Adaptation of a Vocabulary Test from

British Sign Language to American Sign Language

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This study describes the adaptation process of a vocabulary knowledge test for British Sign Language (BSL) into American Sign Language (ASL) and presents results from the first round of pilot testing with twenty deaf native ASL signers. The web-based test assesses the strength of deaf children's vocabulary knowledge by means of different mappings of phonological form and meaning of signs. The adaptation from BSL to ASL involved nine stages, which included forming a panel of deaf/hearing experts, developing a set of new items and revising/replacing items considered ineffective, and piloting the new version. Results provide new evidence in support of the use of this methodology for assessing sign language, making a useful contribution toward the availability of tests to assess deaf children's signed language skills.

Introduction

Signed languages have been recognized as autonomous languages in many countries, including the US and most of Europe, and are used world-wide by large numbers of deaf individuals. Yet, sign language research can be considered a fairly young field, which did not start until the 1960s, whereas studies of hearing children's language development have a much longer history and traditionally have focused on spoken languages, exploiting the auditory modality. The study of signed languages makes an important contribution to the area of language development by allowing researchers to raise and explore issues that would not and could not be raised if human languages were confined only to the spoken modality (Meir, 2012). One such issue is the question of how and in what ways the physical modality of language transmission influences development.

Signed languages differ considerably from most spoken languages both with regard to modality (visual-gestural vs. aural-oral) and also due to their lack of a standardized written form (Meir, 2012; Sutton-Spence & Woll, 1999). In addition, only a small number (5-10%) of all deaf children have deaf parents (DCDP) (Mitchell & Karchmer, 2004) and acquire a natural signed language (e.g., ASL) from birth. The majority of deaf children are born to hearing parents (DCHP) and their early language experience is more variable, ranging from access to signed language to oral language input only (see Allen, 2014, for a more detailed description of these groups). It is necessary because of these differences to understand more about how early experience influences deaf children's linguistic development. This however requires the development and availability of appropriate test instruments for sign languages to document a) the effects of different ages of intial exposure to sign language and b) possible effects on language fluency depending on whether the language is a first or second language (Mayberry & Eichen, 1991; Morford & Mayberry, 2000). However, only a small number of such assessments exist internationally, and even fewer of those have been standardized. This is due to various reasons such as the relatively small size of the signing population and its heterogeneous nature, limited accessibility to deaf native signers and the young age of sign language research, particularly outside the US (see Haug & Mann, 2008; Mann & Haug, 2014, for a review). Based on these constraints, one strategy researchers have used is to adapt existing tests from one signed language to another. The most widely known example is the British Sign Language Receptive Skills Test (Herman, Holmes, & Woll, 1999), a test to measure the comprehension of morpho-syntax, which has been adapted, to date, into several other sign languages, including German Sign Language (Haug, 2012) and American Sign Language (Enns & Herman, 2011). Another strategy is to adapt existing assessments from spoken language. For example, the MacArthur

Communicative Development Inventory (Fenson et al., 1993), a parental checklist for English to monitor language development in children between the ages of 8-36 months, which has been adapted for many different languages, including ASL (Anderson & Reilly, 2002) and BSL (Woolfe, Herman, Roy, & Woll, 2010). The present paper adds to this research and delineates the process of adapting a new measure of deaf children's vocabulary knowledge in BSL, the web-based BSL vocabulary tasks (BSL-VT; Mann & Marshall, 2012), to ASL as part of a larger study, which investigated lexical acquisition in ASL and English by deaf children between 6-10 years (Authors, under review). Currently, there are no standardized assessments available for either ASL or BSL that measure vocabulary knowledge in the same detailed way as the BSL-VT and the ASL-VT.

The web-based BSL Vocabulary Test (BSL-VT)

The web-based BSL-VT (Mann & Marshall, 2012) measures vocabulary knowledge in BSL in deaf children aged between 4-15 years. More specifically, it examines variation in signers' understanding of different mappings between phonological form and meaning in single BSL signs. The BSL-VT consists of four tasks: form recall, meaning recall, form recognition, and meaning recognition. Each task contains 120 items, which are the same across tasks. All of these items are signs only; no fingerspelling[1] is used, e.g., B-A-N-K. Stimuli include pictures and video recordings of BSL signs and all tasks are web-based.

The BSL-VT is based on a model from second language acquisition (SLA) that assesses vocabulary size and strength (Laufer & Goldstein, 2004; Laufer, Elder, Hill, & Congdon, 2004). Compared to conventional tests, which have been criticized for testing vocabulary knowledge in a superficial way by focusing exclusively on vocabulary size (Laufer & Goldstein, 2004, 400),

[1] Fingerspelling is used in signed languages to spell out names of people and/or places for which no sign may exist.

e.g., Peabody Picture Vocabulary Test, Dunn & Dunn, 1997), the BSL-VT allows a more in-depth measurement of test takers' understanding of each individual item. Similar to the model by Laufer and colleagues, the underlying construct of the BSL-VT is based on the assumption that two or more learners may have different knowledge about the same word or sign. Table 1 illustrates this construct of strength of form-meaning mappings, ranging from 1, the weakest mapping (meaning recognition) – 4, the strongest mapping (meaning recall).

Table 1: Construct of strength of form-meaning mappings in BSL

Type of mapping	Strength of mapping	*Task description*
	Strong	
4. Meaning Recall	↑	Produce three BSL responses to a sign prompt
3. Form Recall		Produce the target BSL sign for a picture prompt
2. Form Recognition		Match a picture prompt with one of four BSL signs
1. Meaning Recognition	↓	Match a prompt in BSL with one of four pictures
	Weak	

During the form recall task, participants see an image and are asked to produce the corresponding BSL sign. In the form recognition task, participants are presented with a stimulus image and four signs and have to select the sign that best matches the image by using the mouse to click a radio button below the video. Similarly, in the meaning recognition task, participants see a stimulus sign and four images on their screen and have to select the image that best illustrates the meaning of the sign by clicking the radio button below the image with the mouse. Finally, for the meaning recall task, participants see the target BSL sign and have to supply a different BSL sign with an associated meaning. For the two recall tasks, participants' responses are manually entered by test administrator in a scoring form, which appears together with the stimulus on screen whereas responses for the two recognition tasks are automatically saved (for a detailed description of the procedure for each task, see Mann & Marshall, 2012).

As can be seen, two of the measures (form recall, meaning recall) involve production and two involve comprehension (form recognition, meaning recognition). A signer, who can recall the meaning (level 4) or form (level 3) of a sign, is also likely to recognize that sign's form (level 2) or meaning (level 1) when presented. Evidence in support of the construct includes research on signed (Mann & Marshall, 2012, Mann, Roy, & Marshall, 2013) and spoken language (Laufer et al., 2004; Laufer & Godlstein, 2004), which revealed significant differences in participants' performance across tasks. With each of the four mappings representing a different level of vocabulary strength, the test provides an estimate of test takers' vocabulary knowledge.

