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# The Effect of Elaboration and Nonelaboration of Sign List Recall Tasks on Rate of Learning in Deaf Individuals

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# THE EFFECT OF ELABORATION AND NONELABORATION OF SIGN LIST RECALL TASKS ON RATE OF LEARNING IN DEAF INDIVIDUALS

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**Dissertation Approval**

This is to certify that the thesis presented to us by ______________________________ on the ______ day of __________________, 20___, in partial fulfillment of the requirements for the degree of Doctor of Psychology, has been examined and is acceptable in both scholarship and literary quality.

Committee Members' Signatures:

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## Abstract

Purpose: Little research has been done on American Sign Language (ASL) based list learning in deaf individuals. The present study examined the effect of elaboration and non-elaboration of sign list recall tasks on rate of learning in deaf individuals. One of the main approaches for instruction of deaf individuals is the use of elaboration, or the combination of visual with linguistic information in the classroom. Visual aids or visual representations of information are commonly recommended as an effective strategy for teaching deaf individuals (DeafTEC, 2014). The main reasons for this approach are the assumption that vision is a stronger more efficient channel for instruction, "sensory compensation," and the documented benefits of associating verbal with visual information, also known as dual coding theory (DCT; Paivio, 1971). Functional MRI studies have provided evidence of left temporal activation in deaf signers using ASL (Pettito, 2000), further suggesting that right activation, noted in fMRI studies of DCT, through the addition of pictures should support recall of ASL signs much like English words. The goal of the current study was to investigate the effectiveness of pairing visual imagery with ASL as a common instructional recommendation. Method: Twenty deaf adults, whose primary mode of communication was ASL, were administered two modified versions of the Signed Verbal Learning Test (SVLT; Morere, 2013). One version included line drawings of objects embedded into the video and paired with their associated sign. The other included black screens where the pictures would have been. Session conditions were mixed and administered 3 weeks apart to reduce potential familiarity effects. Participants' rates of learning over five trials on each version of the SVLT were recorded and statistically analyzed to determine potential effects of the added visual imagery. Results: To test the hypothesis that visual images presented with ASL signs on a list recall task will improve rate of learning in deaf subjects, a repeated measures analysis of variance was conducted. The results show that there was no significant effect of experimental condition, picture/nonpicture, on rate of learning, $F(1.0, 20.0) = 2.75$, $p = .113$. Conclusions: While the number of participants and use of adults rather than children in the process of learning language, as well as content, in this study limit the strength of validity, these results suggest that the addition of pictures does not increase rate of learning for ASL signs. This outcome raises further questions regarding the benefit of elaboration in the instruction of deaf individuals whose primary mode of communication is ASL. Additionally, future studies investigating the effectiveness of alternative memory accommodations and strategies for ASL-based list learning could provide valuable information for educators of deaf individuals.

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# Chapter 1: Introduction

One of the main approaches for instruction of deaf individuals is the use of elaboration, or the combination of visual with linguistic information in the classroom. Visual aids or visual representations of information are commonly recommended as an effective strategy for teaching deaf individuals (DeafTEC, 2014). Visual strategies, particularly pictures, help give a context to participants or situations to help reinforce new vocabulary (National Deaf Children's Society [NDCS], 2008. The main reasons for this approach are the assumption that vision is a stronger, more efficient channel for instruction, "sensory compensation," and the documented benefits of associating verbal with visual information, also known as dual coding theory (DCT; Paivio, 1971).

DCT postulates that concrete nouns additionally access a second image-based processing system in the right hemisphere (Paivio, 1986). Therefore, provision of a visual image during encoding of a concrete noun increases recall since the activation of both hemispheres of the brain occurs. The sensory compensation hypothesis applied to deafness predicts that deaf individuals may develop enhanced visual functions to compensate for lack of auditory input (Bavalier, Dye, & Hauser, 2006). However, empirical studies have not yet provided clear evidence that supports this hypothesis. Despite the lack of empirical evidence, deaf individuals are still often viewed as having a "visual learning style" (Marschark, 2012). DCT (Paivio, 1971) provides support for the use of visual imagery in association with verbal information for enhancement of learning and bolsters the use of visual strategies in instructional settings. However, the bulk of the research on DCT involves visual imagery associated with English, not American Sign

Language (ASL). These visual strategies are incorporated into the classroom, where the main mode of instruction is ASL, without the benefit of direct empirical data to demonstrate their effectiveness on memory or learning.

Research into the cognition of deaf individuals has long focused on the differences between deaf individuals and their hearing counterparts. Conceptualization of intelligence and areas of neuroprocessing have been derived from the lack of access to auditory information or spoken language. This between-groups theme in the research, while informative, has resulted in a generalization of visual-learning strengths of the deaf individual. In instructional settings, deaf students have often been referred to as "visual learners" (Dowaliby & Lang, 1999; Marschark, 2012). While no research specifically suggests that deaf individuals are more capable visual learners than their hearing peers, many studies seem to support the notion of a visual learning style.

As early as 1928, Drever and Collins noted that when language was not a factor in the administration of an intelligence measure, deaf children were able to perform equally to hearing children. Much of the early research assumed that since deaf individuals did not have access to spoken English, they therefore did not have a true language. In recent decades, however, researchers more familiar with the field of deafness have understood that sign languages are, in fact, true languages (Stokoe, 1960).

Still, even research by those with more knowledge of sign language has continued to highlight differences in visual nonlinguistic and verbal linguistic abilities. Studies have consistently demonstrated lower Verbal IQ scores for deaf students than for hearing students (Braden, 1994; Maller & Braden, 1993; Moores et al., 1987). Other studies (Braden 2000) focused on deaf examinees typically performing better on nonverbal measures that incorporated motor skills, such as the Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV) Block Design, NEPSY-II Block Construction, and the Universal Nonverbal Intelligence Test (UNIT) Cube Design. When considering the ongoing theme of these studies and the apparent lack of or limited access to auditory/verbal information, one can easily see how a theoretical leap to a “deaf visual-learning style” could be considered logical and would be generally applied to instructional approaches in the classroom setting. Similar patterns have been noted in the studies of memory in deaf individuals. Studies using certain visual-spatial memory assessments have shown deaf adults and children performing superior to their hearing counterparts (; Alamargot, Lambert, Thebault, & Dansac, 2007; Blair, 1957; Geraci, Gozzi, Papagno, & Cecchetto, 2008; Logan, Mayberry, & Fletcher, 1996; Wilson, Bettger, Niculae, & Klima, 1997).

Still, the study of memory in deaf participants is more complex than a simple advantage of using visual materials. One of the complicating factors in studying memory in deaf/hard-of-hearing individuals has been the lack of assessments that use ASL. ASL is the native language of many deaf individuals; however, much of the memory research has been devoted to acquisition and recall of nonverbal visual information or English language. While this information may be important, it may not help understand acquisition and recall of information in a deaf individual’s most common language of instruction. However, the recent development of the Signed Paired Associates Test (SPAT; Pollard, Rediess, & DeMatteo, 2005) and the Signed Verbal Learning Test (SVLT; Morere, 2013) now provides opportunities to assess memory in deaf individuals through their native communication modality. While data from these assessments indicate memory skills parallel to those of hearing individuals using spoken English, information regarding the benefits of visual imagery with ASL still does not exist, yet it is used daily in instructional settings for deaf/hard-of-hearing students.

The questions regarding the benefits of elaboration become more important when considering recent research regarding the neurological basis for language. Functional MRI studies of deaf adults viewing sentences in sign language revealed similar brain activation with the left-hemisphere language areas in deaf users of ASL to that of spoken language in hearing individuals (Bavelier et al., 1998; Neville et al. 1998). Further evidence for a neurological basis for language, sign or spoken, was provided by Petitto et al. (2000). Functional MRIs of deaf and hearing adults generating verbs in sign and spoken language revealed activation of the Brodmann areas of the brain in both sets of participants. Based on some of the current research and the involvement of the left hemisphere in ASL, incorporation of the right hemisphere via DCT theoretically should improve recall for the linguistic, in this case, ASL information similar to the improvement of English language.

The same current research that has lent support for a neurological basis for language, however, also complicates the potential for benefit of elaboration resulting from incorporation of the right hemisphere via DCT. Similar fMRI and PET studies have also indicated bilateral activation within the right hemisphere in deaf adults using ASL (Petitto, L.A., Zatorre, R.J., Guana, K., Nikelski, E.J., Dostie, D. & Evans. A.C. 2000; Soderfelt B., Ronnberg, J., & Risberg, J., 1994). Activation of both hemispheres was not seen in hearing adults using spoken language in those studies. However, an fMRI study by Jessen F., Heun R., Erb M., Granath D. O., Klose U., Papassotiropoulos A., (2000) revealed stronger activation in the lower right parietal lobe and precuneus in addition to in the left parietal areas and left inferior frontal gyrus anterior of Broca's region. Considering the additional bilateral activation occurring in the brain of a deaf individual viewing sign, the question of benefit from additional visual information during coding becomes more complex.

