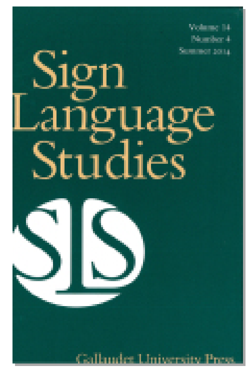
The Signed Verbal Learning Test: Assessing Verbal Memory of Deaf Signers



Donna A. Morere

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DONNA A. MORERE

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Abstract

Memory assessment involves the measurement of a wide range of memory functions, both verbal, or linguistic, and nonverbal. Although research suggests that modified measures of visual memory may be adequate for deaf signers, this is not the case for measures of linguistic memory. Few measures of memory for signs are available, and direct translation of measures developed in English is likely to be invalid for use with deaf signers. The current article briefly reviews the literature on verbal memory assessment of deaf individuals and presents a measure of list learning developed for individuals using American Sign Language that takes into account the influence of both English and ASL on learning and memory performance.

Neuropsychological assessment in both research and clinical practice requires evaluation of memory functions. Comprehensive memory evaluation involves multiple areas of assessment, including visuospatial memory and multiple aspects of verbal memory (Lezak, Howieson, and Loring 2004). Lezak and colleagues suggest that the latter should include tasks such as story (prose) recall and list learning and that the latter should be tested using both free recall and recognition trials; this will provide a learning curve based on repeated learning trials. Studies suggest that standard measures of visuospatial

Donna Morere is the Neuropsychological Assessment Director for the VL2 Psychometric Toolkit Study and the Early Education Longitudinal Study and Professor in the Clinical Psychology Program at Gallaudet University.

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memory can be used with deaf individuals (Golden 1975; Hauser et al. 2007). Indeed, deaf signers may outperform hearing peers on some aspects of visual memory (Arnold and Mills 2001; Arnold and Murray 1998; Cattani, Clibbens, and Perfect 2007; Flaherty 2003; Hamilton 2011; Wilson et al. 1997).

Although visual memory may be adequately assessed by adaptations of standard measures, the same cannot be said for the assessment of verbal, or linguistic, memory. As Pollard (2002) notes, English-based measures may be invalid and therefore inappropriate for deaf signers. Ethically, psychologists should use linguistically appropriate measures whenever possible; however, accessible measures of linguistic memory for deaf signers have been limited, and therefore appropriate measures are not always available. More recent measures provide research norms for ASL-based measures of prose recall (Pollard et al. 2007) and paired associate learning (Pollard, Rediess, and DeMatteo 2005); however, standardized, ASL-based measures of list learning have been lacking.

List-Learning Tasks

A number of list-learning tasks are available in English as well as other languages. While some use lists of unrelated words, recall on the first trial of such lists is reported to be only five to six items (Lezak et al. 2004). Even on such tasks, during repeated learning trials, subjects tend to make associations between words to enhance retention and retrieval, resulting in responses with clusters of semantically related words produced on subsequent trials. The Rey Auditory-Verbal Learning Test (RAVLT; Rey 1964) is one of the oldest and most widely used verbal learning measures in research and particularly in clinical settings. The RAVLT was developed in French, and the English translation retained the words and order of the original task (Lezak et al. 2004). Alternate forms have been developed to allow for repeated testing, and the RAVLT has been translated into at least six additional languages (Strauss, Sherman, and Spreen 2006). Strauss and colleagues note that the RAVLT is based on a single trial task originally developed "in the early 1900s, making it one of the oldest mental tests in continuous use, albeit in a modified form" (776). Indeed, composite norms for both children and adults continue to be generated (Vakil, Greenstein, and Blachstein 2010).

In its current form, the test typically consists of five learning trials of fifteen concrete nouns (List A) presented in a fixed order. The task instructions are presented before each learning trial regardless of performance on previous trials. After the response to the fifth trial, an interference trial (List B) is presented, and once the individual recalls the items from the interference list, recall of the initial list is requested (delayed free recall). Following a twenty-minute interval, during which other tasks (not involving verbal learning) are performed, the individual is requested to again recall the items from the initial learning list (long-delay free recall). Subsequently, the individual may be asked to identify words in a story that were from the list or recognize words from the list imbedded in a larger set of words that includes not only the words from Lists A and B but also phonemically and semantically similar words (Strauss, Sherman, and Spreen 2006). The individual is asked to endorse only those words that were on List A. This task allows not only the investigation of initial recall following the first presentation of the list but also analysis of the learning process. A learning curve can be generated for the performance during the learning trials, the impact of the interference trial can be determined, and retention of the list over time for free recall and recognition—including discrimination between the target items and various foils—can be analyzed. Additionally, since the responses are recorded verbatim, repetitions, intrusions, and serial and semantic clustering can be examined.

