlapping effects of all variables).

Discussion

The findings from this study did not support the hypothesis that an ASL accommodation changes (i.e., either increases or decreases) student performance on reading and mathematics items from a state-standardized assessment. There are many challenges to understanding and interpreting the implications of these findings. This section discusses central issues in data interpretation including the nature of the study sample, the proficiency level of study participants, potential differences in how students are using the ASL accommodation during assessment, and ties to recent research on the use of “in-the-air” communication during classroom instruction. We conclude each topic with recommendations for next steps in understanding potential contributing factors to the results of this study.

Sample Specificity

The specificity of the study sample is both a limitation and an area for further contextualization of the study findings. ASL is used as the primary language of instruction in relatively few settings with a small number of students across the United States. To that end, it was necessary to find students who used ASL on a regular basis in classroom instruction in order for the study of ASL as an accommodation to be an appropriate fit with student experiences. The sample of this initial study was thus limited to students at schools that use ASL, even if supplemented by other modes of communication. All the students in this study were at schools for the deaf where ASL was the primary mode

of instruction. There was therefore little variability in the classroom ASL experience across the sample. That said, exposure to ASL did appear to play a role in student performance on an ASL-accommodated assessment, at least in mathematics. Further research investigating the role of classroom exposure to ASL would benefit from an extended sample of students who experienced ASL, such as those in a bilingual classroom or in an inclusive classroom with the aid of an interpreter.

Proficiency Level

The results overall not only indicate a wide range of proficiency in the population but also indicate an overall low level of performance; results ranged from a mean of 42% to 47% correct responses on test items depending on the condition and subject area. Some students performed at a far lower level, indicating that there may have been situations where students were simply guessing at the responses instead of drawing from their knowledge of the material. Students ranged in grade enrollment from fifth to eighth grade, but the reading ITBS scores indicate that there was a much broader range of proficiency—from 1.5 to 6.6 grade level in reading and from 1.9 to 7.6 grade level in mathematics. The average student, at a grade-equivalent level of 3.6 and 4.2 for reading and mathematics, respectively, was approximately two grades below the targeted grade level of the assessments. Whereas the content of the reading and mathematics items were in line with grade level enrollment, they may not have been in line with student background skills. As a caveat, teachers of SDHH recommend that students within 2 years of the assessed grade level use accommodations, and not an alternate assessment with alternate standards (Cawthon, 2007). It is therefore reasonable to assume that students with these characteristics would have participated in state assessments with an accommodation (even if not an ASL-items-translated accommodation). Although the study did not indicate floor effects for proficiency (no students were incorrect on all items), it is possible that ASL as an accommodation would only have an effect with a higher baseline of skills match with item demands.

Could ASL accommodations lead to greater access to test content for high-skill students? Results from our correlation analyses indicate that the stronger a student's proficiency, the less likely it was for ASL to increase his or her performance on the test items. For stronger readers, ASL may have been a distraction and not a way to increase access to test content. The literature on similar accommodations for students who are hearing (i.e., read aloud) indicates that the accommodation helps lower performing readers to increase their scores but does not provide a boost to students already proficient in the subject area (Meloy et al., 2002). The lower subject area proficiency of the sample in this study would appear to parallel those in the previous studies. Yet, the results here do not support the hypothesis that only weaker readers would benefit from the accommodation. Unfortunately, there was not enough variability in the impact of ASL to allow for analyses of potential predictor variables of changes in scores.

