EFFECTIVENESS OF PICTURE COMMUNICATION SYMBOLS IN THE ACQUISITION OF SPECIFIC AMERICAN SIGN LANGUAGE VOCABULARY BY DEAF STUDENTS WITH INTELLECTUAL DISABILITIES

by

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Abstract

This study utilized an adapted alternating treatments design to compare the effectiveness of a unimodal (ASL-only) instructional presentation and a multimodal (ASL+Picture Communication Symbols) instructional presentation in teaching American Sign Language (ASL) vocabulary words to two deaf children with intellectual disabilities. The results indicated that, overall, instruction resulted in increases in the participants' ability to produce unknown ASL vocabulary. However, the two participants demonstrated differences in their ability to produce the target ASL vocabulary words correctly. For one participant, the ASL+PCS instructional condition was somewhat more effective, but no difference across the two conditions was demonstrated for the second participant. The results are discussed in terms of their educational and research implications, limitations, and applicability to future research.

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CHAPTER 1

Introduction

Research Problem

Deaf children with intellectual disabilities have been the focus of very little research. The existing body of literature about these children has focused primarily on assessment procedures, diagnostic labeling and identification of specific disabilities associated with deafness, and strategies for teaching functional skills (e.g., Deirkson & Peters, 1981; Garner, Becker, Schur, & Hammer, 1991; Jones & Dunne, 1988; Orlansky & Bonvillian, 1984a; Ratner, 1985; The Committee on Multiply-Handicapped Students, 1988). However, due at least in part to the heterogeneity of the population and to difficulties with identification and diagnosis, relatively little has been written on the extent to which the language and communication development of these children may differ from that of typical deaf children. Thus, the prevailing practice is to teach deaf children with intellectual disabilities to use the same manual sign systems used by other deaf children (e.g., American Sign Language [ASL] and Signed English [SEE]).

In contrast, both American Sign Language (ASL) and various graphic representational systems (GRSs) have been used successfully for communication by hearing individuals with intellectual disabilities who are unable to speak (e.g., Bryen, Goldman, & Quinlisk-Gill, 1988; Bryen & Joyce, 1986; Orlansky & Bonvillian, 1984a; Snyder, Freeman-Lorentz, & McLaughlin, 1993). Research to date in this area has focused primarily on strategies for teaching these individuals to communicate using either manual signs or GRSs. Scant research has investigated the extent to which learning in one modality (e.g., GRSs) may facilitate learning in another (e.g., ASL signs). Such cross-modality learning may be especially important for deaf children who have an intellectual disability, since "virtually all professionals who are familiar with this population agree that the cumulative effects of multiple impairments greatly inhibit the development of language" (Orlansky & Bonvillian, 1984a, p. 73).

The purpose of this study was to compare the relative efficacy of two approaches to learning manual signs in deaf students with intellectual disabilities. This research is seen as a first step toward identifying teaching interventions that may be appropriate for deaf students who have difficulty learning new signs because of intellectual or other cognitive impairments (e.g., autism, acquired brain injury). Terms and definitions relevant to the study will be presented briefly in the sections that follow.

Definitions

Deaf Students with Intellectual Disabilities

Although the existence of multiple disabilities among deaf children is statistically higher than that in the general population, little contemporary research exists concerning this population (Mauk & Mauk, 1992; Moores, 1982). That which does exist demonstrates the vast inconsistencies with regard to labeling, probably due to the heterogeneity of the population as well as to changing terminology. Such terms as "multi-handicapped deaf students" (The Committee on Multiply-Handicapped Students, 1988), "developmentally delayed deaf students" (Deirkson & Peters, 1981), "students with multiple disabilities and hearing impairment (MDHI)" (Mauk & Mauk, 1992), "multihandicapped hearing-impaired (MHHI)" (Orlansky & Bonvillian, 1984a) and "hearing impaired learner with special needs" (Stepp, 1981) have all been used to refer to these individuals.

Of interest to this study are students with a prelingual hearing loss (severe to profound loss prior to language learning) and intellectual disabilities (moderate to severe/profound). In order to conform with current identification practices within the B.C. Ministry of Education, Skills and Training as well as to current terminology practices within the field of education for deaf/hard of hearing students, I will refer to these individuals as deaf students with intellectual disabilities in this report. The range of hearing loss from severe to profound is defined as a loss of 71 decibels or more (B.C. Ministry of Education, Skills and Training, 1995). The age of onset of deafness is also significant; individuals whose hearing is affected prior to the development of language are said to have a prelingual hearing loss, whereas those whose loss occurs after language is acquired are said to have a postlingual loss (Martin, 1994). Obviously, a prelingual hearing loss has a greater impact on both speech and language acquisition than does a postlingual loss. Finally, students in the moderate to severe/profound ranges of intellectual disability are those with intellectual functioning "greater than 3 standard deviations below the norm on an individually administered Level C assessment instrument of intellectual functioning, [as well as] delayed adaptive behavior and functioning of similar degree" (B.C. Ministry of Education, Skills and Training, 1995).

American Sign Language

American Sign Language (ASL) is the language used by the majority of Deaf people in North America. ASL is a dynamic, visual-spatial, temporally-based language (i.e., based on visual perception and spatial cognition), in contrast to spoken languages, which are auditory-aural and are processed through an auditory-oral modality (Emmorey, 1991; Humphrey & Alcorn, 1995; Meier & Newport, 1990; Sevcik, Romski, & Wilkinson, 1991; Siedlecki & Bonvillian, 1993). It is generally accepted that, in many ways, the acquisition and development of ASL by deaf children of deaf parents parallels that of hearing children acquiring spoken languages (Meier & Newport, 1990; Siedlecki & Bonvillian, 1993; Tabor, 1988). Furthermore, ASL is as complex and as grammatically ordered as are spoken languages (Humphrey & Alcorn, 1995; Meier & Newport, 1990; Orlansky & Bonvillian, 1984a; Tabor, 1988).