The RAVLT has been the model on which the various list-learning tasks currently available have been based. These more recent tasks include the Hopkins Verbal Learning Test-Revised (HVLT-R; Brandt and Benedict 2001) and the California Verbal Learning Test (CVLT; Delis et al. 1987) and its revised version (CVLT-II; Delis et al. 2000). The CVLT and its revision use sets of words from common semantic categories and, in addition to the free recall and recognition trials, provide cued recall trials that elicit responses based on categorical cues (e.g., "Tell me the items from the list that are fruits"). On the original CVLT, the sixteen items are presented in a shopping-list format: The learning list represents the "Monday" shopping list, and the interference trial is labeled the "Tuesday" shopping list. This shopping-list format was abandoned for the CVLT-II in order to allow for a wider range of items, such as transportation and animals. However, both versions of the task involve four items from each of four categories, resulting in a total of sixteen items. The items in the interference list also represent four categories, two of which overlap with the learning list. This allows for an in-depth analysis of the processes involved in learning and memory in addition to the simple outcome data.

Use of List-Learning Tasks with Deaf Individuals

In the past, researchers and clinicians have used print administration or signed translations (presented either via sign alone or with concurrent voicing) of standard measures or tasks developed for specific investigations (Hanson 1982, 1990; Hamilton and Holzman 1989; Hill-Briggs et al. 2007; Miller 2007; Shand 1982). Indeed, the RAVLT has recently been used with a signed administration in psychiatric research with deaf adults (Horton and Silverstein 2011) and oral presentation to deaf children in genetic research (Kawasaki et al. 2006). Some studies have used signed, fingerspelled, or printed words (Krakow and Hanson 1985), while others have used pictorial stimuli, with the recall being produced in the participants' preferred mode of communication (MacSweeney, Campbell, and Donlan 1996) or print (Rudner and Ronnberg 2008). However, each of these approaches has limitations.

While testing of memory in ASL/English bilingual deaf individuals should include both print and signed recall, testing via print alone is no more adequate for a deaf person than it would be for a hearing person. Indeed, it is likely less so since not only would the testing be presented in the person's nonpreferred language, but deaf individuals' reading skills may be limited compared to their hearing peers (Qi and Mitchell 2012), and their performance may be further hindered by limited English vocabulary (Luckner and Cooke 2010). Furthermore, research with print-based materials has suggested differences in the way deaf students retain what they read (Marschark 1998; Marschark et al. 1993). Additionally, among deaf students, strategies for the retention of print varied: Students with better English skills used more information from syntax, while those with weaker English depended more on semantic relationships (Akamatsu and Fischer 1991). Thus, even if hearing norms are available for print-based testing, they may not be valid for deaf individuals. Furthermore, print-based data may not directly translate into outcomes that might occur given a signed administration. For example, serial-position effects for printed or fingerspelled administrations differed from those observed when the stimuli were signed (Krakow and Hanson 1985).

In addition, deaf individuals and hearing individuals may approach learning tasks in different ways. For example, Bebko and colleagues carried out a series of studies indicating that on verbal memory tasks, deaf children may attend to visual aspects of stimuli rather than accessing typical rehearsal strategies, and although effective rehearsal strategies can be elicited by task demands, spontaneous use is related to a child's language proficiency and automatization (Bebko 1984; Bebko et al. 1998; Bebko et al. 1992; Bebko and McKinnon 1990).

Furthermore, testing an individual—even one who is to some degree bilingual—in the individual's nonpreferred language is likely to yield an underestimate of linguistic memory functioning. Indeed, research with Spanish/English bilinguals has indicated that, when tested in their nonpreferred language, individuals whose English skills were weaker than their Spanish skills learned and recalled fewer words than did English monolinguals when tested in English. This was the case despite the fact that the bilinguals demonstrated comparable skills when tested on an equivalent task in their primary language (Harris, Cullum, and Puente 1995). Thus, it is critical to develop appropriate tasks that evaluate verbal learning in the individual's preferred language.

Considerations for Development of a Signed Verbal Learning Task

When considering the development of a verbal learning test designed for use with deaf signers, one must carefully consider the parameters that may affect performance. For example, because evaluation of errors on such instruments is integral to the appropriate interpretation of results, control of the parameters related to expected errors is important. It has long been accepted that both phonemic and semantic similarities affect the learning of spoken words and that the relative effects of these parameters depend on task demands (Baddeley and Levy 1971; Shulman 1971). Although research on nonsigning hearing subjects suggests that word lists are processed based on semantic relationships and a speech-based code, exceptions to this may occur. For example, on a signed memory task, hearing individuals who were bilingual in Spanish and Spanish Sign Language used a combination of spoken language and visuospatial coding (García-Orza and Carratalá 2012). Furthermore, highly educated deaf signers may use a speech-based code for serial recall of printed words but sign-based code when the stimuli are signed (Krakow and Hanson 1985). These results suggest that both deaf and hearing individuals' coding may be affected by the stimulus type.