An additional surprise in the results of this study is that there was only a subject area match in the predictors of ASL-accommodated scores. Because the items for mathematics were word problems and not computation items, it is plausible that a strong level of reading proficiency would help students in their mathematics assessment. Problem solving in mathematics draws on critical thinking skills and applying computational skills to real-world problems (National Council of Teachers of Mathematics, 2000). Researchers in deaf education have emphasized the great need for further emphasis on these higher level skills (e.g., Pagliaro & Kritzer, 2005; Stewart & Kluwin, 2001). Much of the debate about the validity of mathematics test items that are presented "in the air" (i.e., through oral or sign) hinges on the idea that written language is a barrier to students who are not fluent readers. Accommodations such as ASL are used to remove this barrier and to provide students with more direct access to test item content. Perhaps surprisingly, although ITBS scores in mathematics were a significant predictor of their performance on study items, student proficiency in reading did not have a contributing effect to student performance in mathematics once skills in math were accounted for in the regression model. Access to the

word problems presented in this study, therefore, may have been more closely tied to a student's ability to approach the problem-solving task than in decoding and comprehension of the question's intent (Ansell & Pagliaro, 2006).

Use of ASL Accommodation

If taken at face value, it is possible to interpret the findings of this study as indicating a noneffect of ASL as an accommodation for SDHH in reading and mathematics. This would possibly temper some of the concerns about interpreting accommodated test scores as potentially invalid measures of the test construct. However, the findings also raise the question of the actual use of the ASL accommodation. It is possible that some of the readers in this study did not use the ASL accommodation as intended either because they did not attend to the accommodation or because they relied more on their reading skills than on the accommodation. We did not remove the print version of the test items altogether, and participants did not respond in ASL but via printed items in booklets. It is also possible that the ASL accommodation did not improve scores because it was not a sufficient supplement to reading the item text. We offer two plausible explanations for these results, below.

SDHH in this sample may have struggled with the ASL translation because it did not follow the form of conversational ASL or how material is presented in classroom instruction. This distinction may mean that the translated ASL did not add to the level of comprehension for students. In this case, the ASL translation would be a supplement, not a replacement, to student access through written print. Without an added benefit, one would expect to see a student's baseline skills in the subject area be the most significant predictor of performance on the assessment. This is, indeed, what may be the case in this study, as evidenced by the negative relationship between student proficiency in reading and their improvement in ASL versus unaccommodated version of the test. Furthermore, the sequence of the test item translations (written English–ASL–written English) may have triggered additional translation confusion for

students. Although this may not be specific to one subset of our student population (i.e., students who are proficient in the content area vs. below grade level), there may be some variance due to the dual-mode item presentation.

The question of adequacy of translation of ASL is an empirical one that can be investigated in further measures of student accommodations use and comprehension of test items presented in multiple formats. Related research in the use of ASL translation in instruction raises questions as to the potential impact of different forms of communication on student learning (e.g., Marschark et al., 2006, 2009). Results of these studies indicate that the ASL-based tools may vary in their facilitation of knowledge acquisition, with some evidence for efficacy of text-based (such as C-print) over in-the-air translations of teacher speech. Marschark, Sapere, Convertino, Seewagen, and Maltzen (2004) found that SDHH using ASL versus ASL transliteration performed similarly on college-level assessments. An extension of this study in Marschark et al. (2009) found that SDHH who wrote responses instead of signing them performed higher on a reading comprehension and summary task. A student's reading and writing skills appear to be a better indicator of performance on assessments than the use of an accommodation that is based on ASL instead of text.

There are differences, certainly, between readers who are in secondary and postsecondary settings and those who were in the current study—elementary and middle school students with lower reading and mathematics skills levels. The above findings about the efficacy of instruction accommodations inform, but cannot replace, empirical study of the efficacy of ASL as an assessment accommodation once the student has learned the material. Furthermore, whereas the above studies manipulated both the input (instruction) and the evaluation (assessment), the assessments in the current study were not explicitly tied to the content of instruction nor the student's own proficiency in ASL. Although each of the schools reviewed the items for their appropriateness for their students, we did not control for previous practice on specific types of reading tasks or math problem-solving skills. The purpose of this study was not to ascertain

the level of content knowledge students had learned but to look at the potential differential impact of ASL as an accommodation on item sets of matched difficulty.