The aim of the reported work was to develop and pilot an adapted version of the BSL-VT for deaf children between the ages of 6-10 years in the USA as a baseline measure for a larger study that investigated signing deaf children's response to scripted mediation in ASL and to investigate the reliability and validity of the adapted measure. At the time of this work, there was no standardized ASL vocabulary test available that measures strength of vocabulary knowledge. All of the presented work took place in the US.

Method

In our adaptation of the BSL-VT to ASL, we followed the steps outlined by Enns & Herman (2011) and added a number of additional stages. This resulted in nine steps, presented in Table 2. A tenth stage, standardization on a larger sample, is currently in progress.

Table 2: Adaptation process for the BSL-Vocabulary Test to ASL

1. Consultation with ASL panel, consisting of deaf/hearing US experts all of whom were fluent or native signers*
2. Development of new test items/distractors*
3. Adjustment of items/images to account for cultural differences*
4. Validation of target items**
5. Recording of new target signs and distractors + introduction and instructions*
6. Changes to the web-based format**
7. Revision of items based on comments from panel*
8. Pre-pilot of ASL Vocabulary test prototype with two deaf adults*
9. Pilot I with complete set of items*

** = outlined by Herman & Enns (2011) ** = newly added*

Stage 1

During stage 1, we recruited a panel of experts at a university in Central Texas, consisting of seven members, four of whom were deaf and three were hearing. All panel members were either fluent or native signers, who used ASL as their primary means of communication. An additional part of this stage was the review of studies on sign structure/vocabulary acquisition in ASL and BSL to ensure suitability for adaptation. Findings suggested similar structures of the lexicons in the source (BSL) and target (ASL) sign languages, consisting of a native lexicon, which is divided into a core and a noncore lexicon, and a nonnative lexicon, which contains fingerspelled representations of spoken words (e.g., C-A-R).

The core lexicon of the native lexicon comprises lexicalized (i.e., fingerspelling that looks like a sign, e.g., NEWS), or established, signs (e.g., CAT, HOUSE, CAR) whereas the noncore lexicon comprises agreement verbs (e.g., GIVE-TO, SAY-NO-TO) and pointing signs (e.g., YOU, I). Other similarities relate to early sign development: findings from research that collected early normative data from signing deaf children using an adapted version of the MacArthur Communicative Development Inventory (for ASL: Anderson & Reilly, 2002; for BSL: Woolfe et al., 2010) indicate overall similar developmental patterns by deaf children acquiring signed language in a natural environment (from their deaf parent(s)).

Stages 2 & 3

During stages 2 & 3, two of the deaf native panel members reviewed the list of items from the BSL vocabulary test and discussed whether these items were appropriate for use in ASL. Both signers had previously taught at the school for the Deaf where the pilot was carried out and were well acquainted with the sign vocabulary used by children in the target group. This made it possible to control for regional variation. Given the smaller age range of the US target group for the present study (6-10 years), only a subset of 80 items was considered for adaptation, based on the performance of UK children in this age range. Following the discussions with the deaf experts, 66 of these 80 items were accepted for adaptation without further changes and could be translated directly to ASL. Of the remaining 14 items, 10 items required a change to the target item (and development of new items). These included the sign for PARIS, which was replaced by NEW YORK, in part because the sign in ASL is fingerspelled but also to make the item more culturally appropriate. Three items required a change to the label, due to differences between British English and American English. These items were 'tap' ('faucet' in American English), 'rugby' ('football' in American English), and 'rubbish' ('trash' in American English).

Upon completion of the item revisions, the final list was presented to the Deaf experts, who agreed that it was a representative sample of vocabulary items for the targeted age group.

As in the BSL-VT, the multiple-choice format used for the two receptive tasks (i.e., meaning recognition; form recognition) consisted of four types of responses: the target, a phonological distractor, a semantic distractor, and a visual distractor or an unrelated sign. These responses were presented in random order within a 2 x 2 arrangement.

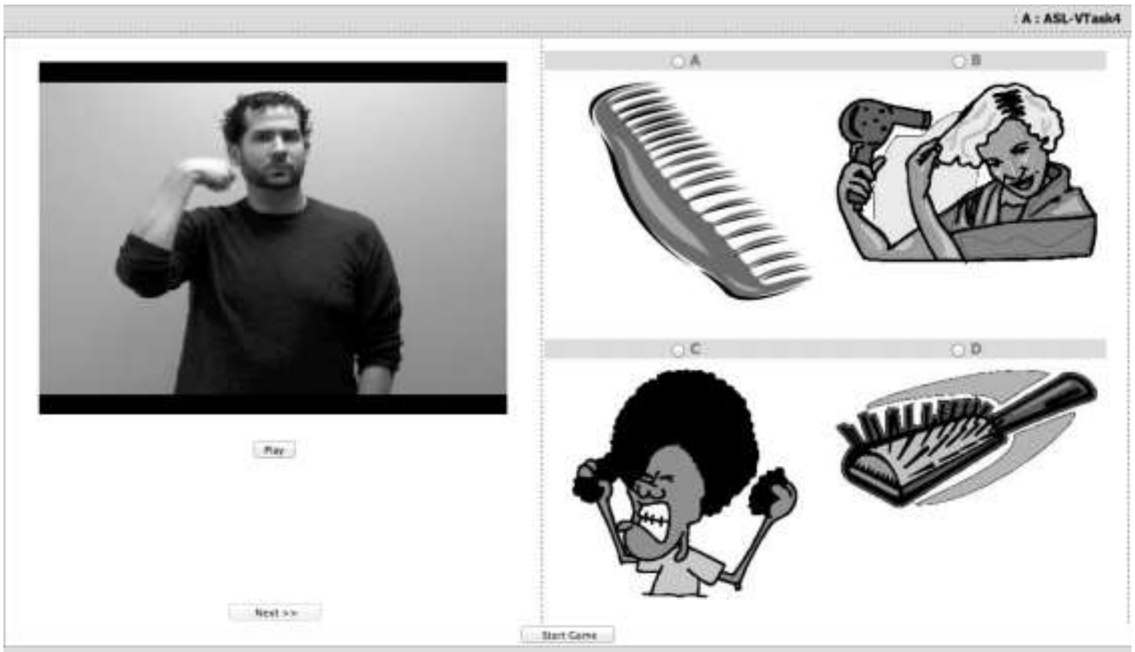
Phonological distractors were similar to the target item in that both shared one or more phonological parameter (e.g., hand configuration, location, movement). In the example for COOK (choice D), shown in Figure 1, the ASL sign CLEANER (choice A) is the phonological distractor because it shares handshape and location with the target item but differs with regard to movement (i.e., a flipping movement in the sign for COOK vs. a brushing movement in the sign for CLEANER). Both signs share the final downwards movement, which indicates PERSON.