A number of studies in the past few decades have demonstrated that while some deaf individuals may use a speech-based code for certain verbal memory tasks (Hanson 1982, 1990), prelingually deaf individuals who use ASL or other forms of signed communication may employ a sign-based code for short-term encoding of linguistic information (Klima and Bellugi 1979; Marschark and Mayer 1998; Poizner, Bellugi, and Tweney 1981; Siple, Caccamise, and Brewer 1982; Wilson and Emmorey 1997, 1998, 2003). Indeed, studies of deaf signers have suggested the presence of a sign-based memory loop (Wilson and Emmorey 1997) analogous to Baddeley's (2000, 2003) phonological loop for encoding and rehearsal in working memory.

In both clinical and research settings, standard list-learning tasks have typically been administered to deaf individuals with the accommodation that the words on the lists were signed; however, aside from the lack of standardization involved in the selection of signs by individual clinicians, direct translation of verbal recall instruments is inappropriate. A wide range of factors affects performance on verbal memory tasks. These include word (or sign) frequency, as well as phonemic, graphemic, and semantic similarities or relationships among the words. Each of these factors may be different for deaf individuals relative to their hearing peers. For example, many English words have no signed equivalent. This is not an issue limited to English-ASL translation; Lim and colleagues (2009) note that this issue arises when translating English measures to other spoken languages. When this occurs in an adaptation of a measure from English to ASL, the options are to either substitute a different word (further modifying the task) or fingerspell the word (requiring involvement of the nonpreferred language). These decisions should be made only with careful consideration of the potential impacts on the outcomes, and this is not possible for the clinician translating the test as it is being administered. Furthermore, since more familiar words are more readily learned than less familiar words (Roodenrys et al. 1994), the frequency of signs in the ASL lexicon must be considered since the relative frequency of a word in the English lexicon may differ from that of its equivalent sign. Furthermore, the frequency (or form) of a sign may vary between formal ASL, educational variations of signing, and the actual experiences of many deaf individuals. Thus, signs to be used must be selected carefully if one is to attempt to replicate high-frequency words on a memory task.

In addition to the structural components of words such as their phonetic properties, the learning of words is also affected by factors such as the degree to which the construct may be concrete or abstract, the level of imagery, its association level, how readily the construct can be categorized, and potential emotional responses to the item (Lezak et al. 2004). Lezak and colleagues caution that such factors must be taken into consideration when developing alternate forms of memory tasks or using such instruments with different groups of participants. They refer test developers to a standard text that provides ratings of English words "along the seven dimensions of concreteness, imagery, categorizability, meaningfulness, familiarity, number of attributes or features, and pleasantness" (419); however, no such text exists for signs. Indeed, the variability in signs identified as ASL would make the development of such a text a daunting task. Thus, while an attempt at standardization is critical, when developing verbal memory tasks for deaf individuals, variability in demographic and linguistic backgrounds should be considered if the goal is to make the measure broadly applicable.

When considering the dimensions of words for the development of a comparable sign-based test, concreteness is one of the more readily addressed parameters since a word that represents a concrete item will, by definition, equate to a sign representing the concrete item. A similar relationship would be expected to exist between the imagery of words and related signs. Indeed, words that were readily imaged were better remembered by both deaf and hearing children; however, recall by the deaf children was also dependent on the *signability* (the ability to represent the word with a single sign) of the words

(Bonvillian 1983). This suggests that, despite the use of English stimuli, the deaf children were using some degree of sign-based coding to enhance recall.

This suggests that, in addition to shared characteristics, signs have features that are less of an issue with words. Another such feature is iconicity. Signs may provide varying degrees of visual representation of the target item. This is not restricted to concrete signs or nouns; although "house" is represented by a simple outline of a house "drawn" in the air, "sleep" is represented by the signing hand "closing the eyes" of the signer. Bosworth and Emmorey (2010) do not see enhanced recognition of iconic signs relative to noniconic signs, and neither Bellugi and Klima (1976) nor Poizner, Bellugi, and Tweney (1981) found any significant impact of iconicity on the short-term recall of signs. Nonetheless, the potential influence of iconicity on learning and recall cannot be ignored. Indeed, less skilled signers (deaf and hearing) tended to process nonsense signs more as "visual pictorial events" than as linguistic stimuli, suggesting that this may be an issue for deaf individuals with less developed sign skills (Siple, Caccamise, and Brewer 1982). Thus, variability in the effect of iconicity on learning and recall may exist among the range of deaf individuals, and therefore its potential impacts should be considered during sign selection.