A significant limitation of this study is the lack of a validation measure of student proficiency in ASL or their experiences within the assessment. The "exposure-to-ASL" variables were very rough summaries of how long students had experienced ASL at home or in the classroom. These were only proxy variables to what may be the most important predictor of ASL accommodations' effectiveness: ASL proficiency. Without this as a direct measure, we cannot fully understand the relationship between a student's use and knowledge of ASL and the role of ASL translations in standardized assessments. A related issue may be the DVD format of the ASL in this study. Administrators of the DVD were encouraged to monitor for student comprehension and to repeat items should students need more time. Some students did need to have additional clarification of the language background inventory, indicating that the ASL presented in the DVD format was not always sufficient for students to comprehend the meaning of the questions. It may be that when the DVD was shown to a group (and not individually), that the students found it more difficult to follow instructions than if they had been working one-on-one with an interpreter. However, we did not directly measure how students tracked information and how they used it in their responses. For example, although the pilot study included careful monitoring of student comprehension of test items in the ASL-translated format, the main study did not require checks or the use of "think-aloud" paradigms for further clarification of points where ASL accommodation may have increased student comprehension. Further research could include not only "think aloud" but also indicators of eye gaze, DVD rewinding or tracking, and other attentional cues to indicate what students use as input in an ASL-accommodated assessment. This kind of microlevel analysis would be helpful in understanding if the translated ASL challenges, if they existed, were due to vocabulary, syntax, or other differences between English order and ASL order structures.

Student Background

The authors' original model of how accommodations interact with student characteristics assumed that the student language–accommodations interaction would be a pivotal component of understanding variability in accommodations efficacy within the population (Cawthon et al., 2009). Yet the results of this study point to a larger question of how to look at an interaction of student language and accommodation use for SDHH. It is important to know how a student gains access to test content, but it may be that looking at the relationship between language factors and subject area proficiency is more important than language factors and accommodations use. For example, Marschark et al. (2009) found that simultaneous communication facility was significantly correlated with higher recall of study-dependent variables, whereas reported skills in ASL and spoken language were not significantly related to student performance. The findings of the current study also support work that student-reported experiences in sign language do not predict student performance on accommodated or standard conditions of assessments (Convertino et al., 2009; Marschark et al., 2009). Although both the current study and the previous research rely on student-report measures (and not teacher ratings such as those in Antia, Jones, Reed, and Kreimeyer [2009]), indicators are that the focus on the content of assessment, and not the form of assessment, may be most critical in understanding how language factors affect student performance.

Conclusions

This study represents a first step in understanding the role that ASL may play in how young SDHH participate in standardized assessments. State assessment policies that restrict the use of ASL accommodations for test items are based on the assumption that changing the language of the assessment changes the construct being measured by the test item. In a broad sense, the results of this study suggest that inflated test scores of students who have test items administered via ASL may not be a real concern. (Although there may be related issues of familiarity with the interpreter and variability in different interpreters that continue to be central to policy decisions.) The questions raised here

indicate that the way that information is accessed in an assessment is a relevant issue but that it relates back to the need to know more about the way language shapes learning of academic content for SDHH. In this case, knowledge development and knowledge assessment represent two ends of a developmental process. In essence, the questions here connect to our evolving understanding of how language and cognition are shaped in SDHH (Marschark & Hauser, 2008; Marschark & Wauters, 2008). Future studies need to directly address the question of what schemas are activated when a student sees a test question in ASL versus when it is read in a written form. It may be that the format of the assessment activates the same schema of knowledge, one that exists independently of how it is retrieved on the assessment. Or, alternatively, that different schemas are activated, each with a different match to the construct measured by the test item. What is central to any plausible explanation is a more direct measurement into the process within the “black box” of student learning and how we evaluate those outcomes. This is critical both for understanding how language factors affect learning and how we then use language in high-stakes standardized assessments. In conclusion, although language certainly plays an essential role in assessment, what we found in this study is that translating test items into ASL may not address the needs SDHH have when they participate in standardized assessments.

Supplementary Data

Supplementary material is available at <http://jdsde.oxfordjournals.org/>.

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Conflicts of Interest

No conflicts of interest were reported.

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