Similarly, semantic distractors were semantically related to the target item, as illustrated in Figure 1 where SALAD (choice B) is the semantic distractor.

Figure 1: Example of phonological and semantic distractors

One considerable challenge in developing a sign language vocabulary test refers to the iconicity of signs (Jansma, Baker, & Knoors, 1997; Kyle, 1990; White & Tischler, 1999). Iconicity is the presence of a relationship between a lexical item's meaning and its phonological form. Children, who encounter an unknown sign in a test may be able to correctly guess the meaning by exploiting its iconic features (e.g., TELEPHONE in ASL which resembles the shape of a telephone as the fist has thumb and little finger protruding, BIRD in BSL which makes reference to a beak). To account for iconicity, we used two strategies: (a) we excluded items from categories, which show high levels of iconicity in ASL (e.g., body parts, numbers) and (b) included visual distractors, e.g., pictures that resembled the shape of the sign (Meaning Recognition) or non-signs (gestures) that were similar to the shape of the object or action presented in the picture (Form Recognition). For instance, the image of a person pulling out his hair was selected as a visual distractor for the target sign BRUSH in the meaning recognition task, because the hand configuration and movement used for this sign resemble the picture response in Figure 2 (see choice ‘C’). The correct choice for this item was D.

Figure 2: Example of a visual distractor



Stage 4

In addition to Age of Acquisition data from a BSL norming study by Vinson and colleagues (2008), we used a simplified version of the Mode of Acquisition (MoA) rating scale by Wauters and colleagues (2003) for ASL as an additional validating measure of our target items. MoA refers to the *type of information* children utilize in acquiring the meaning of a word or a sign (Wauters et al., 2008, p.175). It draws on the idea that knowledge of a word’s meaning can be understood as the interrelated array of the many different associations one has with that word, both linguistic associations but also expressions and perceptual associations. Recent findings indicate that MoA can be reliably measured by asking adults to judge the MoA of words

(Wauters et al., 2003, Wauters et al., 2008) and even signs (Tellings & Wauters, 2007) on a five-point scale.

In the present study, we gave a list with glosses of our final target signs to all elementary teachers at the participating school (N=12) and asked them to rate each ASL sign on a five-point scale. All were (deaf) native or near-native signers and had, on average, more than ten years of experience working with deaf children. A rating of one indicates a sign that is acquired mainly through perception, e.g., FLOWER, HOUSE, whereas a rating of five indicates a sign that is acquired mainly through linguistic information, e.g., UNIVERSE. A rating of three indicated that the sign is acquired through a combination of perception and linguistic information, e.g., DISCUSSION. By using the MoA ratings, our aim was to validate the choice of target signs of the ASL-VT as being appropriate for the targeted age range (6-10 years). Because our item pool included a combination of concrete/imageable (e.g., BIKE) and abstract/less imageable signs (e.g. WORK), we expected a spread of ratings across the scoring range. This is exactly what we found: MoA ratings showed an average score of 2.4 ('1' = 3 (3.75%), '2' = 44 (55%), '3' = 24 (30%), '4' = 9 (11.25%)). None of the signs received a rating of '5' ('learned through language'). The lack of any such items and/or the smaller number of items rated as '4' can be explained by the constraints to find suitable pictures for these, more abstract, items.

Stage 4 also included the addition/revision of pictures to be used as target stimuli and/or distractors. For the BSL-VT, Clipart (www.clipart), an online picture database, was used to ensure consistency of style. For the ASL version, we worked with Dreamstime (www.dreamstime) as an additional resource. In order to validate our target pictures for the ASL version of the vocabulary tasks, we enlisted the help of 18 undergraduate students from the department of Communication Sciences & Disorders. Students were presented with pictures of all target items and asked to write down for each picture their 3 best guesses what it meant. Any picture for which less than 50% of respondents guessed right was replaced. This happened in four out of 80 cases.

Stage 5

During Stage 5, all target and distractor signs were videorecorded in high definition and saved in flash player format so they could be uploaded to the web. We used the same two deaf native signers as models, who had reviewed all target signs during Stage 2 and, thus, were highly familiar with the test items and the procedure. The test introduction and instructions for each of the four tasks were signed by another native signer, who was not part of the panel in a way that was considered appropriate for children in the targeted age range.

Stage 6

Following the revisions of the instruction videos, we made a number of additional changes to the (web-based) test format during Stage 6, which included moving the selection buttons in the recognition tasks directly above each response to make it easier for the participant to associate a response with an item. In the BSL-VT, all selection buttons are located below the bottom response. We also changed the format of one of the tasks, meaning recall, by increasing the number of responses to be generated by the test taker from one to three. This revision was informed by recent work of Sheng and colleagues (2012) on spoken language. Our rationale for adapting Sheng's repeated meaning association task format was to collect more in-depth information on deaf children's representation and organization of semantic knowledge and to document differences in their retrieval patterns of semantic associations (i.e., categorical and thematic) across repeated elicitations.

Stage 7

During Stage 7, two members of the panel, both fluent in ASL and with a background in linguistics, reviewed the test and distractor items for the two comprehension tasks (Tasks 2 + 4). They were given a 3-point rating scale and asked to evaluate the quality of each item (including pictures and signs), with ‘1’ suggesting major revisions or removal of the item, ‘2’ recommending minor revisions, e.g., replace one of the distractor signs, and ‘3’ indicating that the item works well. Reviewers were asked to rate each item based on this scale and to make use of the whole range. For any rating lower than ‘3’, they had to provide detailed comments. Based on the reviewers’ comments changes were made for 19 items for the Form Recognition task (Task 2), including 16 minor and 3 major revisions. For the Meaning Recognition task (Task 4), changes were made for 22 items, including 21 minor and 1 major revisions. Minor revisions generally required re-filming signs that were judged as less commonly known variants or replacing distractor signs or images that were too close to the target. Major revisions included replacing target/distractor signs or pictures that were not clear enough or too similar to the target.

Next, we administered the two receptive vocabulary tasks to a control group of 87 age-matched hearing children (M: 8;6 SD: 12.9 Range: 6;4 -11;2 years; 47 girls and 40 boys) with no knowledge of ASL to measure whether our efforts to reduce unwarranted effects of iconicity from the test were successful. The percentage of correct responses on the Form Recognition task was 33.84 (SD: 7.22, Range: 15-50) and 28.48 (SD: 7.03, Range: 10-45) on the Meaning Recognition task, both indicating that children performed above chance level (25%) although only marginally. This result is similar to findings by Hermans et al. (2009), who administered a receptive vocabulary task for Sign Language of the Netherlands (SLN) to a control group of 28 hearing children aged 11-12 years. The average percentage of hearing children’s correct responses was 33.5% (Range: 21.3 - 42.6). For both tasks, the maximum amount of correct responses is 80. As suggested by Hermans and colleagues, it is possible that hearing non-signers are able to take advantage of the spoken components of the assessed sign language (e.g., mouthed words) in addition to or instead of the iconic features of a target sign to guess the correct answer.