The use of manual sign systems such as ASL with hearing individuals who have intellectual disabilities is well documented in the literature (Bonvillian & Miller, 1995; Bryen & Joyce, 1986). Research in this area has stimulated questions concerning the rationale for using manual signs with this population (e.g., Bryen & Goldman, 1988; Bryen & Joyce, 1986; Orlansky & Bonvillian, 1984a). Nonetheless, there is general agreement that the primary advantages for using sign language with individuals who have intellectual disabilities include: (a) the fact that signs are more iconic than spoken words (Doherty, 1985; Orlansky & Bonvillian, 1984a), (b) the fact that signs bypass the complex motor requirements of speech (Romski, Sevcik, & Joyner, 1984), (c) the relative portability of signs over other types of non-speech communication (Hodges & Schwethelm, 1984; Luftig & Bersani, 1988; Orlansky & Bonvillian, 1984a), (d) the potential access afforded to the larger community of sign users (Bryen & Joyce, 1986) and (e) the fact that sign language provides unrestricted access to vocabulary (Orlansky & Bonvillian, 1984a). On the other hand, sign language may pose a problem for individuals with cognitive, memory, or visual perceptual disabilities with regard to language learning, due to its transient nature and dependence on recall memory (Sevcik et al., 1991).

Graphic Representational Systems (GRSs)

GRSs are two-dimensional communication symbols that include, for example, photographs and line drawings. GRSs differ from both speech and sign language in that they are static and non-transient, and their comprehension depends on recognition memory (Sevcik et al., 1991). GRSs have traditionally been used with individuals who have little or no functional speech as well as severe communication and motor impairments (Bloomberg, Karlan, & Lloyd, 1990).

Research on the use of GRSs with individuals with intellectual disabilities has resulted in considerable support for their use (e.g., Sevcik et al., 1991; Snyder et al., 1993). Advantages of using GRSs include (a) ease of learning due to iconicity (Mizuko & Reichle, 1989), (b) increased communicative independence (Snyder et al., 1993), and (c) accessibility to a large communication audience (Beukelman & Mirenda, 1998). It has been demonstrated that some symbol sets are more easily recognized by persons unfamiliar with them than others, and are easier to both learn and recall (Beukelman & Mirenda, 1998). Picture Communication Symbols (PCS; Mayer-Johnson Co., 1996) have been identified in several such studies as being among the easiest symbol sets to learn (Bloomberg et al., 1990; Mirenda & Locke, 1989; Mizuko, 1987; Mizuko & Reichle, 1989).

Purpose of the Study

The following question was posed as central to this investigation: During a structured learning task with deaf children with intellectual disabilities, will the use of an ASL+Picture Communication Symbol (PCS) presentation result in fewer days required to reach criterion performance than an ASL-only presentation, for novel ASL vocabulary items?

CHAPTER 2

Review of the Literature

Deaf Individuals with Intellectual Disabilities

Definition and Incidence

The Annual Survey of Deaf and Hard of Hearing Children and Youth (Gallaudet University, 1995-96) reported that 33.7% of deaf children and youth in the United States had additional disabling conditions. This percentage includes cognitive/behavioral conditions, physical conditions, and combinations of the two. There is no Canadian equivalent for this report; however, the incidence has been estimated as being close to that of the United States (S. Bailey, Coordinator, Special Programs Branch, B.C. Ministry of Education, Skills, and Training, personal communication, January 16, 1996). B.C. Ministry of Education, Skills, and Training guidelines do not specifically discuss students with deafness and intellectual disabilities, and refer only to students with multiple disabilities who are "dependent" (i.e., physically disabled) or "deafblind" (B.C. Ministry of Education, Skills, & Training, 1995) Thus, for the purpose of this study, it is necessary to draw on the definitions of both "intellectual disability" and "hearing loss" in order to describe the population of concern.

First of all, this study focuses on deaf students who are identified as having a severe to profound prelingual hearing loss through standard audiologic assessment procedures. Students with a hearing loss within this range may miss up to 100% of speech information without amplification, will require support in language and reading subjects, and may be candidates for signing systems (B.C. Ministry of Education, Skills, & Training, 1995). A small proportion of deaf students also have a moderate to severe intellectual disability, and require additional supports in the areas of language and communication development, cognitive development, fine and gross motor development, and life skills (B.C. Ministry of Education, Skills, & Training, 1995).

Students with these combined disabilities are the focus of this study. A brief review of the major etiologies of deafness is offered here in order to illustrate the significance of additional disabilities.

Major Etiologies of Deafness

Each year, the Center for Assessment and Demographic Studies (Gallaudet University, 1995-96) surveys deaf and hard of hearing children and youth in the United States to track the causes of deafness and the presence of disabilities. Several major etiologies of childhood deafness, both congenital and postnatal, are related to a number of educationally significant disabilities. A brief summary of the major etiologies of deafness (in the United States) is presented here to illustrate the interactions with additional disabilities.

Heredity. In the United States, heredity accounts for 27.6% of individuals who are born deaf or hard of hearing (Gallaudet University, 1995-96). Approximately one-third of genetic deafness is associated with some other trait, Waardenburg Syndrome and Usher's Syndrome being the most common. Both may involve deafness, as well as progressive blindness and central nervous system lesions (Vernon, 1982).

Meningitis. Postnatally, meningitis accounts for 14.8% of all deafness (Gallaudet University, 1995-96). Children who experience deafness due to meningitis may have severe neurological disabilities, including aphasia, mental retardation, neuropsychological sequelae, and cortical disorganization (Schildroth & Karchmer, 1986).