When considering the influence on the "categorizability" of a sign or how readily a target may be placed in a semantic category (e.g., a chair might be categorized as furniture and love as an emotion), Bosworth and Emmorey (2010) report semantic priming effects on sign recognition even though they find no effects of iconicity. In addition, Rudner and Ronnberg (2008) observe the influence of semantic similarity on the working-memory performance of both hearing nonsigners and deaf and hearing signers. Furthermore, Liben, Nowell, and Posnansky (1978) reported the use of semantic reorganization of items on free recall of signed lists, with higher levels of semantic clustering when responses were required to be signed rather than written. In contrast, formational (sign-based) clustering was not seen to occur spontaneously and was limited even when semantic similarities were not provided. This contrasts with the results of studies of ordered recall of signs, which indicated impacts of formational parameters but limited semantic impacts (Bellugi and Klima 1976; Poizner, Bellugi, and Tweney 1981).

When developing a sign-based list-learning task, the formational relationships among the signs must also be considered. Since most signers are bilingual, the relationships among the English translations of an ASL-based list-learning task continue to represent significant potential factors. Thus, a signed linguistic or "verbal" learning task must take into account both the factors considered relevant for standard, oral list-learning tasks and those specific to signs.

Additionally, it must address other factors that may affect list-learning tasks, such as the use of culturally appropriate stimuli. Lim and colleagues (2009) note that list learning is one of the most commonly used measures of verbal learning and have adapted such a task for use with multiple languages and dialects. They note that simple matching of word frequency and length was not sufficient to produce comparable results across languages and cultures. They used a shopping-list format typical of many list-learning tasks but took care to ensure that the items on the lists were culturally appropriate for each cultural and linguistic cohort. Thus, even though two lists were generated in English, the one intended for U.S. participants differed from that for Australians due to cultural factors. For example, Americans relate more to the word "candy," while "lollies" was considered more appropriate for Australians. Similarly, "ketchup" is a common item on shopping lists in the United States, but Australians would be more likely to shop for Vegemite, an item unfamiliar to most Americans. The authors report that when cultural influences were taken into consideration, comparable results were achieved in six different lists in English, French, Mandarin, and Malay. This suggests that list-learning tasks may reflect an underlying verbal learning process common in languages, and with careful adaptation, measures can reflect this verbal memory process despite significant cultural and linguistic differences. Furthermore, it appears to be less important for the stimuli to be identical than it is for them to reflect comparable familiarity and relevance across the groups.

The Signed Verbal Learning Test

The Signed Verbal Learning Test (SVLT; Morere 2012) is a verbal learning measure developed for use with deaf signers. It was designed to be loosely analogous to the CVLT but with the influence of ASL taken into consideration. Thus, as many of the aforementioned issues as possible were addressed. The goal was to produce a measure that would have relatively broad applicability rather than a measure restricted to individuals who were highly proficient ASL signers. Thus, every attempt was made to use signs that were widely used or would be readily recognized both across geographic regions and along the continuum of signing used in the United States.

As with the CVLT, the SVLT involves five learning trials, an interference list, and short- and long-delay free and cued recall trials followed by a recognition trial. Order of recall is not important, and this is emphasized to the participants during the instructions for each trial. This is important, as previous research has suggested that, although deaf individuals' ordered recall may be lower than that of hearing peers, recall not requiring sequencing is comparable between the two groups (Hanson 1982). Visual parameters of handshape, location, and movement were balanced for two sixteen-sign learning lists, one of which is the learning list, the other the interference list. The learning list included four items from each of four semantic categories, two of which overlapped with the categories on the interference list. Additionally, a forty-four-sign recognition list was developed that included items from both lists (including all of the learning-list items) as well as foils representing anticipated error types. The lists were originally piloted on a group of ten deaf signers using a videotaped administration (Morere, Frugé, and Rehkemper 1992). A revised instrument was administered to a cohort of deaf undergraduates using videoclips presented via computer (Morere 2012). It was deemed crucial that the stimuli be presented via video to avoid confounds although standard verbal learning tasks involve word lists read by the examiner or researcher. Although accents of examiners reading word lists aloud may produce some degree of variability in the stimuli, if the word on the list is "pants," for example, an examiner is unlikely to substitute the word "slacks"; however, "pants" can be signed in multiple ways. Thus, in order for the structural characteristics (both spoken and signed) of the items to be maintained, a standard list of signs must be presented. This requires video presentation of the stimuli.

For both the pilot study and the VL2 Psychometric Toolkit study, the participants' signed responses were videotaped for later review and clarification of scoring. This was again considered necessary, as realtime scoring of signed responses was considered vulnerable to errors. The basic format of the original and revised measures was identical; however, because of the results of the pilot study, changes were made in the categories and items, and the instructions were elaborated.

Pilot

The original task instructed the participants to imagine that they were planning to move and that they would be presented with a list of items they would pack (List A). The list of sixteen items was read five times, and following each trial they were asked to report all of the items they could remember, including those that they had previously mentioned. After the fifth trial, they were given the interference list (List B) and told that a friend was helping them with the move and that this was a list of items that the friend would pack. Following the response to that trial, without further presentation of the items they were then asked to repeat the list of things they themselves were supposed to pack. The short-delay, cued-recall trial followed immediately, and the participants were asked to report items from each of the four categories: kitchen, bedroom, bathroom, and study (or office). Following a twenty-minute delay, the free and cued-recall trials were repeated and were followed by a recognition trial.