Stages 8 & 9

The next two stages included a pre-pilot and pilot testing of the completed set of test items in order to finalize the prototype of the adapted ASL vocabulary test. The specific procedures and results of the pilot testing and description of the psychometric properties of the prototype are discussed in the next section.

In a pre-pilot, we asked two deaf adults to complete all vocabulary tasks and to provide feedback on any items they considered problematic and/or suggestions of format-related changes. This was done as an additional measure to ensure test validity. Both participants scored close to 100% correct on all tasks (T1: 98%, 96%; T2: 91%, 95%; T3: 83%, 92%; T4: 95%, 94%). Based on the feedback, any final revisions were made and uploaded to the test website.

Participants

In the final stage (Stage 9), we piloted the test with a small group of deaf children (N=20, 8 boys and 12 girls) in the target age range (M=8;5, SD=1.3, range=6;3 -10;11 years). They were recruited from a residential school for the Deaf in Central Texas. Ethical approval for the study was obtained from the university prior to any testing. Only children with parental consent were included. Biographical information on each participant was collected by means of a teacher survey. This survey included questions on children's age, type of hearing loss, amplification used, parental hearing status, and communication used at home. All children had at least one deaf parent and acquired ASL from birth. Out of 14 students for whom this information was available, 71% per cent received free or reduced school lunches whereas 29% paid for their lunches. Three of the remaining six students were residential students, who are not required to fill out an application for reduced lunch and for the other three day students parents did not fill out applications.

Measures administered in the pilot stage. In addition to the ASL-VT, participants also completed the ASL Receptive Skills Test (Enns & Herman, 2011), which assesses understanding of syntactic and morphological aspects of ASL in deaf children between the ages of 3-12 years. This test is in the process of being standardized. Given the posited close relationship between vocabulary and wider language skills in spoken languages (Clark,1993), one might expect to find deaf participants ASL-VT scores to be correlated with their performance on the ASL-RST.

Procedures

Table 3 provides a summary of the pilot version of the ASL-VT.

Table 3: Pilot version of the ASL-VT

Tasks	Number of items	Maximum Score	Coding	Scoring Method
Meaning Recall (4)	80	240	‘0’/’0.5’/’1’	Manually
Form Recall (3)	80	80	‘0’/’0.5’/’1’	Manually
Form Recognition (2)	80	80	‘0’/’1’	Automatic
Meaning Recognition (1)	80	80	‘0’/’1’	Automatic

The ASL-VT tasks were presented to each child individually in a quiet room at the school, using a Macintosh computer with a 26-inch screen and internet access. We kept the same overall administration format as used for the BSL version by administering the four tasks over the course of two sessions, with two tasks per session. The order of administration was, as follows: Form recall, form recognition (session one), meaning recall, meaning recognition (session two). All participants completed the tasks in the same order, which was chosen to minimize, where possible, learning effects. A deaf native signer, who worked at the school, administered all ASL-VT testing and the non-verbal IQ in separate sessions. The ASL-RST was administered separately by the hearing speech language pathologist, who used ASL on a daily basis.

Results

Reliability

Reliability for internal consistency. Cronbach's alpha measures were computed separately for each form-meaning mapping measures. Because of the limited numbers available in each age band, all ages were collapsed into one. The average alphas for the four mapping ranged from .54 to .94. Following guidelines set forth by Nunnally (1978), an alpha coefficient of at least .70 is considered adequate for an instrument in early stages of development and a coefficient of at least .80 to be adequate for a more developed instrument. Three of the four tasks, i.e., meaning recall (.94), form recall (.86), and form recognition (.71), met these requirements whereas the significance for the meaning recognition task was low (.55). As will be discussed later, this was the least discriminating task for the immediate target population, with ceiling effects in the older age groups (see below). Given these findings, a more detailed item analysis was carried out.

Item analysis. Item analysis showed that 12 items were passed by all participants on three of the four levels of vocabulary knowledge (meaning recognition, form recognition, and form recall) but none of these items were passed by all participants on the meaning recall task. There was one item in the form recognition task that was failed by all children. No one item was failed by all participants across all four levels. While items that are not discriminating would normally be taken out, this was not possible due to the structure of the test so they were retained. In addition, this level of high performance is likely to be associated with the nature of the target sample of school-aged children all of whom were deaf native signers with deaf parents (DCDP). One would expect the identified items to be more challenging for a younger sample (e.g., 4-6 years) and/or for the more heterogeneous group of deaf children with hearing parents (DCHP), who represent the majority of the deaf population (90-95%, Mitchell & Karchmer, 2004).

Inter-rater reliability. Items from the two productive vocabulary tasks were coded by the first author and responses of 4 participants (20% of the sample) were coded independently by a graduate student with background in sign language linguistics and fluent knowledge of ASL, who was not involved in the study and blind to the results. Cohen's kappa was calculated to determine the level of agreement between the raters' judgments. Following the guidelines provided by Landis and Koch (1977), the agreements between raters' judgments for scoring the form recall task (k=.91) and for scoring the meaning recall task (k=.85) were very good. Items from the two receptive tasks were automatically scored by the computer upon selection of the response.

Validity

Content Validity. Evidence in support of content validity was collected in two ways: by working closely with an expert panel, which included deaf native signers, on the development of the target and distractor items (see stage 1 of task adaptation). This led to revisions of 14 items. In addition, we used MoA ratings by teachers of the Deaf for our test items (see stage 4 of task adaptation) to evaluate the type of information (or combination of types) used by children to acquire these items. Findings showed a spread of ratings over most of the range with exception of items (rated as '5') that are acquired exclusively through language. As suggested, this may be due to the format of the test, which requires any item to be presented as a picture.

Construct validity. In order to provide a developmental picture of vocabulary growth in ASL, we first examined whether participants' performance on the different tasks correlated with age. We then investigated differences between participants' performances across tasks. Mean performance scores on the four ASL-VT tasks for the total sample (N=20) are shown in Table 4.

Table 4: Percentage scores for the vocabulary tasks

Test scores	Mean %	SD	Range
Meaning recall (4)	58.83	8.63	34-70
Form recall (3)	85.13	8.02	66-98
Form recognition (2)	88.88	5.19	80-96
Meaning recognition (1)	91.94	4.17	84-99

Bivariate correlations between each of the tasks and age were computed, using a Pearson correlation coefficient, with the alpha reduced to .013 for multiple comparisons, k=4. These correlations are presented in Table 5.