Unknown. For 12.6% of the individuals born deaf and 6.6% of those identified postnatally, the cause of deafness is unknown (Gallaudet University, 1995-96). According to Moores (1987) this is a "sizable proportion of the deaf school-age population" (p. 105). As medical practitioners increase their ability to diagnose the causes of deafness, we may observe a decrease in "etiology unknown" cases and a concomitant increase in other causes, along with their associated disabilities.

Premature. Prematurity is associated with 9.9% of identified causes of deafness (Gallaudet University, 1995-96). Moores (1987) stated that "Although prematurity (defined as a birthweight of 5 pounds, 8 ounces or less) is more common among the deaf population than among the normal hearing, the degree to which it is a causative factor is debatable" (p. 106). Prematurity may be associated with learning disabilities, cerebral palsy, emotional disturbances, and mental retardation (Vernon, 1982). It has been predicted that improved medical practices, which result in increased survival rates of premature infants, will result in an increase in the number of deaf children with additional disabilities (Moores, 1987).

Cytomegalovirus infection. Cytomegalovirus infection (CMV) is the cause of deafness in 3.4% of the identified population (Gallaudet University, 1995-96). Additional disabilities as a result of CMV can include "low birthweight, abnormally reduced head size, and mental retardation" (Moores 1987, p. 106).

Maternal rubella. Maternal rubella accounts for 3.3% of identified congenital deafness in the United States (Gallaudet University, 1995-96). Vernon and Hicks (1980) noted that "In addition to physical sequelae that include hearing, vision, urogenital, and endocrine disorders, major, often late-appearing neuropsychological sequelae consist of mental retardation, autism, abnormal behavior patterns, impulsivity, hyperactivity, rigidity, and learning disabilities"(p.531).

Other. Additional causes of deafness include: trauma and other complications at birth (9.7%), Rh incompatibility (0.8%), high fever (4.5%), mumps (0.1%), infection (4.6%), measles (0.3%), otitis media (0.5%), and trauma and other causes after birth (7.9%) (Gallaudet University, 1995-96). It is evident from these statistics that the major etiologies of deafness may be related to one or more additional disabilities. According to Moores (1987), the incidence of additional disabilities is higher in the population of deaf individuals than in the general population.

Each of these etiologies with their combinations of potential associated disabilities has implications for individuals' educational, social, and psychological development.

Deafness and Additional Disabilities

Table 1 provides a summary of children and youth identified with deafness and additional disabilities, by disability category (Gallaudet University, 1995-96).

Table 1

Percentage of Additional Disabilities: Students Identified with Deafness

Additional Disability	Percentage
Specific learning disability	9.0
Mental retardation	7.9
Other health impaired	4.2
Emotional or behavioral problem	3.9
Attention deficit disorder (ADD)	3.9
Other	3.4
Uncorrected visual problem	3.0
Cerebral palsy	2.9
Orthopedic	2.7
Legal blindness	1.5
Brain damage or injury	1.2
Heart disorder	1.2
Epilepsy (convulsive disorder)	1.0

Note. The percentages do not equal 100%, since some students have more than one additional disability.

From this Table, it is clear that approximately 7.9% of deaf individuals also experience intellectual disabilities (i.e., mental retardation). It is important to note that a moderate to profound hearing loss alone places an individual at an obvious disadvantage for language acquisition through the auditory modality. The combined impact of deafness and intellectual disability results in even more significant learning challenges, due to the combined impact on both sensory and cognitive functioning. Thus, the combination of these two disabilities is not simply additive; rather, it is exponential, since the problems these individuals encounter are more complex and unique than can be accounted for by each disability in isolation. In particular, language and communication development may be severely affected.

Although systems of manual communication and speech training have been used in language intervention programs with deaf individuals, systems combining and integrating sign, speech, and GRSs have been used with those having communicative disorders and/or intellectual disabilities (Moores, 1987). For deaf individuals with combined communicative disorder and intellectual disability, a system which integrates modalities for language and communication intervention may be advantageous in its ability to address their complex learning challenges and expand their communicative options. The cognitive, memory, motor, and perceptual demands of ASL and GRSs will be compared and contrasted in the sections that follow, in order to understand the challenges posed to deaf students with intellectual disabilities in acquiring language and communication skills.

Efficacy of Manual Sign Language and Graphic Representational Systems for Students with Intellectual Disabilities

Manual Sign Language

The usefulness of sign language communication training with children who have intellectual disabilities can be traced as far back as 1847, when the benefits of using alternative communication with these children was first recognized (Bonvillian & Miller, 1995). At least limited effectiveness of manual signing with these individuals has since been documented in several studies (e.g., Bonvillian & Miller ,1995; Bryen et al., 1988; Bryen & Joyce, 1986; Mochizuki, Nozaki, Watanabe, & Yamamoto, 1988). According to Bryen and Joyce (1986), the rationale for teaching manual signs to students with intellectual disabilities is that signs are "cognitively less demanding and thus more easily learned than spoken language" (p. 187).

However, Bryen and Joyce (1986) also noted that this rationale is not based on unequivocal evidence, and outlined several assumptions that have been used to promote the use of manual sign interventions with this population:

1. Sign language can bypass the oral-motor speech mechanism in cases where the prognosis for developing speech is not optimistic;
2. The cognitive and conceptual demands of sign language on the learner are not as great as the demands of spoken language. Signs are more iconic, whereas spoken language symbols are arbitrary; and
3. Manual signs are easier to teach because they may be held visually static, providing a better model to imitate and an opportunity for the teacher to physically mold or shape the student's hands(s) for sign production (p. 183).