On the recognition trial, items were selected to represent five types of potential errors in addition to novel errors that did not represent any of the other categories. The first type of error represents items from the interference list (List B) that shared categories with List A. For the pilot study, this included items from the kitchen (e.g., bread) and bedroom (e.g., blanket). The second error type represented items from the interference list that came from categories not shared with List A. The third type of error represented novel items that shared a semantic category with List A but were not formationally similar (sharing at least two parameters) to the List A items. The fourth type of error represented novel items that shared a List A category and at least two formational parameters with one of the List A items (i.e., both semantically and formationally related to a List A item). The fifth type of error represented novel items that did not represent semantic categories from either list A or List B but were formationally similar to a List A sign. The final category of errors was that of items not meeting either the formational or the semantic relationships listed earlier.

During the pilot study, a typical learning curve was produced for participants who had clearly understood the task. Additionally, proactive interference from List A was noted on the learning of List B. That is, fewer items in general were learned from the single presentation of List B than were learned on the first trial of List A. This is consistent with expectations for this type of task (Delis et al. 1987). In contrast, again consistent with expectations, List B appeared to produce little retroactive inhibition on the short delayed-recall of List A immediately following the List B trial. Thus, despite some issues with the instructions, the task appeared to produce outcomes consistent with expectations based on similar spoken-language tasks. Cued recall did not appear to provide significant benefit retrieval. This may have been due to a combination of good recall without such cueing combined with issues related to the categories. For example, some items, such as medicine, could have been found in multiple rooms, causing confusion for some participants.

As expected, most target items were correctly identified on the recognition trial; however, numerous intrusion errors were noted. The most common types of errors involved intrusions from List B that shared categories with List A, whereas items that were not on List B and did not involve either categorical or formational similarities to list A were uncommon. As anticipated from the literature, formational errors were also relatively common. This suggests that the previously reported effects of the formational properties of signs on memory were appropriately tapped by this measure. These data suggested that, despite some issues, this signed learning task taps the underlying linguistic learning and memory processes reflected in comparable measures of spoken-language memory and learning. Thus, as the technology evolved to make this type of measure more practical in standard clinical and research settings, a revised version was developed.

Issues and Revisions

One of the main problems with the initial task was that it required several people in the room in order to present the task via videotape (with pauses and starts as needed), videotape the participants' responses, and perform the other activities required to administer the test. This was somewhat awkward even in a research setting; it would be impractical in a clinical setting. Additionally, several issues with the measure as devised and presented were discovered in the pilot study. First, some of the participants appeared to have difficulty understanding the distinctions between the personal and the friend's packing lists when asked to repeat the items for the short- and long-delay recall trials. Thus, for the revised task, in addition to indicating that List A would be packed by the participant, it was added that these items would be packed during the week. The items on List B would be packed by a friend who was going to help with the packing on the weekend. Each time a response was requested, both the person and the time frame were indicated (e.g., "Now tell me all of the things that your friend packed on the weekend"). This additional separation of week versus weekend appeared to clarify the distinctions adequately, as no issues were noted with overall list confusion on the revised task.

Another concern was the potential presence of some items in multiple rooms. Some items, such as "medicine," may be commonly kept in a number of different rooms. Thus, some items were removed and replaced with items that may be more readily distinguished by room, and the "bathroom" category on list A was replaced with the "garage" category from list B to decrease the observed confusion between some categories representing rooms within the house. Although no item may be guaranteed to be understood by all individuals to be best associated with a specific location, an effort was made to make items relatively unique to the target location. Some stimuli were also replaced in order to better balance the error types in addition to minimizing confusion. As with the original instrument, care was taken to limit the number of signs that were visually similar, both within each list and between the A and B lists. An effort was also made to limit the speech-based similarities of the items (e.g., avoiding items that rhymed or shared other phonemic similarities) on the lists. Although it was difficult to generate lists of common items for which standard signs were available that were visually distinct, most signs on the lists varied by at least two parameters (e.g., handshape, location, and movement) from all other items on the A and B lists. Additionally, the number of items on the recognition list was decreased from forty-four to forty.

The VL2 Toolkit SVLT

The revised task, described in Morere (2012), was used in the VL2 Psychometric Toolkit. It involved the presentation of a list of sixteen items, four each from the categories of kitchen, study/office, bedroom, and garage. The items on the videoclips used for the task administration were signed by a native deaf user of ASL. Each list and the instructions were signed separately, and the video clips were then edited to produce the QuickTime movies used for the task administration. Consistent with standard practice, the signs were presented at one-second intervals, and the signer's hands returned to her sides at the end of each sign. The movies were presented to the participant on an iMac in full-screen mode, and although the examiner recorded the responses during the task presentation, the participants' responses were also recorded via videotape for later review to ensure accurate scoring and for further analysis. The procedure was consistent with that of the pilot study, although the instructions added the weekday/weekend time factor to the A and B lists. Since the computer presentation required only a single examiner to administer the test, the task was more consistent with standard clinical and research practice.