Table 5: Correlation between age and ASL-VT raw scores

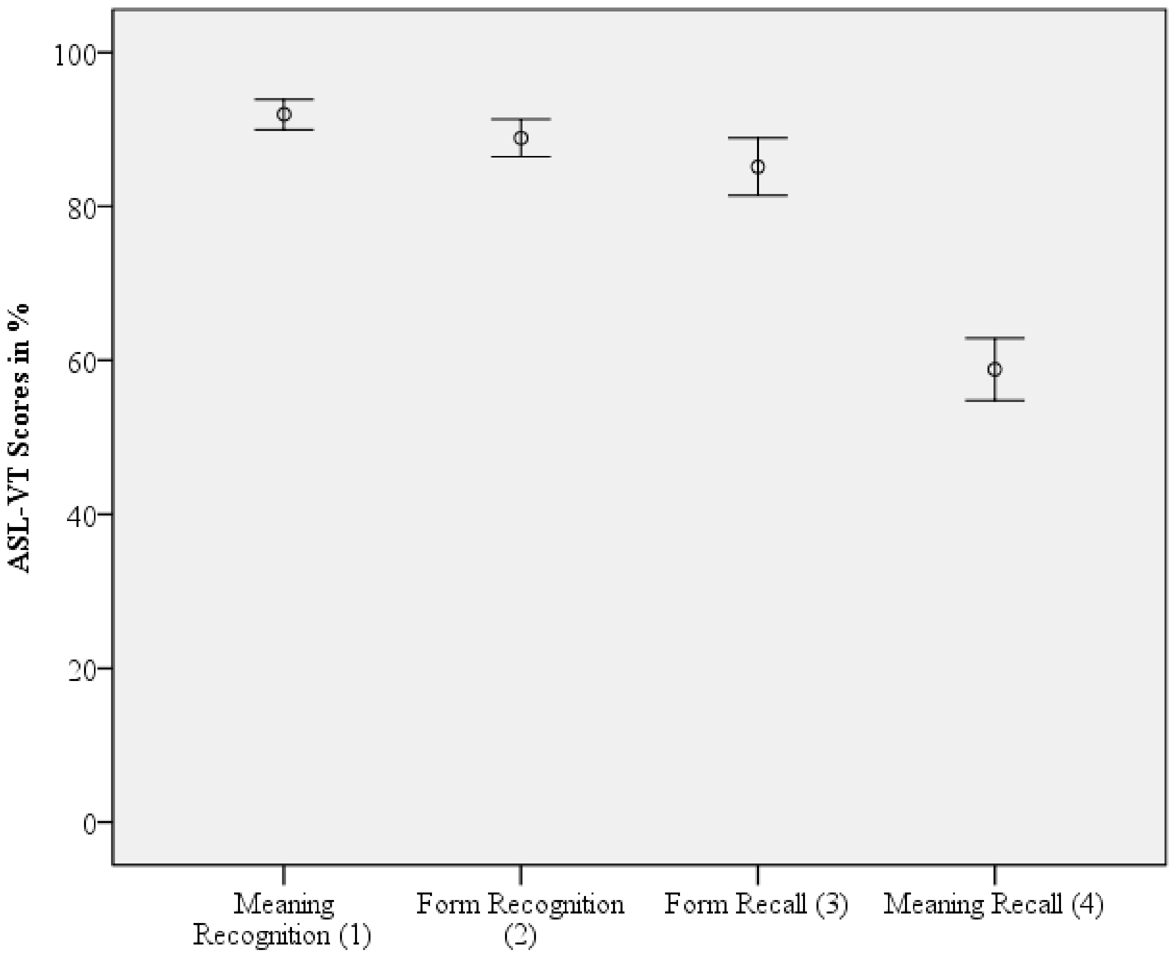
Variable	Meaning (1) Recognition	Form (2) Recognition	Form (3) Recall	Meaning (4) Recall
Age	0.49* [.08-.79]	0.68** [.37-.89]	0.63** [.35-.84]	0.43 ns [-.01-.77]

Ns = not significant, *<.05 **p<.01, BCa bootstrap 95% CIs reported in brackets

Two of the correlations were significant (form recall, form recognition) under our strict regulations. The correlations were run a second time, using bootstrapped confidence intervals to account for the small sample size. No differences were found.

Next, we tested the construct validity of the items based on the order of difficulty, predicted by the model of strength of form-meaning mapping (see Table 1). Findings from previous research on the BSL version of the test had confirmed the validity of the model (Mann & Marshall, 2012). However, because the target populations differed and test adaptations carried out (see above), it is important to investigate the construct validity of the ASL version. Accordingly, we conducted a repeated measures analysis of variance (ANOVA), using a one-level design with task (form recall, form recognition, meaning recall, meaning recognition) as the within -participant repeated measure. Effect sizes (η_ρ^2) were calculated and interpreted using Cohen's criteria of small, medium, and large effects: .01= small, .06=moderate, .14= large (Cohen, 1988). Prior to examining the repeated measures ANOVA results, the assumption of sphericity was tested and Greenhouse-Geisser correction was applied. Results showed a main effect of task, $F(3, 57) = 213.253$, $p<.001$, $\eta_\rho^2 = .918$. This is illustrated in Figure 3.

Figure 3. ASL-VT mean scores in % by task. Error bars denote 95% confidence intervals.



Post-hoc tests with Bonferroni corrections showed that participants scored higher on form recall than meaning recall (p<.001); higher on meaning recognition than form recall (p<.01); higher on form recognition than meaning recall (p<.001); higher on meaning recognition than form recognition (p<.05); higher on meaning recognition than meaning recall (p<001); and higher on form recognition than form recall (p=.09) but fell short of significance on the last comparison in this small sample. Together, these results demonstrate that knowledge of form-meaning mappings improves with age and that the different tasks tap the strength of these mappings to differing extents, with meaning recognition being the easiest task, followed by form recognition and form recall, completed by meaning recall as the hardest task. Results from repeated calculations with age as covariate did not show any differences.

Concurrent Validity. To collect evidence for concurrent validity, we compared participants' performance on the four vocabulary tasks with their ASL-RST scores. The mean raw scores (SDs) by age group were, as follows: 6 yr.: 31, (0); 7yr.: 32.5 (3.99); 8yr.: 32.0 (3.16); 9yr.: 35.25 (3.20); 10yr.: 34.5 (4.2). In order to compare these results with ours we converted the raw sores to percentage correct scores (see table 6), with a mean group score of 78.81 (8.32).