Another potential advantage of manual sign systems for persons with intellectual disabilities was offered by Orlansky and Bonvillian (1984a). They grounded their discussion of ASL acquisition in cognitive-motor development theory, hypothesizing that "because visual motor areas of the brain mature more rapidly than the cortical centers which govern speech, ASL may be well-suited to the young child's developing perceptual and motor capacities" (p. 73). They discussed the danger of underestimating the language acquisition potential of children with intellectual disabilities, and suggested that sign language may enhance their communicative abilities. In addition, Luftig and Bersani (1988) referred to the "portability and conventionality" (p. 52) of sign systems as being advantageous, and noted that manual sign languages may facilitate normalization, since they draw less attention to the individual than other types of augmentative communication systems.

Although there are numerous reasons for teaching manual signs to individuals with intellectual disabilities, the outcomes are not always positive. For example, Bryen et al. (1988)

investigated the use of sign language with school-aged students with intellectual disabilities. Questionnaires were completed by the speech/language clinicians involved with 118 students with intellectual disabilities in non-residential educational facilities. Results indicated that, for more than half of these students, "sign language was the first alternative communication system tried" (p. 132). The reasons provided for such intervention, however, rarely reflected "empirically-based and clinically-sound rationales" (p. 132). The students in this investigation had been learning various sign systems for a mean of 2.9 years (range = <1-16 years); however, on average, they were able to imitate only 9.24 signs, produce only 4.23 single signs spontaneously, and produce less than one multi-sign combination. Although conclusions drawn from this study must be considered in light of the maturational differences of the students and the lengthy time-span of their language learning, the researchers concluded that sign language "does not appear to be a powerful communicative alternative" (p. 130) for this population. They suggested several possible reasons for the poor outcomes in their study:

1) Insufficient rationales for using signs on the part of those developing the intervention, suggesting that students may not have had the necessary prerequisite motor, cognitive, and social-interactive abilities;
2) Questionable practices used to select the specific vocabulary items that were taught;
3) Vague goals, objectives, and teaching methodologies; and
4) Inadequate support of signs in the learning environment (p. 130)

It is clear from Bryen et al.'s (1988) study that a rationale for the use of manual signs with deaf individuals who have intellectual disabilities can only be established through systematic empirical investigation. Clearly, advantages exist for using manual sign systems over speech interventions with deaf students with intellectual disabilities; however, the learning demands of sign systems could present significant challenges for these individuals during initial acquisition. In the next section, evidence for and against the use of graphic representational systems with these individuals will be reviewed briefly.

Graphic Representational Systems (GRSs)

Since the 1950s, GRSs have been used to support the language and communication development of individuals with congenital disorders such as developmental delay, cerebral palsy, autism, and specific language disorders, as well as those who became disabled later in life as a result of (for example) multiple sclerosis, traumatic brain injury, stroke, and spinal cord injuries (Beukelman & Mirenda, 1998). GRSs are similar to manual signs in that they bypass the oral-motor speech mechanism and are less cognitively and conceptually demanding than speech (Sevcik et al., 1991). In addition, the static nature of GRSs permits increased inspection time before a message disappears. This "non-transient" nature of GRSs may be advantageous to individuals with intellectual disabilities, who may require additional time to process meaning from messages.

Many studies have documented the usefulness of GRSs in communication interventions with individuals who have intellectual disabilities (Beukelman & Mirenda, 1998; Reichle, York, & Sigafoos, 1991). In particular, there is some evidence that GRSs may facilitate speech production in individuals who are able to verbalize. For example, Snyder et al. (1993) investigated the effectiveness of GRSs in increasing the rate of vocabulary acquisition in five elementary school-aged children with mild and moderate intellectual disabilities. The pretest-posttest design resulted in "significant differences in rates of vocabulary acquisition with the introduction of the [GRS] systems" (p. 79). Similarly, Pecyna Rhyner (1988) examined the combined effects of GRSs and speech training with three groups of children with Down Syndrome. The intervention was most effective when "graphic symbols were incorporated into the speech and language training program, at least in terms of decreasing the number of prompts required for the subjects to use the training words/symbols expressively" (p. 44). From studies such as these, it appears that the incorporation of GRSs into communication programs may have a beneficial effect on both vocabulary development and speech development. In addition, Sevcik et al. (1991) suggested that "the use of an alternative modality may make the language learning task easier for persons with severe cognitive disabilities [who do not speak] since, among other factors, they do not employ the auditory/vocal channels" (p. 162). Research directed at the effects of GRSs with children with multiple disabilities, including deafness, is scarce at present. Thus, it is difficult to predict the effects of GRSs in supporting other communication modalities without further investigation.

Learning Requirements of ASL and GRSs

Cognitive Demands

American Sign Language. To date, the cognitive demands of various symbol systems have been investigated largely in terms of a construct known as "iconicity." Iconicity has been defined as the degree of relationship between a sign and its referent (Bellugi & Klima, 1976; Luftig & Lloyd, 1981). Within the continuum of iconicity, manual signs can be either transparent, translucent, or opaque. Transparent signs are signs for which the meaning is easily guessed by a naive viewer (Bellugi & Klima, 1976; DePaul & Yoder, 1986; Lieberth & Bellile Gamble, 1991; Luftig, 1983; Luftig & Lloyd, 1981). Translucent signs are those that do not have an obvious relationship with their referents but whose relationship can be understood by naive viewers once it is known. Opaque signs are generally not guessable, nor is there a clear and logical relationship between the sign and its referent (Luftig & Lloyd, 1981).