## Statement of the Problem

While the bulk of the research supports visual approach to instruction, the question, "How much does it benefit learning?" still remains. DCT suggests that the addition of visual imagery should improve recall, but research has looked only at benefit to English recall. Research has yet to demonstrate gains in learning made as a result of association of visual imagery to ASL, the common language of instruction in the deaf classroom. Does the imagery deepen encoding of the concepts, thereby allowing for more accurate and efficient recall? Or, does the visual nature of ASL combined with the imagery result in overload of the immediate memory system? Or, is improvement minimal as a result of preexisting bilateral activation in the brain of signing deaf individuals? Considering the current instructional recommendations and technological advantages that make visual imagery that much more accessible in the classroom, the question of benefit is quite relevant. Several confounding factors still exist in terms of sign language accessibility in early development. Ninety percent of deaf/hard-of-hearing children are raised in spoken-language environments (Gallaudet Research Institute, 2002), often resulting in delays in language, socialization, and general knowledge caused by limited access to language. However, if researchers can begin to gain some understanding of the benefit of visual imagery associated with ASL, modifications to instructional environments could be made to improve overall efficacy of achievement for deaf students.

## Purpose of the Study

The purpose of this study was to determine if deaf individuals benefit from associating visual imagery with ASL signs by administering the SVLT with and without associated pictures. The SVLT evaluates the rate of learning for a list of ASL signs over repeated trials with and without the addition of an associated picture.

## Chapter 2: Review of the Literature

### Introduction

Since the latter part of the $20^{th}$ century, various theories of learning and memory have been developed, many of which are now being linked to neuroanatomy of the brain through the use of increasingly sophisticated fMRI technology. Learning can be defined as the process of acquiring new information, while memory is the persistence of learning that can be assessed at a later time (Squire, 1987). These theories also have been used to understand how deaf individuals encode information. Historically, a division in verbal and visual information formats has influenced theories about the way deaf individuals process and encode language. The lack of auditory access to language often was viewed as a limitation to encoding language; however, recent studies have suggested that American Sign Language (ASL) is processed similarly to spoken language (Newman, Supalla, Hauser, Newport, & Bavelier, 2010).

Atkinson and Shiffrin (1968) proposed a model of memory consisting of three stages: sensory, short-term, and long-term. Sensory memory, which includes iconic memory (visual) and echoic (verbal), has large volume but short persistence. Often these memories occur outside the span of our attention and dissipate rapidly.

Short-term memory has limited volume but longer duration than sensory memory. Short-term memory often is also broken down into visual and verbal components. The most common example of short-term memory is remembering a phone number. Practice will help encode the number into the short-term store for quick recall. The volume or capacity for short-term memory has been noted to be seven chunks of information, plus or minus two (Miller, 1994). Visual short-term memory often includes memory for spatial locations, designs, faces, and pictures. Verbal short-term memory includes numbers, words, sentences, and stories. However, these stimuli need not be in spoken language or accessible auditorially to be considered "verbal." Research has shown that deaf individuals process sign language in much the same way as a hearing person processes spoken language, that multiple regions of the brain are involved, and that these regions are similar between deaf and hearing individuals (Newman et al., 2010). Therefore, despite the visual-spatial nature of ASL, memory for signs, sign sentences, and ASL stories would all fall under linguistic short-term memory.

Long-term memory stores memories for days or years. This aspect of memory is the enduring storage area. Long-term memory has often been categorized into two subdivisions: declarative and nondeclarative memory. Declarative memory is information that we have conscious access to, including personal and world knowledge (Gazzinga M.S. & Heatherton, T., 2002). Declarative memory is often broken down into two subdivisions, episodic and semantic. Episodic memory is described as our autobiographical memories, while semantic memory is our factual knowledge. Nondeclarative memory is information that we have no conscious access to, for example, motor and cognitive skills (procedural knowledge), perception, and simple learned behaviors that derive from conditioning, habituation, or sensation (Gazzinga M.S. & Heatherton, T. , 2002).

This modal model of memory is dependent upon the differentiation between short-term and long-term memory. This differentiation was often related to serial-order position effect. List-learning tasks often demonstrate this concept. When a group of participants is given a list of words to remember, a pattern for the number of correctly identified words emerges. Those who recall the words on the beginning of the list show a primacy effect, while those who recall words near the end of the list demonstrate a recency effect. The modal model also suggests that rehearsal is the vital method by which information is encoded. However, researchers have found that factors other than rehearsal seem to influence long-term memory (Miller, 2007). Levels of processing were also introduced as a theoretical model for memory. This theory states that the more meaningfully a stimulus is processed, the more likely it can be consolidated and stored in long-term memory (Craik & Lockhart, 1972). Several studies have shown that individuals with brain damage and the inability to form short-term memories were still able to form new memories, thus indicating that short-term memory is not a gateway for deeper encoding (Gazzinga M.S. & Heatherton, T., 2002).

## Working Memory

To address the limitations of the modal model of memory, the concept of working memory was developed (Baddeley & Hitch, 1974). Working memory has been strongly connected with acquisition of new information. Working memory refers to the capacity-limited ability to maintain and manipulate information relevant to an ongoing task (Baddeley & Hitch, 1974; Baoutla, Supalla, Newport, & Baveleir, 2004). Working memory is not a specific storage area but rather is a framework of subdivisions or components. In the most widely referenced model proposed by Baddeley (2003), working memory is comprised of three main units, a central executive and two storage systems. The recall of verbal materials (spoken, written, or signed) has been shown to be governed by a *phonological –articulatory loop*. Similarly for visual information, a *visual-spatial* *sketchpad* governs recall of visual and spatial information. Both of these storage units are then controlled by the central executive control system, which is of limited attentional capacity and can manipulate information. More recent studies have further divided the visual storage system into visual and spatial subdivisions (Baddeley, 2003).

Baddeley and Hitch's (1974) theoretical framework has provided a platform for comparative studies between visual and verbal memory abilities in deaf. Using this structure, memory research for deaf has focused on how deaf individuals use either of these governing systems compared to their use by hearing peers. The resulting studies have shown that deaf students may outperform hearing peers on some aspects of visual-spatial memory (Arnold & Mills, 2001; Arnold & Murray, 1998; Cattani, Clibbens, & Perfect, 2007; Flaherty, 2003; Hamilton, 2011: Wilson et al., 1997), while at the same time underperform compared to hearing peers on verbal-temporal aspects of memory (Bebko, 1984). The use of the memory framework has organized the research for memory in deaf persons and continued to highlight how deaf individuals might encode and retrieve information more efficiently using visual channels. However, little research exists measuring the use of visually based memory strategies commonly used within the classroom.

## Linguistic/Verbal Memory

Verbal memory has historically been a problematic area of research for deaf individuals. Many researchers early in deafness research focused on the inability to recall English language, which is largely connected to spoken language and phonetic coding systems. This focus led to much of the research further highlighting deficits in verbal memory of deaf individuals. ASL is the primary language used by deaf individuals in the

United States and Canada. Its structural properties differ markedly from those of English (Fischer & van der Hulst, 2003). Researchers unfamiliar with ASL nuances of assessing deaf individuals may inappropriately use English-based measures in cognitive, personality, and neuropsychological assessments of deaf individuals, thus possibly yielding invalid results (Brauer, Braden, Pollard, & Hardy-Braz, 1998; Leigh & Pollard, 2003; Pollard, 2002; Samar, Parasnis, & Berent, 1998).

Despite the visual and manual nature of ASL, simply stating that it is a nonverbal modality of communication is not accurate. Studies of aphasics who use ASL and recent MRI studies have demonstrated that many aspects of cerebral organization of spoken languages are similar to those of signed languages (Corina, 1998; Emmorey, 2003; Poizner, Klima, & Bellugi, 1987). Thus, deaf and hearing individuals both possess verbal cognitive abilities.

Even with this knowledge of ASL as a true language that is not simply a nonverbal cognitive ability, few ASL-based tests have been developed to accurately assess the verbal memory of deaf individuals. Only Pollard, Rediess, and DeMatteo (2005) with the Signed Pair Associates Test (SPAT), Pollard et al. (2007), with ASL-based measures of prose recall, and Morere (2013), with the Signed Verbal Learning Test (SVLT), have used ASL as the center focus of the memory assessment. The results of both of these measures have provided evidence that deaf participants perform similarly to hearing participants on parallel verbal-memory tasks when ASL is used as the communication modality.

Early studies of verbal learning and short-term memory were conducted in an attempt to understand the role of language and memory in deaf individuals; however, the validity of these studies must not be questioned on the assumption that language means spoken language. This misunderstanding led to the assumption that deaf individuals encoded linguistic information in a manner similar to that of hearing individuals. People with access to auditory information and who primarily use spoken language use verbal-sequential coding to remember short lists of information. The code consists of phonological, articulatory, or acoustic information (Baddeley, 1986). When presented with working memory, reading, and spelling tasks, deaf children are less likely than hearing children to employ phonological coding (Beech & Harris, 1997; Harris & Beech, 1998; Leybaert & Alegria, 1995; Merrills, Underwood, & Wood, 1994; Nielsen & Luetke-Stahlman, 2002; Tranxler & Reitsma, 2005). Owing to their lack of access to auditory information and spoken language, deaf individuals appeared more likely to rely on more visual-spatial memory codes.