Table 6: Pilot testing results

		Mean Performance in % (SD) and range				
Age	Child/ Year	Meaning (1) Recognition	Form (2) Recognition	Form (3) Recall	Meaning (4) Recall	ASL-RST
6	2	88.13 (2.65)	80.00 (0.00)	74.07 (11.05)	48.55 (20.33)	73.81 (0.00)
		R: 86-90	R: 80-80	R: 66-82	R: 34-63	R: 74-74
7	6	91.04 (4.50)	88.33 (4.92)	82.09 (6.60)	56.50 (6.73)	77.38 (9.49)
		R: 84-96	R: 84-96	R: 71-89	R: 48-64	R: 64-93
8	4	90.63 (2.98)	86.88 (5.05)	84.69 (7.54)	60.47 (9.51)	76.19 (7.53)
		R: 88-94	R: 83-94	R: 77-95	R: 48-70	R: 67-83
9	4	92.50 (5.20)	91.88 (2.39)	89.22 (5.96)	62.45 (5.31)	83.93 (7.62)
		R: 91-99	R: 90-95	R: 82-96	R: 55-67	R: 79-95
10	4	95.94 (1.57)	93.13 (2.17)	91.57 (4.91)	62.19 (4.73)	80.95 (10.10)
		R: 94-98	R: 91-96	R: 86-98	R: 56-67	R: 71-95

Bivariate correlations between each of the vocabulary measures and performance on the ASL-RST with the reduced alpha level revealed no significant correlations between ASL-RST score and meaning recognition, R(20) = .049, p = .836, form recognition, R(20) = .144, p = .544, form recall, R(20) = .058, p = .808, or meaning recall, R(20) = .114, p = .632. A repeated set of calculations with age partialed out did not show any differences. This finding was unexpected and against prediction. However, inspection of the distribution of scores on the vocabulary tasks and ASL-RST revealed some similarities between the ASL-VT and ASL-RST in their profiles across age bands (see table 5). These include considerable overlap in score ranges across age bands, and very small (or no) progression for children between the ages of 7-8 years and between 9-10 years. The limited progression is particularly visible in younger children's performance on the two recognition tasks and the ASL-RST and in older children's performance on the meaning recall task of the ASL-VT. This lack of systematic progression across age groups with older groups achieving marginally lower mean scores than their younger peers at times is probably crucial in understanding the lack of expected correlations between the ASL-VT and ASL-RST. For all measures the most marked performance gains were found from the youngest age group of 6 year-olds to the next 7 year-old age band.

Discussion

This study described the adaptation process of a vocabulary knowledge test for British Sign Language (BSL) into American Sign Language (ASL). Because one of the main aims of the present study was to develop a vocabulary assessment measure for ASL that worked in a similar way to the BSL-VT, we examined a number of psychometric properties of the ASL version of the vocabulary tasks. Our analyses of reliability revealed that the internal consistency of three of the four ASL-VT tasks fell within an acceptable range for newly developed instruments (.70+).

Possible explanation for the low correlation coefficient for the fourth task, meaning recognition, include the highly proficient signing skills of the target group (DCDP), the low strength of form-meaning mapping for this task according to our underlying model, and a possible learning effect over the course of the task administration. Inter-rater reliability for the production tasks was sufficiently high although the live assessment of the appropriateness of responses for the meaning recall task remains challenging. We are working towards developing a corpus of acceptable associations.

In addition, we took a number of steps to evaluate different types of validity of the ASL-VT, including content validity, construct validity, and concurrent validity. The evidence we collected in support of content validity included feedback by a panel of deaf and hearing experts related to the target and distractor items as well as feedback by a group of undergraduate students on the quality and clarity of the test images. In addition, we collected Mode of Acquisition (MoA) ratings of our target items reflect the range/spread of item types from concrete to abstract signs. Findings showed that the items are less abstract (no level 5 rated items) for the older group of participants than would be the case in a task for hearing children in that age range. The lack of any (high) ratings describing signs, which are learned exclusively through language (e.g., UNIVERSE) suggests that the ASL-VT in its current (abbreviated) form would need more abstract/less imageable items in order to make the test equally challenging for children beyond the tested age groups (10+ years). This raises a couple of important issues related to one of our tasks, form recall, which uses a picture-naming format. While this format has been commonly/successfully used in many standardized vocabulary tests for spoken language, including the Expressive One Word Picture Vocabulary Test (EOWPVT, Brownell, 2000) or the Boston Naming Test (Kaplan, Goodglass, & Weintraub, 1978), it is not without limitations for signed languages, one being the availability of images for highly abstract words or signs. The way names are used to refer to pictures has been shown to vary across languages; also, less normative data has been collected for pictorial stimuli, compared to verbal stimuli. As a result, the comparison of studies that used pictorial stimuli becomes difficult because the stimuli used in these studies were different (Sanfeliu & Fernandez, 1996).

An additional limitation of using picture-naming tasks in signed language tests may be the common use of fingerspelling or initialized signs for more abstract items. Fingerspelling is used to spell words for which no sign exists e.g. technical terms, names, or locations, to spell words for signs that the signer does not know, or to clarify a sign unfamiliar to the conversation partner. An initialized sign combines an existing sign with a manual alphabet handshape corresponding to the first letter of an English word, e.g., GROUP, FAMILY, WORLD. The extent to which fingerspelling is used in signed languages differs. For instance, ASL users are known to make more use of fingerspelling while this is less the case for users of Turkish Sign Language (Kubus & Hohenberger, 2011) or signed languages of Eastern Europe (Bickford, 2005). Initialized signs are often used as part of signed English (SE), a system of manual communication to represent English. Little detail is known on differences in the use of fingerspelling and initialized signs in ASL and BSL (e.g., Cormier, Schembry, & Tyrone, 2008).

While we acknowledge the paucity of age-appropriate, more abstract signs that are not fingerspelled as a constraint to our range of item difficulty, this potential limitation is at least partially compensated for by our other recall task, meaning recall, which requires children to know the meaning of an item in order to generate associations. This highlights the versatility of the ASL-VT, which does not just reveal levels of difficulty for any one child but goes some way to address the problem of lack of more abstract items. Also, despite its limitations, the form recall task produced a range of results and was positively associated with age, which makes it the most comparable of the four tasks with other vocabulary tests that use this format.

To evaluate construct validity, we examined whether the four ASL vocabulary tasks tap the strength of the form-meaning mapping to differing extents and whether the resulting hierarchy of the degrees of strength is comparable to BSL. Our results show that this was the case. Similar to the UK study, we found that deaf children in the US performed highest on the meaning recognition task, followed by the form recognition task and experienced more difficulties with the two recall tasks – form recall and meaning recall. However, there were some differences between the two groups: the difference between children's performances on the two recall tasks was not significant in BSL ($p=0.15$) at the reduced alpha level we had adopted in our analyses whereas it showed significance in ASL ($p<.001$). This is likely to be a result of our modification of the meaning recall task in the ASL version - participants were asked to produce three signed responses compared to one response in the BSL version - which made the task more challenging. Another difference in task performance on the ASL/BSL version was observed between form recall and form recognition. This difference was significant in BSL ($p<.001$) but not in ASL ($p=.09$). One possible explanation for this is the smaller set of items that was used for the ASL version (only a subset of 80 out of 120 items were adapted for ASL), which may have lacked more difficult items for the form recall task. This is supported by our findings of near ceiling effects on the easier tasks (meaning recognition, form recognition) of the ASL-VT, evident in our current sample of native signers, which are not apparent on the more difficult tasks (form recall, meaning recall). The main rationale for adapting a smaller item subset for ASL was the smaller age range of the American sample, i.e., 6-10 years, compared to the BSL version, i.e., 4-15 years.