Results and Conclusions

With these modifications, participants were able to clearly understand the task and produce acceptable responses. Indeed, the task demonstrated outcomes that were consistent with the normative data for the English list-learning task on which it was based (the CVLT), suggesting that it reflected comparable underlying linguistic memory functions. The patterns of the outcomes (e.g., proactive and retroactive interference) reflect processes consistent with the research on memory in spoken languages. Indeed, with the improved instructions, scores from each of the trials paralleled those on the normative sample of the CVLT: Learning during the initial five trials, List B recall, and short- and long-delay cued and free recall all reflected performances consistent with the spoken-language task.

Perhaps the most fascinating outcome of this study was the error data from the recognition trial. As with the SVLT pilot study, the vast majority of the errors represented intrusions from List B, with 70.9 percent of the errors representing List B items. The total number of errors was relatively small, with an average of five errors for the sample. Thus, the fact that slightly more errors (mean 2.09, SD 0.29) represented List B items from unshared categories than List A items in shared categories (mean 1.51, SD 0.33), while interesting, may have little meaning. Not surprisingly, novel errors with no relationship, either formational or categorical, with either list were rare (1.4 percent of errors, raw score mean 0.07, SD 0.05). This is again consistent with previous findings (Lezak et al. 2004). Interestingly, even when a correction for the inclusion of an extra possible formational error was made, more errors representing relationships with List A were based on formational (12.1 percent) than semantic (6.3 percent) relationships. This suggests that, even though both semantic and structural characteristics of the stimuli are involved in the learning of signs, the signs' formational characteristics may represent a more salient cue to endorse an error on a recognition task despite adequate learning of the items.

Although much further research is required and it is likely that the current measure would benefit from refinement, the availability of a measure that was developed with the parameters of both signed and spoken languages taken into consideration represents a significant advancement in the accessibility of cognitive and psychological testing for deaf individuals.

References

Akamatsu, C. T., and S. D. Fischer. 1991. Using Immediate Recall to Assess Language Proficiency in Deaf Students. *American Annals of the Deaf* 136(5): 428–34.

Arnold, P., and M. Mills. 2001. Memory for Faces, Shoes, and Objects by Deaf and Hearing Signers and Hearing Nonsigners. *Journal of Psycholinguist Research* 30(2):185–95.

Arnold, P., and C. Murray. 1998. Memory for Faces and Objects by Deaf and Hearing Signers and Hearing Nonsigners. *Journal of Psycholinguist Research* 27(4): 481–97.

Baddeley, A. D. 2000. The Episodic Buffer: A New Component of Working Memory? *Trends in Cognitive Sciences* 4: 417–23.

———. 2003. Working Memory: Looking Back and Looking Forward. *Nature Reviews: Neuroscience* 4: 829–39.

———, and B. A. Levy. 1971. Semantic Coding and Short-Term Memory. *Journal of Experimental Psychology* 89: 132–36. doi: 10.1037/h0031189.

Bebko, J. M. 1984. Memory and Rehearsal Characteristics of Profoundly Deaf Children. *Journal of Experimental Child Psychology* 38(3): 51–69.

———, M. A. Bell, A. Metcalfe-Haggert, and E. McKinnon. 1998. Language Proficiency and the Prediction of Spontaneous Rehearsal in Children Who Are Deaf. *Journal of Experimental Child Psychology* 68(1): 415–28.

Bebko, J. M., M. A. Lacasse, H. Turk, and A. S. Oyen. 1992. Recall Performance on a Central-Incidental Memory Task by Profoundly Deaf Children. *American Annals of the Deaf* 137(3): 271–77.

Bebko, J. M., and E. E. McKinnon. 1990. The Language Experience of Deaf Children: Its Relation to Spontaneous Rehearsal in a Memory Task. *Child Development* 61(6): 1744–52.

Bellugi, U., and E. S. Klima. 1976. Two Faces of Sign: Iconic and Abstract. *Annals of the New York Academy of Sciences* 280: 514–38.

Bonvillian, J. D. 1983. Effects of Signability and Imagery on Word Recall of Deaf and Hearing Students. *Perceptual and Motor Skills* 56(3): 775–91. doi: 10.2466/pms.1983.56.3.775.

Bosworth, R. G., and K. Emmorey. 2010. Effects of Iconicity and Semantic Relatedness on Lexical Access in American Sign Language. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 36(6): 1573–81. doi: 10.1037/a0020934.

Brandt, J., and R. H. B. Benedict. 2001. *Hopkins Verbal Learning Test,* rev. ed. Odessa, FL: PAR.