Still, studies have also shown that deaf students with better speech skills tend to rely on speech recoding as a strategy in both memory tasks and reading, whereas deaf students with low to moderate speech-coding abilities tend to use both speech and sign strategies (Marschark, 1997). Many studies have supported the benefits of phonological encoding of information by deaf individuals. The concept of the functional equivalence hypothesis states that visible speech information (articulatory gesture) extracted from the speech signal by the deaf learner is interpreted as a phonologically plausible signal by the brain (Campbell, 1987; Dodd, 1987; Dodd & Heremilin, 1977). Studies also have found that strong deaf readers tend to use phonetic codes in processing printed words (Hanson

& Lichtenstien, 1990; Krakow & Hansen, 1985; Lichtenstein, 1998). Cambell and Wright (1990) conducted a study of memory for pictures in deaf children and teens exposed only to spoken language. The study showed that deaf individuals demonstrated word length effects in memory. The participants showed better memory for pictures for which the spoken names would take less time to pronounce than for pictures that would take more time to label. The improvement in memory was presumed to be because the shorter names fit into the articulatory loop. Some researchers have argued that those results indicate deaf participants have an English-based phonological code available to them in working memory. Bebko and Mikinnon (1990) suggested that while deaf individuals may have a phonologically based memory code, they are less likely to use it strategically and spontaneously compared to hearing individuals. Despite the apparent benefits of phonological coding and speech-reading training, the process within working memory continues to be a debated topic in deaf education (Allen et al., 2009; Mayberry, del Guidice, & Lieberman, 2011; Paul, Wang, Trezek, & Luckner, 2009;).

More recent studies have indicated that deaf individuals use sign-language-based memory codes (Marschark, 1997). Several studies have shown that lists of signs made with similar hand shapes tend to disrupt memory performance while the relative availability of a sign is strongly related to recall (Bellugi, Klima, & Siple, 1975; Poizner, Bellugi, & Tweney, 1981; Wilson & Emmorey, 1997). Marschark (1996) obtained evidence of articulatory coding in working memory by deaf college students using both oral and manual articulatory interference tasks. Deaf and hearing students were asked to recall a string of digits with and without interference. Interference behaviors consisted of oral (saying “lalalalala”) and manual (drumming the fingers of both hands on the table).

Results showed that while hearing participants were affected by the oral interference, they were not by the manual interference, whereas the deaf participants were affected by both forms of interference. Further results from Marschark's study revealed that deaf individuals have a similar articulatory loop capacity to that of hearing individuals, roughly 2 seconds in length when averaged. However, hearing individuals were able to produce longer strings of numbers because the digit production is faster in speech than in sign.

Research such as Marschark's (1996) suggested that articulatory coding and suppression are not necessarily limited to spoken language or limited to those individuals who can hear and speak. A broadening of Baddeley's (1986) concept of articulatory coding to consider a sign-specific mechanism to the working-memory model was suggested (Chalifoux, 1991). The studies also indicated that deaf and hearing individuals have similar capacities, but sign language takes up more of that capacity than spoken language. (More on memory load and attention span will be discussed later.) Wilson (2001) discussed how articulatory suppression in sign language was indicative of similar "verbal" working-memory processes between the different language modalities of spoken language and sign language.

However, differences were noted in how the modalities were encoded into the working memory. Speech-based memory appeared to be encoded serial orders in terms of time, whereas sign-based memory may be able to encode serial order in terms of space. An example of space based memory is the performance of deaf native signers on backward and forward report (Mayberry & Eichen, 1991; Wilson et al., 1997). Hearing participants typically have much greater difficulty in backward report. The infusing of spatial encoding into verbal/linguistic working memory was also suggested to play a functional role for deaf subjects. Some participants used spatial positioning as a way to organize the serial position of specific items. Deaf subjects would return to a specific location in their signing to make a correction. Some researchers have posited that this may be only a supplemental strategy that would benefit anyone; however, studies using hearing participants revealed that they did not benefit from spatial locations being associated with words (Li & Lewandowski, 1993, 1995; Serra & Jonas, 1996). Based on this information, these differences in verbal/linguistic encoding for deaf and hearing individuals seem to be innate and specific to their modalities.

## Visual-Spatial Memory

Spatial positioning is an important element of sign language. All signs are produced in a three-dimensional space in front of the signer's body. All sign languages make use of this space for communication. This area in front of the body can be used to represent objects within scenes, and these representations can be manipulated to show the real-world locations, orientations, and movements of objects (Pickering, 2009). The functional use of this space is unique to sign languages and is represented in the neurophysiological research conducted over recent years. Right-hemisphere activations have been found during the processing of signed languages, suggesting that space is processed in association with linguistic features and plays an important role in the message (Bavalier et al., 1998; Corina, 1998; Hickok, Bellugi, & Klima, 1996; Soderfeldt, Ronnberg, & Risberg,, 1994). These differences in activation of the visual-spatial centers of the brain are also represented in the reported memory strengths of deaf individuals.

Visual-spatial memory refers to the recall of items presented in a visual array, such as blocks on a table or objects in a grid (Hamilton, 2011). Studies suggest that deaf children are less likely than hearing children to employ sequential memory strategies (Marschark & Wauters, 2008). Individuals who used sign language were more likely to employ varied encoding, including spatial encoding (Bavelier, Newport, Hall, Supalla, & Boutla, 2008). Previous literature has supported this view as well (Carey & Blake, 1974; Hanson & Lichtenstien, 1990). Such tests as the Knox Cube Test and the Corsi Block-Tapping Test assess sequential recall of visual-spatial positions of the blocks. Studies using these tests have shown that deaf adults and children perform superior to their hearing counterparts (; Alamargot et al., 2007; Blair, 1957; Geraci et al., 2008; Logan et al., 1996; Wilson et al., 1997). Even on recall of static sequential presentation of shapes (i.e., a line of shapes shown all at the same time not in serial order), deaf participants performed equal to the hearing participants (Olsson & Furth, 1966).

Studies that looked at recall of logographic languages, such as Japanese, versus phonologically based languages, such as English, have shown that deaf Japanese students were comparable to hearing Japanese students in sequential memory span for Kanji. Deaf Japanese students reported using a gestalt memory strategy, seeing the entire sequence as a whole rather than in a serial order (Flaherty & Moran, 2001). These studies further support the benefits of visual-spatial recall for deaf individuals but also suggest benefits of the employment of a visual-spatial strategy to a sequential linguistic task. However, visual-spatial drawing tasks, such as the Revised Visual Retention Test (Benton, 1974) and the Rey-Osterrieth Complex Figure Test (Hauser, Dye, Cohen, & Bavelier, 2007), found no significant differences between hearing and deaf participants on recall. So, the actual benefits of such memory strategies linked to learning in the classroom setting still remain in question.

Visual-spatial working memory has been of particular interest to researchers in the field of deafness. Many studies have focused on the phonological-articulatory aspects of working memory in regard to deaf individuals (as discussed earlier), butfew have been focused on visual working memory. The theory of sensory compensation was popularly applied to deaf individuals, and assumptions of stronger visual-spatial skills have been noted. Keenher and Atkinson (2006) demonstrated that deaf native signers outperform nonsigners on different spatial working-memory tasks. However, no evidence of superior visual working memory has been found in other studies (Kyle & Harris, 2006; Parasnis, Samar, Bettger, & Sathe, 1996). These studies are to be viewed with caution, though, since they employed serial recall of visual information. Deaf individuals have been shown to perform poorly compared to their hearing counterparts on temporal/sequential memory tasks (Bebko, 1984). Recall by deaf children was found to be better than recall by hearing children when information was presented simultaneously as opposed to sequentially (Todman & Cowdy, 1993; Todman & Seedhouse, 1994). The improved recall by deaf children is purported to arise from the simultaneous natural presentation of visual-spatial information in signed languages versus the sequential nature of spoken languages (Penney, 1989). Consequently, the results of visual working-memory studies using a sequential format may be unrealistic because of the limited capacities of deaf subjects. A significant amount of information is being shared simultaneously during a signed communication exchange. In addition to the signs themselves, the spatial locations, and the movements of the signs are the facial expressions that can also signal linguistic purpose. Facial expressions can add tonality, emphasis, and emotional intent. Research has indicated an increased sensitivity to facial features by deaf individuals. Arnold and Murray (1998) found that recall of faces was better among deaf signers than among hearing signers, who were better than hearing nonsigners. However, no increased recognition memory has been found for global facial features, only for detection and discrimination of local features (Pickering, 2009).