Several studies have provided support for the fact that translucency and transparency facilitate sign learning, recognition, and retention, at least for some individuals (e.g., Beykirch, Holcomb, & Harrington, 1990; DePaul & Yoder, 1986; Lieberth & Bellile Gamble, 1991; Luftig, 1983; Luftig & Lloyd, 1981). However, Orlansky and Bonvillian (1984b) cautioned against assigning too prominent a role to iconicity, given the results of their longitudinal study of early sign language acquisition in hearing children of deaf parents. They concluded that, "… although it [iconicity] may play a significant role in early sign language acquisition, does not appear to be the most important factor in children's ability to learn, use, or remember ASL signs" (p. 291). Other studies, such as one that involved school-aged students with severe disabilities (Kohl, 1981) have also found inconclusive evidence for an "iconicity advantage" related to manual sign acquisition. It has also been noted that, although ASL has a higher proportion of transparent or translucent vocabulary items than do spoken languages, the majority of ASL signs are not highly iconic (Luftig & Lloyd, 1981).

It is not clear whether the general research base on the iconicity of manual signs applies to deaf individuals with intellectual disabilities, for several reasons. All of the studies that have investigated the facilitative effects of manual sign translucency and transparency involved hearing subjects; and, in all but two (Luftig, 1983; Orlansky & Bonvillian, 1984b), subjects had no identified disabilities at all. Furthermore, a paired-associates instructional paradigm, which is not comparable to a natural learning paradigm, was used in the majority of these studies and limits the generalizability of the results. Thus, from the current evidence, it cannot be assumed that high iconicity has the same facilitative effects on manual sign learning for deaf individuals or those with intellectual disabilities as for hearing individuals with no cognitive impairments, although this conclusion seems logical.

<u>Graphic representational systems.</u> Similar to manual signs, GRSs are characterized by their degree of iconicity, ranging from transparent to opaque (Mirenda & Locke, 1989; Mizuko, 1987). Several studies have compared various GRSs in terms of ease of learning. The results of these studies suggest that the iconicity of symbols is directly related to the "learnability" of a

system, and that there is a predictable hierarchy of "learnability" among GRSs. For example, Mizuko (1987) compared the transparency and ease of learning of Picture Communication Symbols (PCS), Blissymbols, and Picsyms with 36 normally developing 3-year-olds, across nouns, verbs, and adjectives. The participants learned more PCSs than either Picsyms or Blissymbols during the training period. Mirenda and Locke (1989), with school-aged subjects ranging from mildly to severely intellectually handicapped, also concluded that PCSs and other line drawing symbols (e.g., Picsyms) were more transparent than Blissymbols, using both receptive language and match-to-sample tasks for assessment. Similar findings were reported by Mizuko and Reichle (1989) in a study that involved adults with intellectual disabilities in transparency and recall tasks. Bloomberg et al.(1990) asked fifty undergraduate students to rate the relative transparency of five symbol sets: Picsyms, Pictogram Ideogram Communication (PIC), PCSs, Rebuses, and Blissymbols, across nouns, verbs, and modifiers. Results indicated that PCSs and Rebus symbols were equivalent in translucency and were the most translucent of the five systems.

From these studies, it appears that PCSs are among the most transparent and easiest to learn GRSs. They have the highest proportion of transparent and translucent lexical items among the symbol sets most commonly used in North America (Mayer-Johnson, 1995). However, it is important to note that other symbol systems also contain a high proportion of translucent items; therefore, "there is no 'one' best symbol system or set for representing an initial lexicon" (Bloomberg et al., 1990, p. 724). GRS selection should take into account both the characteristics of the symbol set and the characteristics (e.g., learning style) of individual users.

ASL compared to GRSs. Four studies to date have addressed the comparative learnability of manual signs and various types of GRSs. Goossens' (1983) investigated the relative iconicity and learnability of ASL signs, Blissymbols, and Rebus symbols. Both Bristow and Fristoe (1984) and Luftig and Bersani (1988) compared the learnability of Blissymbols with manual signs; Hodges and Schwethelm (1984) compared the learnability of manual signs and Non-SLIP symbols (small plastic symbols that are opaque in iconicity).

Goossens' (1983) discovered a significant correlation between iconicity and learning for both Rebus symbols and ASL signs, and provided evidence that both manual signs and Rebuses were easier to learn than Blissymbols. In contrast, Luftig and Bersani (1988) discovered that Blissymbols were learned "significantly faster than manual signs" (p. 55). Hodges and Schwethelm (1984) concluded that sign language was easier to learn than "noniconic graphic systems" (p. 246) such as Non-SLIP symbols; Bristow and Fristoe (1984) found no significant difference in the acquisition of manual signs and Blissymbols.

The disparate findings across these studies may relate to the differences in intellectual functioning level of the study participants. Goossens' (1983) 54 subjects were all moderately intellectually disabled, and 30 had known memory constraints. Hodges and Schwethelm (1984) employed 52 profoundly retarded, nonverbal children. In contrast, Luftig and Bersani (1986) used undergraduate students with no intellectual or memory constraints, while Bristow and Fristoe (1984) utilized elementary-aged children functioning at grade level. As Kangas and Lloyd (1988) cautioned, "while information from normally developing children can lead us into many productive areas for intervention and research, we need to constantly ask whether or not the same conditions and relationships will apply to other populations" (p. 214).

In addition to the above, there was wide variability with regard to the manual sign systems and vocabulary items used in the studies. Luftig and Bersani (1986) did not specify the manual sign system they used, and Hodges and Schwethelm (1984) failed to specify the specific ASL vocabulary items that were taught. Bristow and Fristoe (1984) used vocabulary from the Signed English Dictionary (Bornstein, Hamilton, Saulnier, & Roy, 1975) rather than ASL vocabulary.