Overall, our findings from ASL support an earlier claim by Mann and Marshall (2012) that signers' knowledge of the mapping between form and meaning is not an all-or-nothing phenomenon but depends on what they are required to do with the knowledge. More specifically, it shows that recall requires a stronger mapping than recognition and signers, who successfully recall the form of a sign or supply another sign, or several signs, with an associated meaning would be also expected to recognize that sign's form or meaning, as predicted by our underlying model of strength of form-meaning mappings. The presented findings suggest that this model seems to hold across signed languages.

Finally, as a measure of concurrent validity, we compared participants' ASL-VT scores to their performance on the ASL-RST, an assessment instrument recently adapted from BSL, which targets morpho-syntactic skills in deaf children between the ages of 4-13 years. While none of the four vocabulary measures correlated significantly with the ASL-RST, both tests showed similarities in their profiles across age bands, which included considerable overlap in score ranges across age bands, and very small (or no) progression for children between the ages of 7-8 years and between 9-10 years. These findings are similar to studies that used the ASL-RST (Enns & Allen, 2013; Enns & Hermann, 2011), which showed relatively little progression within the age range that was targeted in this study (6-10 years). The lack of systematic progression across age groups observed in some of the tasks of the ASL-VT and also in the ASL-RST raises another important issue pertaining to signed language tests, which is the development of items that are equally challenging for the sub-groups within the larger signing population(s) involved. Because of the small percentage of deaf children with deaf parents (DCDP) within the deaf population (5-10%, Mitchell & Karchmer, 2004), finding such a sample large enough to establish norms is often difficult. Even with such a sample, one question that remains is whether/to what extent these norms represent the larger population of deaf children with hearing parents (DCHP), whose signing skills are much more variable. Issues around the ‘representativeness’ of norming samples are not limited to signing populations. However, in contrast to the hearing population, their mixed experiences and exposure to ASL/BSL as opposed to other forms of communication present an additional confound in establishing normative data for signing populations (see Mann, Roy, & Marshall, 2013, for a discussion). One way to approach this issue is to develop norms for larger combined DCHP and DCDP populations and report sub-groups means to support finer interpretations of individuals’ performance within those groups.

A possible explanation for the lack of any significant correlations between the ASL-VT and the ASL-RST scores could be the different nature of tasks: the ASL-VT assesses children’s strength of semantic knowledge of single ASL signs whereas the ASL-RST measures their understanding of ASL grammar in phrases and sentences, including negation, number and distribution, and noun-verb distinction. Another reason may be the difference in sample of test takers, especially the age range which is much wider for the ASL-RST (4-12 years) compared to the ASL-VT (6-10 years).

Other directions for future studies include the comparison of deaf children’s vocabulary knowledge across different signed languages. While the findings we report for deaf native signers from the US indicate a hierarchy of strength of vocabulary knowledge that is similar to findings for deaf native signers from the UK (Mann & Marshall, 2012) this needs to be studied in more detail on larger, age-matched, samples. Finally, taken into account the bilingual status of many deaf language users, an adaptation of our test for spoken English suggests itself as a measure with children known or suspected to be language impaired. Such a test could benefit signing deaf children, whose English skills are in general assessed based on standardized tests developed for a different target group, i.e., hearing children, and/or deaf children who are using spoken language as their dominant language or have been trained exclusively oral.

Conclusion

We have set out to report in a very detailed way a procedure for adapting tests from one signed language to another. The work we reported here on the adaptation of the BSL vocabulary tasks to ASL is still in progress and awaits standardization on a larger sample. Nevertheless, the presented findings make a number of valuable contributions to the field of language assessment both practical and theoretical. From a practical point of view, the tasks provide practitioners with a tool to assessing different levels of deaf children's vocabulary knowledge. From a theoretical perspective, our work contributes to the comparison of vocabulary development between deaf learners using different sign languages. Findings from our work on BSL and ASL suggest that the construct of vocabulary knowledge as different degrees of strength of the mapping between form and meaning of signs holds for these two sign languages. This encourages the adaptation of the tasks for other signed languages. At the time, it stresses the need for test 'adaptation' as opposed to translation that takes into account cultural differences and goes beyond the simple substitution of words such as New York for Paris.

Finally, our work addresses some key issues faced by spoken language test developers, including construct definition and validation of language assessments, assessment of smaller, non-mainstream populations, assessment of vocabulary knowledge, and the impact of technology on language assessment. There are notable parallels for developing sign tests and those for minority spoken languages, especially where there is limited or no linguistic research in part due to the small number of native speakers. These parallels encourage more active collaborations between researchers in both fields.

Acknowledgments

This research was supported by a Marie Curie International Outgoing Research Fellowship within the 7th European Community Framework Programme awarded to the first author. The authors would like to thank the team of deaf experts who helped adapting the vocabulary tasks to ASL, Mark Gobble, Mike Wynn, & Leah Geer for modeling all target and distractor signs, Lynn Hou and Leah Geer for reviewing the target and distractor items, and David Simmons for signing the ASL instructions. We would also like to thank David Quinto-Pozos, Richard Meier, and Stephanie Cawthon for their comments on the test format. We are very much indebted to the three anonymous reviewers for their insightful comments on earlier versions of this work. Finally, we would like to express our gratitude to all the children, parents, teachers, and others at the school, who took part in and supported this research study.

References

Allen, T. E. (2014). The Deaf Community as a “Special Linguistic Demographic”: Diversity Rather Than Disability as a Framework for Conducting Research with Individuals Who Are Deaf. In E. Orfanidou, B. Woll, & G. Morgan (Eds.), *Research Methods in Sign Language Studies: A Practical Guide* (21-40). Wiley-Blackwell.

Anderson, D., & Reilly, J. (2002). The MacArthur communicative development inventory: normative data for American Sign Language. *Journal of Deaf Studies and Deaf Education*, *7*(2), 83-106.

Authors (submitted). Child Modifiability as Predictor of Language Impairment in Deaf Children who use American Sign Language. *American Journal of Speech Language Pathology*.

Bickford, J. A. (2005). *The signed languages of Eastern Europe*. SIL International.