Further confounding the research on visual working memory was the possible use of phonetic coding during visual tasks, as discussed earlier (MacSweeney, Campbell, & Donlan, 1996). Keehner and Atkison (2006) have also indicated that the communication modality of deaf individuals could shape the development of working memory in deaf children; however, the literature regarding deaf children of different communication backgrounds (Koo, Crain, Lasasso, & Eden , 2008; Miller, 2001) or of deaf individuals of differing levels of hearing loss (Marschark, 1998) is minimal. The deaf population is diverse, with wide-ranging differences in access to spoken language as well as in communication modalities. This diversity leads to further questions in the research of verbal working memory, as well as of visual working memory. Crespo, Daza, and Lopez (2012) attempted to answer this question by assessing the visual working memory of deaf participants with differing communication modalities (i.e., Spanish, Spanish Sign Language [SSL], and both) and of hearing subjects. They also used a simultaneous choice through a delayed matching task to reduce the confounding effects of phonological coding. Results of their study indicated that performance by deaf children was modulated by the communication mode. SSL and oral children obtained lower scores than bilingual and hearing children. These results were found to be in contrast to those of Miller (2001), who compared oral versus sign language users on a working memory task employing linguistic stimuli.

**Associative Memory**

Dual coding theory (DCT) was developed from specific experiments on the role of imagery in associative learning (Paivio, 1963, 1965). DCT is a theory of cognition that postulates that both visual and verbal information is used to represent information (Sternberg, 2006). Paivio (1963, 1965) used the idea that mental images aid in learning (Reed, 2010). Supporting evidence shows that memory for some verbal information is enhanced if a relevant visual is also presented or if the learner can imagine a visual image that matches the verbal information, real world or imagined (Anderson & Bower, 1973). Paivio (1969) found that participants were better at recalling words and pictures when they were shown a rapid sequence of pictures, as well as words. The subjects, however, recalled the sequential order of the words more easily than they recalled the sequence of pictures. The easier recall for word sequences supported Paivio's theory for two separate memory systems for verbal and visual information and further supported Baddeley and Hitch's (1974) theory for working memory. This theory has been applied to multimedia presentations, as they require both spatial and verbal working memory. Individuals dually code information presented and are more likely to recall the information when tested at a later date (Brunye, Taylor, & Rapp, 2008).

Neurophysiological research has further supported the DCT. Through fMRI analysis of participants' identification of concrete words and abstract words and nonwords, Jessen et al. (2000) and Binder, Westbury, McKiernan, Possing, & Medler

(2005) demonstrated a number of common areas in the left hemisphere of the brain. Additional areas of the right hemisphere were activated for concrete words, demonstrating greater bilateral-hemisphere activation for more visually represented words. Concrete words are more easily visually represented and therefore activate visual-spatial areas of the brain as opposed to more abstract words, which require greater activation within the linguistic areas of the left hemisphere. Similar fMRI results have been seen in studies of deaf individuals using sign, as mentioned earlier. Right-hemisphere activations have been found during the processing of signed languages, suggesting that space is processed in association with linguistic features and plays an important role in the message (Bavelier et al., 1998 Corina, 1998; Hickok et al., 1996; Soderfeldt et al., 1994). Newman et al. (2010) also found that both narrative and nonnarrative sentences in ASL evoked bilateral activation. One could then surmise that, neurologically speaking, deaf individuals would benefit from the addition of visual imagery with verbal information, as signs are already eliciting activation bilaterally within the brain.

Hamilton (2011) described imagery as the ability to create, maintain, and manipulate a visual image in working memory. Visual-spatial abilities of deaf individuals compared to those of hearing individuals have been reported to be enhanced with the use of imagery (Blair, 1957; Emmorey & Kosslyn, 1996 Emmorey, Kosslyn, & Bellugi, 1993; McKee, 1988). Early studies involving dual coding and associative learning using imagery within the deaf population have revealed similar results. Conlineand Paivio (1975) investigated the effects of word imagery and signability in deaf subjects. In ASL, some words are finger spelled while others are conveyed by manual configurations or gestures. Signability was defined as those words that can easily be represented as gestural signs. Odom, Blanton, and McIntyre (1970) suggested that word signability may be a critical variable in the verbal learning performance of the deaf. Their study found that deaf participants learned significantly more words that have sign equivalents than words that did not. The improved learning for words with sign equivalents was different from the hearing subjects, for whom signability had no effect on their learning. However, such variables as word imagery concreteness were not controlled for and therefore the results viewed cautiously.

In their study, Conline and Paivio (1975) investigated the various strategies that deaf and hearing participants used to recall the second word in a pair of presented words. They found that recall was generally better for high-imagery than for low-imagery words overall for both deaf and hearing participants but that deaf participants' use of gestures or sign-based strategies resulted in significantly higher recall. Similar results of better recall with highly visual word pairs have been noted in other studies as well (; Craig, 1973; Cornoldi & Sanavio, 1980; Hienen, Cobb, & Pollard, 1976). While all of these studies found similar recall for words with high signability, they all looked at associative memory only within the context of English print words and the use of signs or gestures as a strategy for recall. None looked at associative recall of signed pairs.

Pollard and DeMatteo took the research further and initially developed and pilot tested the Signed Paired Associates Test (SPAT) based on the Verbal Paired Associates Test (WMS-R; Wechsler, 1987) which was originally called the Wechsler Memory Scale (Wechsler, 1945). The sign pairs were chosen from the Mills and Williams (1982) list of sign associations. In that study, deaf participants were asked to give the first sign that came to mind following a stimulus sign. There responses resulted in a list of signs and their corresponding sign associates in order of relative frequency of occurrence. The early version of the SPAT used only six sign pairs, but a determination was made that a longer list would provide a wider range of results (DeMatteo, Pollard, & Lentz, 1987). The SPAT consisted of 14 sign pairs (seven easy and seven difficult) presented over four learning trials. Following a trial, the subject was cued the first sign and was asked to provide the second sign. Then, after a 20-minute delay, a free-recall trial occurred, asking the participants to recall all 14 sign pairs. Results of the SPAT produced three immediate-recall scores and six delayed-recall results. Results from two studies using the SPAT (DeMatteo et al., 1987; Pollard et al., 2005) showed consistent performances by deaf subjects. They also provided evidence of how deaf participants' performances on the SPAT paralleled those of hearing participants on similar tasks of verbal learning and memory, including the paired associate task of the WMS-R.

**Importance of Elaboration Strategy Research for Deaf Individuals**

To date, the study of the use of visual or visual-spatial memory with deaf has been in the context of conceptualizing memory or understanding the role of language. Results of these studies have resulted in consistent themes of commensurate or stronger visual and/or spatial recall in deaf participants when compared to hearing participants, as well as of free recall over temporal sequential recall. However, these findings have yet to be translated into specific, effective strategy use during instruction. Many questions remain regarding the effective use of visual information with linguistic information as it pertains to learning. While deaf individuals use visual and spatial information at least as effectively as hearing individuals, the incorporation of visual approaches in the classroom setting for deaf individuals has yet to result in improvements in learning. The average performance on tests of reading comprehension for deaf and hard-of-hearing students is several grade equivalents lower than that of their high-school-aged hearing peers (e.g., Allen, 1986; Traxler, 2000; Wagner et al., 2003). One must recognize, however, that these deficits in performances are significantly more complicated than simple instructional techniques. Such issues as language access, early language development, access to generalized conceptual knowledge, differences in ASL and English, appropriateness of standardized assessments used to measure progress in deaf individuals, and the various secondary impacts of differing etiologies of deafness, just to name a few, further complicate the learning picture. Still, gaining any advantage in providing the mind of a deaf child with information that is more readily available and efficiently usable is critical in the overall general learning picture.

Specifically in the use of pictorial information, much of the research has been in regard to recall as it pertains to English words or print. No research has been conducted to date regarding the potential enhancement of verbal/linguistic memory for signs through the association of pictures. The limited research is partially a result of the lack of memory measures developed with ASL as their main mode of communication. However, with the development of the SVLT (Morere, 2013), the potential exists for a study that could explore the potential benefits of visual information on the rate of learning in ASL. Based on the literature on deaf memory and DCT, providing associating visual information along with an ASL sign should enhance the rate at which a deaf subject can learn and recall that sign. DCT and related research for the deaf have shown that concrete words with specific imagery are more easily recalled than abstract words (Bonvillian, 1983 Conlin & Paivio, 1975; Cornoldi & Sanavio, 1980; Hienen et al., 1976; Craig, 1973). Also, sign associations have been shown to be similar to those of hearing spoken-language word associations (Pollard et al., 2005; DeMatteo et al., 1987). However, despite the main use of ASL and free-recall demand of the SVLT, the ordered exposure provides a time/sequential element to the task during encoding. Would the incorporation of pictures with that demand, thus increasing the overall number of elements to recall, only increase the demands upon the deaf participants? Or, would the associations of the signs to the pictures deepen the encoding of those signs more quickly, thus increasing the overall rate of learning?