Thus, it is impossible to tell from the current research literature whether GRSs are more or less cognitively demanding than manual signs. Further research is needed with populations who regularly use manual signs and/or GRSs for functional communication, in order to generate data that are generalizable across participants. Research on the relative iconicity of ASL and GRSs with individuals with multiple disabilities is particularly limited, and additional studies examining this issue are warranted (Mirenda & Locke, 1989).

Memory Demands

American Sign Language. Light and Lindsay (1991) noted that within short-term or working memory are two types of operations. The first, "recognition memory," requires only that the individual confirm that what is seen "matches" a model presented simultaneously. For example, a picture of a cat, presented in the presence of a cat, will be recognized as *cat*. This type of memory is required to identify GRSs, since they do not "disappear" between productions as do manual signs. The second type of operation, "recall memory", involves a two-stage process, since it involves a model that is not presented simultaneously. First, the individual must perform a search within a constructed classification model. Second, the individual must execute a recognition operation to confirm a correct retrieval. Due to the transient (i.e., non-static) nature of ASL, signers are required to retrieve symbols from recall memory (Sevcik et al., 1991). For example, the connection between an ASL sign for "cat" and the appropriate referent must first be recalled, and must then be recognized as *cat*. Recall memory can deteriorate during either of the two stages, and is thus considered to be more demanding than recognition memory (Light & Lindsay, 1991).

Short-term memory capacity is believed to be closely related to intellectual disability. Evidence suggests that the more profound the intellectual disability, the more limited the short-term memory capacity (Drew, Logan, & Hardman, 1992; Evans & Bilsky, 1979). This suggests that individuals with intellectual disabilities may have difficulty learning ASL signs due to the demands they place on recall memory. This could, at least in part, account for the poor longitudinal outcomes for sign language interventions with this population, as reported by researchers such as Bryen et al. (1988). In addition, children with intellectual disabilities have been shown to remain at the one-word language level for longer periods than children with normal language development (Miller, 1987). It would seem logical to hypothesize that memory constraints might play a role in this outcome. Thus, the memory demands of ASL may present a significant challenge to both new vocabulary acquisition and the production of multi-symbol utterances by deaf individuals with intellectual disabilities.

Graphic representational systems. The memory demands of GRSs appear to be less complex than those of ASL. GRSs require recognition memory, which is less demanding as it involves only a one-step process, as described previously (Light & Lindsay, 1991). The static nature of a GRS provides an individual with time to focus on the symbol, thereby facilitating a connection between the symbol and its referent. An individual is not required to mentally search for, or "reconstruct the originally encoded information" (Light & Lindsay, 1991, p. 194), prior to making the connection, as in the processing of manual signs.

ASL compared to GRSs. Since GRSs place demands on simple recognition memory, whereas manual signs place demands on more complex recall memory, the memory constraints of individual users may be directly related to system learnability (Bristow & Fristoe, 1984; Sevcik et al., 1991). In addition, Luftig and Bersani (1988) suggested that a "difference in available inspection time" (p. 56) might result in manual signs (which are transient) placing higher demands on recall memory in comparison to GRSs (which are static). Since intellectual disability is related to memory constraints (Drew et al., 1992), one might predict that the level of cognitive functioning could be a factor in symbol learning (Evans & Bilsky, 1979).

Goossens (1983) specifically addressed memory as a variable in ASL and GRS learning. She found that her 30 participants with moderate intellectual disabilities who showed evidence of memory constraints had more difficulty learning ASL signs than either Rebus symbols or Blissymbols. However, the 25 participants without memory constraints learned both ASL signs and Rebus symbols with comparable ease, although Blissymbols (a very abstract symbol set) were still more difficult. From this study, it appears that at least some GRSs have a memory advantage over ASL signs in that they make fewer demands on short-term memory, which is often limited in persons with intellectual disabilities.

Perceptual and Processing Demands

American Sign Language. Fundamentally, ASL requires that a user be able to see and attend to a sign, given its visual-spatial nature. Furthermore, the individual must be able to perceive the phonological parameters of signs (i.e., the handshape, movement, location, and orientation), interpret both simultaneous and multi-dimensional expressions, process spatial reference indexes, and discriminate facial expressions (Doherty, 1985; Emmorey, 1991; Seidlecki & Bonvillian, 1993). In addition, the demands of ASL on recall memory are closely related to visual-spatial processing abilities. According to Emmorey, Kosslyn, and Bellugi (1993), three mental imagery abilities are thought to be requisites for processing ASL. These include:

1. Image generation: the process whereby an image (i.e., a short-term visual memory representation) is created on the basis of information stored in long-term memory;
2. Image maintenance: the process for maintaining a visual-spatial representation of loci during discourse production and comprehension; and
3. Image transformation: the process for shifting, rotating, and/or reversing spatial loci to convey perspective shift or change in location (p. 179).

There is some evidence that certain linguistic skills, memory skills, and mental transformations may be required before ASL signs can be processed accurately (Emmorey, 1991; Siedlecki & Bonvillian, 1993). Manual signs are not visually static; rather, they are dynamic and temporally based (Emmorey, 1991; Sevcik et al., 1991). Thus, ASL places complex and simultaneous demands on spatial perception, spatial transformation, spatial memory, and grammatical processing (Emmorey, 1991). Nonetheless, manual signs might be easier to process and learn than speech; for example, some studies have shown that nondisabled signers have produced their first signs earlier than speaking children produced their first words (Meier & Newport, 1990; Orlansky & Bonvillian, 1984a). Others have noted that "any sign advantage that may exist appears to be limited to early stages of acquisition and does not seem to persist throughout subsequent milestones" (Meier & Newport, 1990, p. 11).