Cattani, A., J. Clibbens, and T. J. Perfect. 2007. Visual Memory for Shapes in Deaf Signers and Nonsigners and in Hearing Signers and Nonsigners: Atypical Lateralization and Enhancement. *Neuropsychology* 21(1): 114–21.

Delis, D. C., J. H. Kramer, E. Kaplan, and B. A. Ober. 1987. *The California Verbal Learning Test.* San Antonio: Psychological Corporation.

———. 2000. *California Verbal Learning Test,* 2nd ed. San Antonio: Psychological Corporation.

Flaherty, M. 2003. Sign Language and Chinese Characters on Visual-Spatial Memory: A Literature Review. *Perceptual and Motor Skills* 97(3), pt. 1: 797–802.

García-Orza, J., and P. Carratalá. 2012. Sign Recall by Hearing Signers: Evidences of Dual Coding. *Journal of Cognitive Psychology* 24(6): 703–13.

Golden, E. 1975. Visual Memory of Deaf Students in Comparison with Normally Hearing Students of Similar Ages. Master's thesis, Walden University. Distributed by ERIC Clearinghouse. Bib. ID 5293643.

Hamilton, H. 2011. Memory Skills of Deaf Learners: Implications and Applications. *American Annals of the Deaf* 156(4): 402–23.

———, and T. Holzman. 1989. Linguistic Encoding in Short-Term Memory as a Function of Stimulus Type. *Memory and Cognition* 17: 542–50.

Hanson, V. L. 1982. Short-Term Recall by Deaf Signers of American Sign Language: Implications of Encoding Strategy for Order Recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 8: 572–83.

———. 1990. Recall of Order Information by Deaf Signers: Phonetic Coding in Temporal Order Recall. *Memory and Cognition* 18(6): 604–10.

Harris, J. G., C. M. Cullum, and A. E. Puente. 1995. Effects of Bilingualism on Verbal Learning and Memory in Hispanic Adults. *Journal of the International Neuropsychological Society* 1(1): 10–16. DOI: http://dx.doi.org/10.1017/S1355617700000059.

Hauser, P. C., J. Cohen, M. W. Dye, and D. Bavelier. 2007. Visual Constructive and Visual-Motor Skills in Deaf Native Signers. *Journal of Deaf Studies and Deaf Education* 12(2): 148–57.

Hill-Briggs, F., J. Dial, D. Morere, and A. Joyce. 2007. Neuropsychological Assessment of Persons with Physical Disability, Visual Impairment or Blindness, and Hearing Impairment or Deafness. *Archives of Clinical Neuropsychology* 22: 389–404.

Horton, H. K., and S. M. Silverstein. 2011. Factor Structure of the BPRS in Deaf People with Schizophrenia: Correlates to Language and Thought. *Cognitive Neuropsychiatry* 16(3): 256–83. doi: 10.1080/13546805.2010.538231. Epub April 8, 2011.

Kawasaki, A., K. Fukushima, Y. Kataoka, S. Fukuda, and K. Nishizaki. 2006. Using Assessment of Higher Brain Functions of Children with GJB2-Associated Deafness and Cochlear Implants as a Procedure to Evaluate Language Development. *International Journal of Pediatric Otorhinolaryngology* 70(8): 1343–49.

Klima, E. S., and U. Bellugi. 1979. *The Signs of Language.* Cambridge, MA: Harvard University Press.

Krakow, A., and V. L. Hanson. 1985. Deaf Signers and Serial Recall in the Visual Modality: Memory for Signs, Fingerspelling, and Print. *Memory and Cognition* 13: 265–72.

Lezak, M. D., D. B. Howieson, and D. W. Loring. 2004. *Neuropsychological Assessment,* 4th ed. New York: Oxford University Press.

Liben, L. S., R. C. Nowell, and C. J. Posnansky. 1978. Semantic and Formational Clustering in Deaf and Hearing Subjects' Free Recall of Signs. *Memory and Cognition* 6(6): 599–606.

Lim, Y. Y., K. H. Prang, L. Cysique, R. H. Pietrzak, P. J. Snyder, and P. Maruff. 2009. A Method for Cross-Cultural Adaptation of a Verbal Memory Assessment. *Behavior Research Methods* 41 (4): 1190–1200. DOI: 10.3758/BRM.41.4.1190 PII: 41/4/1190.

Luckner, J. L., and C. Cooke. 2010. A Summary of the Vocabulary Research with Students Who Are Deaf or Hard of Hearing. *American Annals of the Deaf* 155(1): 38–67.

MacSweeney, M., R. Campbell, and C. Donlan. 1996. Varieties of Short-Term Memory Coding in Deaf Teenagers. *Journal of Deaf Studies and Deaf Education* 1(4): 249–62.

Marschark, M. 1998. Memory for Language in Deaf Adults and Children. *Scandinavian Audiology* 27, Supplement 49: 87–92.