The implications of these questions are important in terms of application within the classroom setting. Current instructional recommendations for deaf individuals support the use of visually accessible environments to enhance learning (DeafTEC, 2014, NCDS, 2008. Use of such technologies as PowerPoint, computers, and SMART boards, as well as of such programs as Boardmaker, make the combination of visual imagery with sign instruction even more readily available. Hamilton (2011) suggested the use of drag-and-drop tasks through pPowerPoint that could be used for reading instruction, under the premise that the imagery would aid in comprehension. Similar recommendations for using the Lindamood-Bell Learning Processes program were based on its effectiveness with improving the reading scores of hearing children using visualization and imagery (Sadoski & Wilson, 2006). However, this program is based on the theoretical assumption that the visual imagery will enhance the encoding and recall of the print. In most deaf classrooms that use sign language as their main mode of instruction, the pictures would first be associated with a sign, then again with the print. The assumption is that the association with the sign and eventually with the print will enhance learning and recall, but no specific empirical evidence of the effectiveness of such strategies exists.

## Current Study

### Research Question

Owing to the paucity of research regarding the benefit of visual imagery associated with ASL, the current study was designed to address the following question: "Does elaboration of an ASL recall task improve the rate of learning in deaf individuals?"

### Hypotheses

$H_o$ – Related visual images presented with ASL signs on a list recall task will not improve rate of learning in deaf subjects.

$H_1$ – Related visual images presented with ASL signs on a list recall task will improve rate of learning in deaf subjects.

# Chapter 3: Method

## Overview

The purpose of this study was to assess elaboration as a memory strategy for deaf individuals. The goal was to determine if the combination of visual/pictorial information with sign/linguistic information in fact increases the rate of learning, retention, and recall. Typical classroom lessons often incorporate visual imagery or pictures for deaf students. These images are often combined with American Sign Language (ASL). The purpose of the visual imagery is to enhance comprehension and improve retention of the concepts and the related terms. This study paired related pictures with specific ASL signs, administered them to deaf individuals, and compared their performances with those who received only signs. Then the experimental conditions were given to the opposite group to determine within-group improvement in recall.

## Participants

A total of 35 deaf students aged 18 to 40 years from Gallaudet University, a liberal-arts college for the deaf in Washington, DC, were recruited to participate in the study. The students included a balanced group of men and women. Hearing thresholds were gathered for all 35 students. The mean pure-tone average in the better ear was required to be 95 dB. For the purposes of this study, interest focused on deaf students whose primary mode of communication was ASL, intentionally creating a bias toward greater visual skills. All of the deaf participants indicated good ASL skills, rating themselves either as 4 or 5 on a 5-point scale ranging from *none* to *excellent* (Mean = 4.5). All of the participants presented with low-average to above-average nonverbal cognitive abilities based on results of the Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV) perceptual reasoning index (Mean SS = 88).

**Inclusion/Exclusion Criteria**

Individuals were required to have a moderately severe to profound hearing loss bilaterally (55-90+dB loss), low-average to above-average nonverbal cognitive abilities, and fluency in ASL. Individuals with normal hearing, intellectual disabilities, and no familiarity with ASL were excluded from this study.

**Recruitment**

Participants were recruited through campus flyers and e-mail to participate in this study. A small grant was applied for through the Gallaudet Research Institute (GRI) to provide a small compensation to each participant. Interested participants were provided with a description of the purpose of the study and procedures involved and with consent forms explaining their ethical rights and potential consequences of participation. These descriptions and consent forms were explained by Robert Whitaker, Psy. S. NCSP, ABSNP, who is fluent in ASL, to ensure complete comprehension of the purpose and procedures of participation.

**Sample Size, Power, and Precision**

A target number of 35 participants were recruited, providing a sample size that approximates an accurate representation of the typical deaf population.

## Measures and Materials

- Kaufman Brief Intelligence Test, (KBIT) Nonverbal Scales
- Test of Nonverbal Intelligence-Fourth Edition (TONI-4)
- Sign Language Verbal Learning Test
- Laptop for video administration of the Signed Verbal Learning Test (SVLT)
- Video recording device for documentation of responses
- Clip Art for creation of visual images of signs
- SVLT word list for assessment of ASL proficiency related to task
- Flyers for recruitment
- Testing area in the Gallaudet Psychology Department
- Procedural description forms
- Consent forms
- Compensation provided by a small GRI grant
- Administration space provided by the Gallaudet University Department of Psychology

## Research Design

In order to best research the effects of elaboration as a memory strategy for deaf individuals, a mixed experimental design consisting of within- and between-group exposure to the experimental condition was used to counterbalance the results and best determine impact of the visual imagery on deaf individuals compared to others, as well as relative to themselves. A nested analysis of variance (ANOVA) was applied to both within and between conditions to determine any effect by the elaboration on the group and/or individuals.

## Procedure

### Recruitment

Participants were invited to take part in the research via flyers and e-mail at Gallaudet University. A summary of the parameters of the research was given in the e-mail and flyers. Acquisition of a small grant from the GRI provided the opportunity to compensate participants in the study. Students or staff members who responded to the flyers and e-mails were invited to meet with the researcher and discuss further the parameters and potential risks of the study. The procedures and potential risks were explained to the prospective participant by the lead researcher, who is fluent in ASL. Once all procedures and risks were described, those individuals who were still interested were asked to sign a consent form giving their full permission to participate and were compensated on completion of the study.

An initial screening session at the Gallaudet University Department of Psychology was scheduled to determine inclusion/exclusion criteria. Participants were asked to report their specific level of hearing loss on a demographics form. Once hearing levels were established, the Nonverbal Scales of the KBIT were administered to establish baseline cognitive abilities. Participants who met all criteria of the study following these intake procedures were scheduled to take part in the control and experimental conditions of the elaboration study. Those who did not meet the criteria were still compensated for their time but excluded from participation in the study. Participants included in the study were randomly separated into two groups, one control and one experimental, for the first trial. Then the control and experimental groups were reversed for the second trial, counterbalancing the effects of the experimental conditions and determining between- and within-group impact.

**Control Conditions**

| The elaboration study was |
|---|
| Lawn mower |
| Egg |
| Pants |
| Typewriter |
| Rake |
| Coffee |
| Socks |
| Book |
| Apple |
| Screwdriver |
| Chair |
| Blouse |
| Paper |
| Bicycle |
| Bed |
| Spoon |

Video clips of the ASL signs from List A were shown to the participant. Immediately following the showing of the entire list, the participant was asked to recall as many of the signs for that list that they could remember. This recall was recorded via the video-recording device for analysis and scoring later by the researcher. The list was repeated over five trials to determine gain in recall through repetition. Corrections, repetitions, and intrusions of signs during recall were also documented. Immediately following the five trials with List A, an interference list was administered, List B. The participant was asked to immediately recall this list of signs. Again, corrections, repetitions, and intrusions were recorded. Table 2 shows the English words for these ASL signs.

Table 2 *List B*

| |
|---|
| Bread |
| Shoes |
| Camera |
| Medicine |
| Ball |
| Candy |
| Toothbrush |
| Hat |
| Bowl |
| Cards |
| Towel |
| Tennis racket |
| Orange |
| Bed |
| Mirror |
| Coat |
| Blanket |

Following a 20- to 30-minute delay during which the participants worked on nonrelated visual-spatial tasks, the participants were asked to recall any of the ASL signs from List A that they could remember. The recall of List A following the delay was to assess free recall of the ASL signs from long-term memory. Then the examiner guided a cued recall task in which the participants were asked to recall signs based on visual-spatial geographic clusters. Table 3 is a list of those clusters.

Table 3 *Geographic Clusters*

| |
|---|
| Kitchen |
| Study/office |
| Bedroom |
| Garage |

Finally, the participant was presented with a recognition list and asked to identify those signs that he or she had seen previously. The list provides target words from List A and interference words from List B and random interference words. Table 4 shows the recognition list.

*Table 4: Recognition List*

| Sign | Y/N | Category or Error | Sign | Y/N | Category or Error |
|---|---|---|---|---|---|
| Napkin | | 2 | Bicycle | | Garage |
| Lawnmower | | Garage | Medicine | | 2 |
| Dog | | 6 | Blouse | | Bedroom |
| Soap | | 5 (paper) | Piano | | 5 (typewriter) |
| Pencil | | 3 | Bowl | | 1 |
| Apple | | Kitchen | Coffee | | Kitchen |
| Ticket | | 6 | Stars | | 5 (socks) |
| Onion | | 4 (apple) | Pants | | Bedroom |
| Toothbrush | | 2 | Egg | | Kitchen |
| Typewriter | | Study/office | Gas | | 3 |
| Camera | | 2 | Rake * | | Garage |
| Hat | | 1 | Book | | Study/office |
| Door | | 4 (book) | Scissors | | 1 |
| Bed | | Bedroom | Knife | | 4 (egg) |
| Chair | | Study/office | Train | | 5 (egg) |
| Mirror | | 2 | Paper | | Study/office |
| Screwdriver | | Garage | Table | | 3 |
| Key | | 5 (screwdriver) | Socks | | Bedroom |
| Cheese | | 4 (paper) | Orange | | 1 |
| Meat | | 3 | Doll | | 6 |

**Experimental Condition**

Participants in the experimental group were brought to the testing area, which consisted of a small room with a laptop. The researcher explained the testing procedures to the participant in ASL to ensure full comprehension. Following instructions, the participant was administered the SVLT. The SVLT is a video-based ASL sign list memory task. Table 5 shows the English words of the ASL signs on List A.