There is no doubt that ASL is a demanding visual-spatial language. Individuals with intellectual disabilities may experience difficulty with any number of the perceptual demands that are required to attend to and process each manual sign formation. For deaf individuals with intellectual disabilities, the visual aspect of ASL is likely to be advantageous over spoken language; however, its dynamic nature may present considerable challenges.

<u>Graphic representational systems.</u> GRSs are visual communication systems that require an individual be able to see clearly enough to recognize and interpret each symbol. According to Beukelman & Mirenda (1998), three main elements are involved in accurate vision:

1. *Sight*, the reception of sensory stimulation through the eye. This, in turn, is affected by visual acuity (the clarity of vision that allows an individual to discriminate details), the size of the visual field (the area within which objects are visible to the eye without a shift in gaze), oculomotor functioning (coordination of the eye muscles), and light and color sensitivity;

2. *Transmission* of the image along the optic nerve; and

3. *Interpretation* of the image in the visual cortex of the brain (p. 213).

An individual with an uncorrected vision problem in any of these three areas may have difficulty perceiving both manual signs and GRSs. Additionally, use of a GRS requires the ability to visually discriminate between the background and the foreground of a symbol (i.e., figure-ground discrimination), as well as to discriminate between symbols. Visual scanning and tracking are also needed when numerous GRSs are laid out on communication displays. When this is the case, an individual must have adequate oculomotor ability (i.e., control of muscle movement of the eye) in order to scan, track, localize, focus, and fixate on a particular symbol (Beukelman & Mirenda, 1998; DeCoste, 1987).

ASL compared to GRSs. No research to date has compared ASL and GRSs in terms of their relative perceptual and processing requirements. This is probably because decisions to use one or the other type of symbol system are usually made either arbitrarily (Bryen & Goldman, 1988) or after primary consideration of cognitive and memory requirements. Based on the above review, it appears that the perceptual demands made by ASL are greater than those made by GRSs, primarily because the former system is dynamic and transient, while the latter is static and spatial. In addition, GRSs can be designed to accommodate problems with sight in ways that manual signs cannot. For example, GRSs can be made larger to compensate for reduced visual acuity, or can be spaced in ways that compensate for visual field deficits. However, comparative studies investigating the advantages and disadvantages of each from a processing perspective are needed before conclusive comparative statements can be made.

Motor Demands

American Sign Language. ASL signs require numerous fine motor skills for production. The production features of signs that may have an impact on learning have been identified in several studies and have been used as criteria for selection of initial sign lexicons (Dennis, Reichle, Williams, & Vogelsberg, 1982; Doherty, 1985; Kohl, 1981). Directly relevant to this investigation are the characteristics of handedness, symmetry, physical contact, handshape, and movement. These will be discussed briefly in the sections that follow.

Handedness and symmetry. Handedness refers to the number of hands used in the formation of the sign. A sign can be formed with either one or two hands. Symmetry refers to the movement of the hands to form the sign. Signs can be either symmetrical (i.e., both hands move identically) or asymmetrical (i.e., each hand makes a different movement). Karlan (1990) suggested that handedness and symmetry should be considered together, since sign formation requires degrees of both. Doherty (1985) suggested a possible hierarchy of sign learnability related to handedness and symmetry, as follows: (a) one-handed signs are easier to learn than two-handed signs, and (b) two-handed symmetrical signs are easier to learn than two-handed asymmetrical signs. This hierarchy was based on research with individuals with moderate to severe intellectual disabilities, and primarily applies to vocabulary that is high in translucency (Doherty & Lloyd, 1983; Kohl, 1981). Further evidence for the hierarchy beyond these parameters has been informal and inconsistent (Doherty, 1985). Other factors, such as handshape, iconicity, and the effects of movement, should also be considered when assigning difficulty levels to manual signs on the basis of their motor requirements.

Physical contact. The physical contact dimension has alternatively been referred to as production mode (Doherty, 1985), taction (Kohl, 1981), and proximity (Karlan, 1990). It refers to the extent to which the hands contact the body in the formation of the sign, and how they do so. Signs can involve no contact, contact between hands, or contact between a hand and the body (Doherty, 1985; Karlan, 1990). Contact can be further distinguished as either dyadic (i.e., involving two hands) or spatial (i.e., involving one hand and the body); and as involving holding, continuous contact, or grazing (i.e., contact in the middle of a sign formation) (Doherty, 1985). Limited evidence from studies involving both children with intellectual disabilities and college students has generally supported the notion that contact signs are learned more easily than noncontact signs (Doherty & Lloyd, 1983; Kohl, 1981).

Handshape. Acquisition of the various handshapes required by ASL signs is believed to be related to both fine motor development and age. Longitudinal research to substantiate models of motoric difficulty, specifically handshape acquisition, is lacking. Whether or not the degree of complexity of these characteristics in isolation is useful in predicting sign acquisition has yet to be empirically validated. Several models have been proposed in this regard. Boyes-Braem (1973) proposed stages of handshape acquisition after analysis of a one hour sample of signs produced by a deaf child (age 2:7). Dennis et al. (1982) presented handshape development based on the refinement of fine motor skills, but their model does not substantiate Boyes-Braem's stage model of acquisition. Several investigations have supported the stage model of acquisition, at least for Stage 1 handshapes (e.g., A, S, L, baby o, 5, and G); however, longitudinal research is essential to substantiate the model in full (Doherty, 1985).

By comparing the Boyes-Braem (1973) stage model with the motor development model by Dennis et al. (1982), a two-tiered hierarchy of handshape complexity can be hypothesized. Simple handshapes, which are typically acquired first, include those formed with an open palm, extended fingers, palmar grasp, squeezing action, wrist movement, thumb adduction and abduction, and isolated control and isolation of the radial finger. Complex handshapes, which are usually acquired later, include those requiring individual finger isolation, crossed fingers, and thumb contact with individual fingers.