———, R. De Beni, M. G. Polazzo, and C. Cornoldi. 1993. Deaf and Hard of Hearing Adolescents' Memory for Concrete and Abstract Prose: Effects of Relational and Distinctive Information. *American Annals of the Deaf* 138(1): 31–39.

Marschark, M., and T. S . Mayer. 1998. Interactions of Language and Memory in Deaf Children and Adults. *Scandinavian Journal of Psychology* 39(3): 145–48.

Miller, P. 2007. The Role of Spoken and Sign Languages in the Retention of Written Words by Prelingually Deafened Native Signers. *Journal of Deaf Studies and Deaf Education* 12(2): 184–208.

Morere, D. A. 2012. Measures of Memory and Learning. In *Assessing Literacy in Deaf Individuals: Neurocognitive Measurement and Predictors,* ed. D. A. Morere and T. E. Allen, 75–104. New York: Springer.

———, J. G. Frugé, and G. M. Rehkemper. 1992. Signed Verbal Learning Test: Assessing Verbal Memory of Deaf Signers. Poster presented at the 100th Annual Convention of the American Psychological Association, Washington, DC, August.

Poizner, H., U. Bellugi, and R. D. Tweney. 1981. Processing of Formational, Semantic, and Iconic Information in American Sign Language. *Journal of Experimental Psychology: Human Perception and Performance* 7(5): 1146–59.

Pollard, R. Q. 2002. Ethical Conduct in Research Involving Deaf People. In *Ethics in Mental Health and Deafness,* ed. V. A. Gutman, 162–78. Washington, DC: Gallaudet University Press.

———, A. DeMatteo, E. Lentz, and S. Rediess. 2007. A Prose Recall Test Using Stories in American Sign Language. *Rehabilitation Psychology* 52(1): 11–24.

Pollard, R. Q., S. Rediess, and A. DeMatteo. 2005. Development and Validation of the Signed Paired Associates Test. *Rehabilitation Psychology* 50(3): 258–65.

Qi, S., and R. E. Mitchell. 2012 Large-Scale Academic Achievement Testing of Deaf and Hard-of-Hearing Students: Past, Present, and Future. *Journal of Deaf Studies and Deaf Education* 17(1): 1–18. doi:10.1093/deafed/enr028.

Rey, A. 1964. *L'examen clinique en psychologie.* Paris: Presses Universitaires de France.

Roodenrys, S., C. Hulme, J. Alban, A. W. Ellis, and G. D. A. Brown. 1994. Effects of Word Frequency and Age of Acquisition on Short-Term Memory Span. *Memory and Cognition* 22(6): 695–701.

Rudner, M., J. Andin, and J. Ronnberg. 2009. Working Memory, Deafness, and Sign Language. *Scandinavian Journal of Psychology* 50: 495–505.

Rudner, M., and J. Ronnberg. 2008. Explicit Processing Demands Reveal Language Modality-Specific Organization of Working Memory. *Journal of Deaf Studies and Deaf Education* 13(4): 466–484. doi:10.1093/deafed/enn005.

Shand, M. 1982. Sign-Based Short-Term Coding of American Sign Language Signs and Printed English Words by Congenitally Deaf Signers. *Cognitive Psychology* 14: 1–12.

Shulman, H. G. 1971. Similarity Effects in Short-Term Memory. *Psychological Bulletin* 75(6): 399–415. doi: 10.1037/h0031257.

Siple, P., F. Caccamise, and L. Brewer. 1982. Signs as Pictures and Signs as Words: Effect of Language Knowledge on Memory for New Vocabulary. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 8(6): 619–25.

Strauss, E., E. M. Sherman, and O. Spreen. 2006. *A Compendium of Neuropsychological Tests: Administration, Norms, and Commentary,* 3rd ed. New York: Oxford University Press.

Vakil, E., Y. Greenstein, and H. Blachstein. 2010. Normative Data for Composite Scores for Children and Adults Derived from the Rey Auditory Verbal Learning Test. *Clinical Neuropsychologist* 24: 662–77. DOI: 10.1080/13854040903493522.

Wilson, M., J. Bettger, I. Niculae, and E. Klima. 1997. Modality of Language Shapes Working Memory: Evidence from Digit Span and Spatial Span in ASL Signers. *Journal of Deaf Studies and Deaf Education* 2(3): 150–60.

Wilson, M., and K. Emmorey. 1997. Working Memory for Sign Language: A Window into the Architecture of the Working Memory System. *Journal of Deaf Studies and Deaf Education* 2(3): 121–30.

———. 1998. A "Word Length Effect" for Sign Language: Further Evidence for the Role of Language in Structuring Working Memory. *Memory and Cognition* 26: 584–90.

———. 2003. The Effect of Irrelevant Visual Input on Working Memory for Sign Language. *Journal of Deaf Studies and Deaf Education* 8(2): 97–103.