Table 5 *List A*

| |
|---|
| Lawn mower |
| Egg |
| Pants |
| Typewriter |
| Rake |
| Coffee |
| Socks |
| Book |
| Apple |
| Screwdriver |
| Chair |
| Blouse |
| Paper |
| Bicycle |
| Bed |
| Spoon |

Video clips of the ASL signs from List A were shown to the participant. Converse to the control conditions, pictures of each object on List A were shown in between exposure to each sign. The pictures consisted of colored line drawings of the objects with no background details that would influence recall. Figure 1 is an example of the type of picture used during administration.

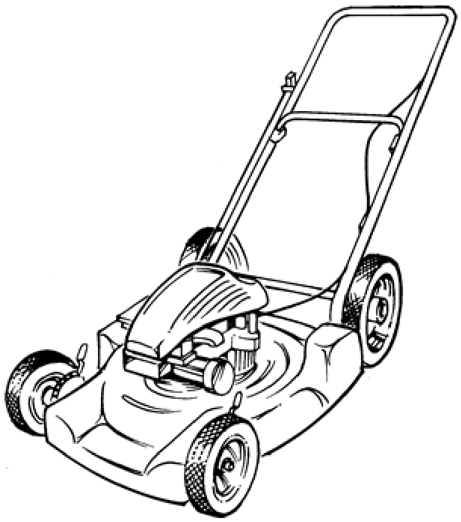

*Figure SVLT Line Drawing*

Immediately following the showing of the entire list, the participant was asked to recall as many of the signs for that list that they could remember. This recall was recorded via the camera on the laptop for analysis later by the researcher. The list was repeated over five trials to determine gain in recall through repetition. Corrections, repetitions, and intrusions of signs during recall were also documented. Immediately following the five trials with List A, an interference list of words was administered, List B. Again, between each of the ASL signs for List B were pictures of the objects. The participant was asked to immediately recall this list of signs. Again, corrections, repetitions, and intrusions were recorded. Table 6 shows the English words for these ASL signs.

Table 6 *List B*

| |
|---|
| Bread |
| Shoes |
| Camera |
| Medicine |
| Ball |
| Candy |
| Toothbrush |
| Hat |
| Bowl |
| Cards |
| Towel |
| Tennis racket |
| Orange |
| Bed |
| Mirror |
| Coat |
| Blanket |

Following a 20- to 30-minute delay, the participants were then asked to recall any of the ASL signs from List A that they could remember. The request for recall following the delay was to assess free recall of the ASL signs from long-term memory. Then the examiner guided a cued recall task in which the participants were asked to recall signs based on visual-spatial geographic clusters. Table 7 is a list of those clusters.

Table 7 *Geographic Clusters*

| |
|---|
| Kitchen |
| Study/office |
| Bedroom |
| Garage |

The participant then was presented with a recognition list and asked to identify those signs that he or she had seen previously. The list provides target words from List A and interference words from List B and random interference words. Table 8 shows the recognition list.

*Table 4: Recognition List*

| Sign | Y/N | Category or Error | Sign | Y/N | Category or Error |
|---|---|---|---|---|---|
| Napkin | | 2 | Bicycle | | Garage |
| Lawnmower | | Garage | Medicine | | 2 |
| Dog | | 6 | Blouse | | Bedroom |
| Soap | | 5 (paper) | Piano | | 5 (typewriter) |
| Pencil | | 3 | Bowl | | 1 |
| Apple | | Kitchen | Coffee | | Kitchen |
| Ticket | | 6 | Stars | | 5 (socks) |
| Onion | | 4 (apple) | Pants | | Bedroom |
| Toothbrush | | 2 | Egg | | Kitchen |
| Typewriter | | Study/office | Gas | | 3 |
| Camera | | 2 | Rake * | | Garage |
| Hat | | 1 | Book | | Study/office |
| Door | | 4 (book) | Scissors | | 1 |
| Bed | | Bedroom | Knife | | 4 (egg) |
| Chair | | Study/office | Train | | 5 (egg) |
| Mirror | | 2 | Paper | | Study/office |
| Screwdriver | | Garage | Table | | 3 |
| Key | | 5 (screwdriver) | Socks | | Bedroom |
| Cheese | | 4 (paper) | Orange | | 1 |
| Meat | | 3 | Doll | | 6 |

Finally, the participant was presented with a picture-only recognition task consisting of pictures of the objects from List A interspersed on a board with interference pictures from List B and random pictures. The participant was asked to point out the pictures that they recalled seeing from the first list administered. Corrections, repetitions, and intrusions were documented.

Both groups were then rescheduled for a second administration of the SVLT at a later date to reduce recency effects on recall of the lists. During the second administration, the groups received the opposite conditions of the first administration. The control group from the first administration received the experimental conditions while the experimental group received the control conditions.

Responses from the study were analyzed and scored by the researcher. Comparisons were made between groups as well as within groups to determine any effect of the elaboration of the ASL signs using pictures of the objects.

# Chapter 4: Results

## Overview

The purpose of this study was to assess elaboration as a memory strategy for deaf individuals. The goal was to determine if the combination of visual/pictorial information with sign/linguistic information in fact increases the rate of learning, retention, and recall. Considering the use of visual imagery or pictures combined with ASL in typical deaf classrooms, an understanding of the impact elaboration has on memory provides key information to overall retention and learning. This study paired related pictures with specific ASL signs, administered them to deaf individuals, and compared the performance with those who received only signs. The conditions were then switched for each group during a second administration to determine improvement within individuals. During the process of the data collection, a second hypothesis emerged regarding improvement on performance during the second session resulting from familiarity with the task. Through discussion with the examiner's committee following data collection, a third hypothesis emerged regarding the potential impact of elaboration on delayed memory trials. The results of these additional hypotheses are summarized in the following section.

The results of the study were analyzed using a repeated measures analysis of variance (ANOVA) to both the picture and nonpicture conditions to determine effect by the elaboration on the group and/ or individuals. A second repeated measures ANOVA was conducted to both Session 1 and Session 2 results to determine effect of familiarity with the task. A third repeated measures ANOVA was conducted to both picture and nonpicture conditions for delayed memory to determine effect by the elaboration on the group and/or individuals.

## Descriptive Statistics

In this study, the total number of participants was 20 adults with a median age of 22 years who were randomly divided into two groups designated for exposure to control or experimental conditions during first sessions. Twenty-six participants partook in the initial session of the study, but five were removed, as they did not complete the second session. Of the 21participants, 80% identified as female and 20% identified as male. Of the group, 85% classified themselves as Caucasian, 15% reported as Hispanic/Latino, 0% reported as African American/Black. All participants were identified as deaf, with the majority of individuals reporting within the Severe Range (dB 70-90; 70%). Most participants rated their ASL skills as Expert (65%). IQs were determined using two different measures of nonverbal reasoning: the Test of Nonverbal Intelligence-Fourth Edition (TONI-4) and the Kaufman Brief Intelligence Test-Second Edition (K-BIT-2). Participants' performances on these measures indicated Average Intelligence for most individuals (TONI-4, $M$ = 103; K-BIT-2 $M$ = 104). One individual performed within the Deficient to Borderline range, while six others had scores that fell within the High Average to Superior ranges on at least one of the measures. Readers are referred to Table 9 for a summary of these statistics.

Table 9 *Demographic Characteristics*

| Characteristics | | Group (%) |
|---|---|---|
| Average age (Years) | | |
| 19-25 | | 66 |
| 26-35 | | 23 |
| 36-58 | | 9 |
| Gender | | |
| Male | | 15 |
| Female | | 85 |
| Race/ethnicity | | |
| Caucasian | | 85 |
| Hispanic/Latino | | 15 |
| Other | | |
| Hearing loss | | |
| 56-70 dB | | 15 |
| Moderately – Severe | | |
| 71-90 dB | | 19 |
| Severe | | |
| 90+ dB | | 66 |
| Profound | | |
| ASL skills | | |
| 3 - Advanced | | 19 |
| 4 – Expert | | 19 |
| 5 – Native | | 61 |
| IQ (SS) | $M = 99.2$ | $M = 98.8$ |

**Hypothesis 1**

$H_0$ – Related visual images presented with ASL signs on a list recall task will not improve rate of learning in deaf subjects

$H_1$ – Related visual images presented with ASL signs on a list recall task will improve rate of learning in deaf subjects

**Results of Hypothesis Number 1**

To test the hypothesis that visual images presented with ASL signs on a list recall task will improve rate of learning in deaf subjects, a repeated measures ANOVA was conducted. Mauchly's test indicated that the assumption of sphericity had not been violated, $X^2(0) = .00$, $p = .$, therefore degrees of freedom were corrected using the Huynh-Feldt estimates of sphericity ($\varepsilon = 1.00$). The results showed that there was no significant effect of experimental condition, picture/nonpicture, on rate of learning, $F(1.0, 20.0) = 2.75$, $p = .113$. These results suggest that the addition of pictures did not increase rate of learning for ASL signs, thus supporting the null hypothesis as noted in table 10.