Brownell, R. (2000). Expressive One-Word Picture Vocabulary Test. Novato, CA: Academic Therapy Publications.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.) New York: Academic Press.

Clark, E.V. (1993). The Lexicon in Acquisition. Cambridge: Cambridge University Press.

Cormier, K., Schembri, A., & Tyrone, M. E. (2008). One hand or two? Nativisation of fingerspelling in ASL and BANZSL. *Sign Language & Linguistics*, *11*(1), 3-44.

Dunn, L. M., & Dunn, D. M. (1997). Peabody Picture Vocabulary Test. Circle Pines, MN: American Guidance Service. *Inc. Publishing*.

Enns, C. J., & Herman, R. C. (2011). Adapting the Assessing British Sign Language

Development: Receptive Skills Test Into American Sign Language. *Journal of deaf studies and deaf education*, 16(3), 362-374.

Fenson, L., Dale, P. S., Reznick, J. S., Thal, D., Bates, E., Hartung, J.P., & Reilly, J.S. (1993). *MacArthur Communicative Development Inventories: User's Guide and Technical Manual*. Singular Publishing Group. *San Diego, CA*.

Haug, T. (2012). Methodological and theoretical issues in the adaptation of sign language tests: An example from the adaptation of a test to German Sign Language. *Language Testing*, *29*(2), 181-201.

Haug, T., & Mann, W. (2008). Adapting tests of sign language assessment for other sign languages—A review of linguistic, cultural, and psychometric problems. *Journal of Deaf Studies and Deaf Education*, *13*(1), 138-147.

Herman, R., Holmes, S., & Woll, B. (1999). *Assessing BSL Development - Receptive Skills Test*. Coleford, UK: The Forest Bookshop.

Hermans, D., Knoors, H., & Verhoeven, L. (2009). Assessment of sign language development: The case of deaf children in the Netherlands. *Journal of Deaf Studies and Deaf Education*, enp030.

Jansma, S., Baker, A. E., & Knoors, H. (1997). Sign Language Assessment: A Dutch Project. *Deafness and Education*, *21*(3), 39-46.

Kaplan, E., Goodglass, H., & Weintraub, S. (1978). *Boston naming test*. Boston: Kapplan & Goodglass.

Krivitski, E. C., Mcintosh, D. E., Rothlisberg, B., & Finch, H. (2004). Profile analysis of deaf children using the universal nonverbal intelligence test. *Journal of Psychoeducational Assessment*, *22*(4), 338-350.

Kubus, O., & Hohenberger, A. (2011). The phonetics and phonology of the TİD (Turkish Sign Language) bimanual alphabet1. *Formational Units in Sign Languages, 3*, 43-63.

Kyle, J. (Ed.)(1990). *Deafness and Sign Language into the 1990's*. Deaf Studies Trust.

Laufer, B., Elder, C., Hill, K., & Congdon, P. (2004). Size and strength: do we need both to measure vocabulary knowledge?. *Language testing*, *21*(2), 202-226.

Laufer, B., & Goldstein, Z. (2004). Testing vocabulary knowledge: Size, strength, and computer adaptiveness. *Language Learning*, *54*(3), 399-436.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *biometrics*, 159-174.

Mann, W., & Haug, T. (2014). Mapping Out Guidelines for the Development and Use of Sign Language Assessments: Some Critical Issues, Comments and Suggestions. In D. Quinto-Pozos (Ed.), *Multilingual Aspects of Signed Language Communication and Disorder* (pp. 123-142). Multilingual Matters.

Mann, W., & Marshall, C. (2012). Investigating deaf children's vocabulary knowledge in British Sign Language. *Language Learning*, *62*(4), 1024-1051.

Mann, W., Roy, P., & Marshall, C. (2013). A Look at the Other 90 Per Cent: Investigating British Sign Language Vocabulary Knowledge in Deaf Children from Different Language Learning Backgrounds. *Deafness & Education International*, *15*(2), 91-116.

Mayberry, R. I., & Eichen, E. B. (1991). The long-lasting advantage of learning sign language in childhood: Another look at the critical period for language acquisition. *Journal of memory and language*, *30*(4), 486-512.

Meir, I. (2012). The evolution of verb classes and verb agreement in sign languages. *Theoretical Linguistics*, *38*(1-2), 145-152.

Mitchell, R. E., & Karchmer, M. A. (2004). Chasing the mythical ten percent: Parental hearing status of deaf and hard of hearing students in the United States. *Sign Language Studies*, *4*(2), 138-163.

Morford, J. P., & Mayberry, R. I. (2000). A reexamination of "early exposure" and its implications for language acquisition by eye. *Language acquisition by eye*, 111-127.

Nunnally, D.J., (1978). *Psychometric theory* (2nd ed.). New York: McGraw-Hill.

Sanfeliu, M. C., & Fernandez, A. (1996). A set of 254 Snodgrass-Vanderwart pictures standardized for Spanish: Norms for name agreement, image agreement, familiarity, and visual complexity. *Behavior Research Methods, Instruments, & Computers*, *28*(4), 537-555.

Sheng, L., Peña, E. D., Bedore, L. M., & Fiestas, C. E. (2012). Semantic deficits in Spanish-English bilingual children with language impairment. *Journal of Speech, Language and Hearing Research*, *55*(1), 1-15.

Sutton-Spence, R. & Woll, B. (1999). *The linguistics of British Sign Language: an introduction*. Cambridge University Press.

Tellings, A.E. & Wauters, L.N. (2007). *Mode of acquisition ratings of word and sign meanings by deaf adults in the Netherlands*, Unpublished manuscript.

Vinson, D. P., Cormier, K., Denmark, T., Schembri, A., & Vigliocco, G. (2008). The British

Sign Language (BSL) norms for age of acquisition, familiarity, and iconicity. *Behavior Research Methods*, *40*(4), 1079-1087.

Wauters, L. N., Tellings, A. E., van Bon, W. H., & Mak, W. M. (2008). Mode of acquisition as a factor in deaf children's reading comprehension. *Journal of Deaf Studies and Deaf Education*, *13*(2), 175-192.

Wauters, L. N., Tellings, A. E., Van Bon, W. H., & Van Haaften, A. W. (2003). Mode of acquisition of word meanings: The viability of a theoretical construct. *Applied Psycholinguistics*, *24*(03), 385-406.

White, A., & Tischler, S. (1999). Receptive sign vocabulary tests: tests of single-word vocabulary or iconicity? *American Annals of the Deaf*, *144*(4), 334-338.

Woolfe, T., Herman, R., Roy, P., & Woll, B. (2010). Early vocabulary development in deaf native signers: a British Sign Language adaptation of the communicative development inventories. *Journal of Child Psychology and Psychiatry*, *51*(3), 322-331.