Table 10

*ANOVA*

Tests of Within-Subjects Contrasts

| Source | Condition | Type III sum of squares | *df* | Mean square | *F* | Sig. |
|---|---|---|---|---|---|---|
| Condition | Linear | 20.024 | 1 | 20.024 | 2.753 | .113 |
| Error (Condition) | Linear | 145.476 | 20 | 7.274 | | |

**Hypothesis 2**

$H_0$ –Familiarity with the list memory task will not improve rate of learning in deaf subjects

$H_1$ –Familiarity with the list memory task will improve rate of learning in deaf subjects

**Results of Hypothesis 2**

To test the hypothesis that familiarity with the list recall task will improve rate of learning in deaf subjects, a repeated measures ANOVA was conducted. Mauchly's test indicated that the assumption of sphericity had not been violated $X^2(0) = .00$, $p = .$, therefore degrees of freedom were corrected using the Huynh-Feldt estimates of sphericity ($\varepsilon = 1.00$). The results showed that there was no significant effect of session sequence on rate of learning, $F(1.0, 20.0) = 2.34$, $p = .141$. These results suggest that familiarity with the memory task did not increase rate of learning for ASL signs, thus supporting the null hypothesis as noted in table 11.

Table 11

*ANOVA*

Tests of Within-Subjects Contrasts

| Source | Time | Type III sum of squares | *df* | Mean square | *F* | Sig. |
|---|---|---|---|---|---|---|
| Time | Linear | 17.357 | 1 | 17.357 | 2.343 | .141 |
| Error (Time) | Linear | 148.143 | 20 | 7.407 | | |

## Hypothesis 3

### Hypothesis 3

$H_0$ – Related visual images presented with ASL signs on a list recall task will not improve delayed recall in deaf subjects

$H_1$ – Related visual images presented with ASL signs on a list recall task will improve delayed recall in deaf subjects

### Results of Hypothesis 3

To test the hypothesis that familiarity with the list recall task will improve delayed recall in deaf subjects, a repeated measures ANOVA was conducted. Mauchly's test indicated that the assumption of sphericity had not been violated, $X^2(0) = .00$, $p$ = ., and therefore degrees of freedom were corrected using the Huynh-Feldt estimates of sphericity ($\varepsilon = 1.00$). The results showed no significant effect of experimental condition, picture/nonpicture, on delayed free recall, $F(1.0, 20.0) = .679$, $p = .420$. These results suggest that the addition of pictures did not increase delayed free recall for ASL signs, thus further supporting the null hypothesis that elaboration does not improve recall as noted in table 12.

Table 12

*ANOVA*

Tests of Within-Subjects Contrasts

| Source | Conditions | Type III sum of squares | *df* | Mean square | *F* | Sig. |
|---|---|---|---|---|---|---|
| Time | Linear | 6.881 | 1 | 6.881 | .679 | .420 |
| Error (Condition) | Linear | 202.619 | 20 | 10.131 | | |

# Chapter 5: Discussion

## Summary of the Findings

In regard to the first research question, “Does elaboration of ASL sign list tasks improve rate of learning in deaf individuals?,” the previous research is in support of the null hypothesis. The results show that there was no significant effect of experimental condition, picture/nonpicture, on rate of learning, $F(1.0, 20.0) = 2.75$, $p = .113$. These results indicate that the addition of pictures along with the American Sign Language (ASL) signs, while reported as helpful by some of the participants, did not significantly improve the participant’s recall for the signs or rate of learning over five trials.

In regard to the second research question, “Does familiarity with the list memory task improve rate of learning?,” the previous research is also in support of the null hypothesis. The results show that there was no significant effect of session sequence on rate of learning, $F(1.0, 20.0) = 2.34$, $p = .141$. These results indicate that despite showing more knowledge of the tasks and appearing to perform better, familiarity did not significantly improve the participant’s recall for the signs or overall rate of learning over five trials.

In regard to the third research question, “Does elaboration of ASL signs improve delayed recall in deaf individuals?,” the previous research is in support of the null hypothesis. The results show that there was no significant effect of the experimental condition, picture/nonpicture, on delayed recall, $F(1.0, 20.0) = .679$, $p = .420$. These results indicate that again, while reported as helpful by the participants, additional visual imagery did not improve recall for ASL signs following a delay.

**Significance of the Findings**

Despite the theoretical support for dual coding theory (DCT: Paivio 1963, 1965) as it pertains to visual information and spoken English language, the benefit reported in previous studies apparently is not similarly applicable when pairing visual information with ASL. While continued evidence has been provided demonstrating similar neuropsychological underpinnings of English and ASL (Petitto et al., 2000), both stimulating similar language areas of the brain, the addition of visual information with ASL does not appear to have the same level of benefit that pictures paired with spoken English do as it pertains to recall, at least for singular signs. This finding is significant in that it would appear to be counterintuitive with the literature regarding DCT. In theory, the additional associated visual information should reinforce and deepen the encoding of the sign during exposure, thus improving recall. According to the results previously mentioned, however, recall was not improved. Upon closer inspection, the results of this study may provide more evidence of the uniqueness of ASL as a language because of its visual-spatial nature, which results in greater bilateral activation (Emmorey & Kosslyn, 1996). While spoken English predominantly elicits activation in the left temporal areas of the brain, more concrete terms related to common objects do cause activation in the right temporal areas, as indicated by studies conducted by Binder et al. (2005). ASL, being an entirely visual-spatial language, already elicits bilateral activation within the brain (Pettito et al., 2000; Solderfelt et al., 1994;). Bilateral activation is more noticeable with signs for concrete nouns and common objects. The iconic nature of these signs, the way they mimic either the look or the movement of the common object, is likely provoking bilateral activation on a more consistent basis. This regularity possibly reduces the overall impact of any additional pictorial or visual information that is then paired with those signs.

While elaboration, as a strategy, continues to be recommended as an effective instructional strategy for deaf individuals (DeafTEC, 2014; NDCS, 2008), the present study suggests that the effectiveness of elaboration as it pertains to recall of information may be called into question. Despite literature supporting the idea of “sensory compensation,” Marshark’s (2012) recent proposal that deaf individuals are not visual learners seems to be plausible when considering the results of this study. Were improved instruction for deaf individuals as simple as pairing linguistic information with visual formats for instruction, then in theory, the pairing of pictures with ASL signs should improve recall to some degree. While much of the research that involved English and visual information may have supported sensory compensation, pairing of pictures with ASL, however, does not appear to provide the same benefit. Considering these results, educators should carefully consider the assumed level of impact elaboration has on their students’ retention and recall of the information contained within their lessons. In an effort to address the learning deficits that can commonly occur with a large percentage of deaf students, specifically children of hearing adults who do not have early access to language, assumptions about visual information as compensatory instructional strategy when ASL is the mode of instruction must be further vettedthrough research. The conceptualization of deaf individuals as visual learners as a result of previous views on

ASL as a language and focus of research on English language needs to be counter researched to better understand more effective instructional strategies.

**Impact of the Findings**

When considering the wealth of research that demonstrates the delays in average reading levels in deaf individuals (Allen, 1994; Furth, 1996; Holt, 1993; Karchmer & Mitchell, 2003; Moores, 2009; Quigley & Kretschmer, 1982; Traxler, 2000) and the increased focus on ASL for early intervention as well as a language of instruction (Morere, 2011), consideration regarding the effectiveness of traditional instructional strategies must be made. Making assumptions about the effectiveness of such strategies as elaboration based on research focused on English language is no longer appropriate as knowledge increases about how the brain of deaf individuals, whose primary language is ASL, functions. The results of this research suggest that elaboration, while widely considered an effective strategy for instruction of deaf individuals, does not appear to have significant impact on rate of learning or delayed recall when used in conjunction with ASL. The perspective of deaf individuals as visual learners and instructional approaches based on sensory deprivation models remain in question. To attempt to close the gap on academic deficits in many deaf individuals, continued investigation of learning strategies within the context of ASL must occur.

Even though this particular study suggests that elaboration does not significantly improve rate of learning or delayed recall in deaf individuals, it does not recommend that elaboration be dropped during instruction. This study looked at additional support of elaboration on concrete ASL signs with adults. Each of these participants had an established foundation in ASL and the conceptual knowledge of the signs that were presented to them. As a result, the focus was specifically on recall of the signs, not on comprehension. While the added pictures did not improve recall of familiar concrete concepts, no current research looks at acquisition of novel concepts in ASL and whether or not elaboration may be an effective tool under those conditions. Deaf individuals, specifically children, who are being taught new, unfamiliar concepts and are also not familiar with the ASL sign may benefit from additional concrete imagery to help ensure comprehension. These results also reinforce the importance of early exposure to language, specifically ASL, to improve overall language development in deaf individuals. The participants in this study were native or expert users of ASL. Their established foundation in ASL may have resulted in automaticity of the concrete familiar signs presented to them. Therefore, their rate of learning was based more on language and not influenced by the additional pictures. Until such research can be conducted regarding elaboration for comprehension, continued use of additional visual information is justifiable.

Perceptual factors also continue to make elaboration an important component to teaching. Qualitative information gathered during data collection revealed that several participants reported benefiting from the addition of the pictures with the signs. Studies such as that by Pashler, McDaniel, Rohrer, and Bjork (2008) have demonstrated that belief in a preferred learning method is often not supported with evidence of improved performance. More specifically, studies involving visualize versus verbalize learning approaches also did not bear evidence that preferred learning approaches, visual for participants who preferred it, increased performance over another learning approach (Massa & Mayer, 2006). Similar findings were made in this study, as rate of learning did not statistically improve with the addition of visual imagery. Gathering such evidence is critical to the development of truly effective strategies. However, perception of advantage can still be powerful in terms of its impact on motivation during learning. Studies have shown that individuals who perceive themselves as more effective perform better because of their positive views (Schunk, 1990). A person's belief about his or her own self-efficacy often can predict cognitive outcomes. While statistically the addition of visual imagery did not prove to be effective, the participants' reports of benefiting from the pictures could theoretically lead to improved learning resulting from their own perception of ability when using the visual materials.

Along with perception, cultural reasons support the continued use of elaboration during instruction. Other studies have shown the benefit of fostering positive attitudes and promoting a healthy learning climate (Brophy, 1982). These studies propose that the quality of resources can influence the attitudes and perceptions of the learners and that under the right conditions students can have certain attitudes and perceptions that establish a mental climate for learning. In regard to deaf learners, many deaf individuals grow up in environments that do not provide accessibility to language, resulting in general language deficits, including written English, which is used in instruction. Deaf learners, therefore, often rely heavily on visual information in their environments from an early age. Visual access to information becomes an integral part of the deaf learner's perception of a positive classroom climate. Thus, a lack of visual information can be viewed as a limitation on accessibility, as culturally insensitive, and, therefore, as negative. Negative feelings about the accessibility of information could reduce motivation to learn in a deaf individual by establishing a perceived unhealthy classroom climate. So, while this study provides informative statistics regarding the limited effectiveness of elaboration, it should not be interpreted as a recommendation to drop elaboration as an instructional practice.

Although a second hypothesis regarding improvement of rate of learning resulting from familiarity with the task emerged during data collection, statistically this hypothesis was not supported. The author surmised that the decreased executive-function demands during the second session might have allowed more cognitive resources to be employed during encoding and recall. However, this hypothesis did not prove to be accurate. One reason is because the task was not complex from an executive-functions perspective, even though it was unfamiliar initially. Once the participant was exposed to the first trial, the concept was acquired, and therefore, little adjustment was necessary for any subsequent trials, including those during the second session. Additionally, the time gap between the experimental and control conditions likely reduced any impact of the executive strategies learned during the first condition. The 3-week time period between sessions reduced recall of the word list and could have also reduced recall of strategy use, thus eliminating any statistically significant impact of familiarity with the task.

In addition to minimal executive-demand and time delay effects, participants also typically settled upon preferred strategies within the first couple of list trials and demonstrated little change thereafter. Strategy exploration was not apparent, and many of the same techniques appeared to be implemented during the second sessions. No specific statistical analysis was done to determine if one or more of these particular strategies was more effective than others in terms of rate of recall; however, no patterns emerged in the raw data that would suggest one was more effective than another. Additionally, these techniques were naturally occurring. They were chosen and implemented by the participant without any instruction or coaching. Preexisting familiarity with the strategy was likely and therefore did not require any additional executive-function demands during either session.

## Limitations

While this study does provide evidence regarding the limited effectiveness of elaboration as an instructional strategy with ASL, limitations to this research must be considered. One of these limitations is the number of participants. Deaf individuals represent a small percentage of the general population, thus inherently limiting the general size of studies involving deaf participants, as well as accessibility. Another factor is the significant variability of hearing loss, ASL proficiency, and etiologies that can result in additional impacts on learning and result in exemption from the study because of the specific criteria. Since the study was conducted at Gallaudet University, accessibility to deaf participants was alleviated, but the specific criteria still narrowed the potential pool for this particular study. Another factor regarding the small number of participants was the format of the study. To test both control and experimental conditions, participants were required to partake in two sessions, approximately 3 weeks apart. Recruiting participants for the initial session proved to be easier than bringing participants back for a second session, further reducing the overall *N* for this study. This limitation in number of participants definitely impacts the power of the results and its relevance to the population as a whole. In a larger study with a larger pool of participants, the statistical significance could vary.

Another limitation of this particular study was in the area of diversity. Despite broad recruiting efforts at Gallaudet University, which is a diverse program in Washington, DC, few individuals of diverse racial and cultural backgrounds participated in the research. Considering the greater diversity that exists in the deaf community as a whole, information regarding the effectiveness of elaboration with a more diverse group of learners is important and needs to be explored further.

## Future Directions

The results of this study have provided information regarding the limited effectiveness of elaboration as an instructional strategy. However, as previously noted, it does not suggest that elaboration should be dropped altogether. What this study does recommend, however, is further investigation of elaboration as an instructional strategy within the context of ASL under different conditions. One of the purposes of this study was to isolate elaboration and eliminate variables that could influence the power of the techniques on rate of learning with deaf individuals. Therefore, a select group of deaf learners with a strong preexisting foundation in ASL was recruited. However, this pool of participants does not represent the variability that exists in the deaf population as a whole. The wide range of etiologies that results in additional learning challenges, lack of access to language during critical periods of development, and variability in communication methodologies for much of the deaf population draw into question the effectiveness of elaboration with individuals outside the criteria for this particular study. Deaf individuals with these diverse learning needs represent a much broader base of the population and also present the greatest instructional challenges. Further studies investigating the impact of visual imagery on rate of recall with these diverse individuals could provide more data by which instructors could make more informed decisions for their classrooms.

Another future direction for this research is in the use of elaboration with ASL to study the improvement in learning of novel or unfamiliar information. This current study used concrete, familiar ASL signs and concepts that were well known by the participants who already demonstrated a strong foundation in ASL. However, no information is available that looks at how elaboration with ASL may improve learning of a new concept. Considering that many concepts presented in educational settings are, in theory, novel, research related to the effectiveness of elaboration is quite relevant. When vocabulary or labels are not preexisting for a new concept, does visual imagery provide information that improves the acquisition of the concept until it becomes concrete and the vocabulary automatic? Such questions are especially important in terms of the age of participants. Deaf children, who are often faced with deficits in language, may rely more heavily on visual information while still trying to develop language. Determining the effectiveness of elaboration with younger deaf individuals would provide more directly relevant information for learning and critical stages of development.

Finally, this study raises questions not only about the effectiveness of elaboration with ASL but also about the impact of other traditional instructional and memory strategies within the context of ASL. Rather than a heavy reliance on only visual imagery with ASL to improve recall, such strategies as rehearsal, organization of information, externalization of information, or linking to prior knowledge also should researched and considered during instruction. Behavioral observations made during the data collection revealed several participants using self-organizational strategies, such as grouping or categorizing of the signs, to improve their recall. Others used counting techniques to add structure to the task and provide a cue to help them determine which signs they had not yet recalled. Some performed rehearsal strategies immediately following each presentation of the sign list. The emergence of these self-strategies during data collection provides evidence that other memory techniques, ones not suggested to be based on sensory deprivation theory, may be more effective and impactful on rate of learning for deaf individuals. Some beginning analysis of these strategies could begin with the information gathered during this particular study, but specifically designed studies targeting these memory strategies and techniques within the context of ASL need to be explored in order to provide the deaf education community with evidence by which they can make more informed instructional decisions and potentially improve rate of learning.

## Conclusions

While limitations exist to this current study, the lack of statistical significance in support of elaboration as an effective strategy for rate of learning or delayed recall when combined with ASL leads to critical questions regarding an instructional approach that is widely accepted as effective for deaf individuals. It highlights the continued need for more research on instructional techniques and strategies implemented in classrooms for the deaf and particularly in those that use ASL as their main mode of communication. Educational researchers working with the deaf community are just beginning to understand learning within the context of ASL, despite the long establishment of it as a language. Hopefully, this study, similar to previous research regarding ASL and memory, will continue to inspire future researchers to continue to ask these critical questions so that richer data can be provided to educators of deaf individuals so that they can make more informed decisions.

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