Movement. Movement has received very little attention in the literature, and it is at present uncertain whether movement patterns in normal development can be predictors of sign movement difficulty (Doherty, 1985). Simple signs may be formed with unilateral movements (i.e., those that do not cross the midline of the body), and bilateral mirror movements (i.e., identical handshapes/movements that do not cross the midline) (Dennis et al., 1982). Complex signs may be formed with bilateral movements (i.e., different handshapes/ movements), movements which cross the midline of the body, bilateral movements with one hand stable or both moving with different handshapes, and bilateral movements which cross the midline of the body (Dennis et al., 1982).

To summarize, it is clear that ASL sign formation requires many fine motor skills, even if sign approximations are considered acceptable. Deaf children with intellectual disabilities may face challenges in producing ASL signs, since intellectual disability is believed to be closely related to motor development (Drew et al., 1992). Evidence suggests a correlation between the severity of intellectual disability and "degree of physical anomaly" (p. 248). Thus, the advantages of ASL for deaf individuals with intellectual disabilities may be counterbalanced by the high motor demands inherent in this type of symbol.

<u>Graphic representational systems.</u> Whereas ASL signs must be executed with the fingers and hands, GRSs are selected by some mode of pointing. Therefore, they require less physical motor competence than manual sign systems. Isolation of any finger for the purpose of pointing, or production of a pincer grasp in order to pick up a symbol, are the minimum requisite motor skills for use of GRSs. However, even individuals with physical motor impairments are often able to use GRSs by means of various adaptive devices such as headpointers, headsticks, and other options (Beukelman & Mirenda, 1998). Thus, while individuals with motor impairments may have difficulty forming accurate manual signs, no such limitations need exist for GRSs.

<u>ASL compared to GRSs</u>. Comparative studies examining ASL and GRSs from a motor perspective are absent in the literature, no doubt because the issues are quite obvious and clear-

cut for most individuals. In fact, one of the primary reasons GRSs are often selected is because an individual lacks the necessary fine motor skills for manual signing (Beukelman & Mirenda, 1998). Of course, for deaf individuals with intellectual disabilities, whose primary language system is the language of the Deaf community, it is not a matter of one versus the other as much as a matter of combining the two, in some circumstances. In the next section, the literature on such combined systems will be reviewed briefly.

Multiple Communication Systems

There are several potential advantages in combining multiple symbol systems for communication and language intervention. First, the communicative audience is extended when aided systems (i.e., GRSs) are combined with unaided systems (i.e., manual signs), similar to the use of two languages by bilingual individuals who can speak (e.g., Iacono & Duncum, 1995; Iacono, Mirenda, & Beukelman, 1993). Thus, individuals using GRSs combined with manual signs would have the advantage of being able to communicate with persons who understand sign as well as those who may not. In addition, most signs and many symbols are not iconic. By using two systems, a user has the flexibility of being able to use the most individually appropriate and understandable modality for each message. Multimodal communication is also more likely to accommodate individual learning styles (Iacono, 1992). Finally, use of a simultaneous, multimodal approach during initial symbol learning may help to determine which type of symbol is likely to be more useful in the long term for individual learners (Reichle et al., 1991).

There may also be a number of disadvantages to a multimodal approach. Multiple communication systems, if they are similar in nature (i.e., if they both tap into the same cognitive processing areas simultaneously), could cause interference in processing (Luftig & Bersani, 1986). If the systems are quite dissimilar in nature (e.g., an auditory combined with a visual system), processing may be confounded by the differential memory demands. Finally, the time and energy required to maintain a multimodal system could also be of concern.

The effectiveness of "unimodal" versus "multimodal" interventions are somewhat speculative at the present time, given the scarcity of empirical research in this area (Iacono et al., 1993). However, limited support exists for a multimodal advantage in language intervention. For example, Iacono and Waring (1996) exposed a young child (age 2:10) to models in a manual sign+speech condition and a manual sign+speech+GRS condition. The manual signs used were Australasian and the graphic symbols were PCSs, organized on a Macaw communication aid (a voice output communication device). An advantage of the manual sign+speech+GRS condition was observed during some but not all instructional sessions. The authors postulated several explanations for the weak results, including the possibility that the participant preferred sign+speech as a function of her individual learning style.

The proposition of individual learning styles affecting success with unimodal versus multimodal communication systems was even clearer in a study by Iacono et al. (1993). Two children participated in this study, which also compared the effectiveness of a manual sign+speech condition and a manual sign+speech+GRS condition (the GRSs were placed on a voice-output communication device). The first child (age 3:6) was diagnosed as mildly intellectually disabled with an etiology of failure to thrive. The second child (age 4:6) was diagnosed as moderately intellectually disabled with an etiology of Down Syndrome. Both children had a history of extensive manual sign instruction in a preschool setting, but had not progressed past the one-word utterance stage. The intervention, which focused on teaching the children two-word sign combinations, provided different results for the two participants. For the student with higher intellectual functioning, no significant difference between conditions was noted; however, for the student with lower intellectual ability, the manual sign+speech+GRS condition was more effective than the alternative. The authors suggested that the differential effectiveness of the multimodal intervention might have been be related to learning style differences between the two children.

Iacono and Duncum (1995) suggested an advantage of using a multimodal communication intervention, at least for some individuals. The participant (age 2:8) had Down Syndrome, with occasional mild conductive hearing loss. Australasian signs were combined with DynaSyms (a type of GRS) on a voice output communication device during an alternating treatments design. For this participant, a multimodal approach was more effective than a unimodal approach. That is, she produced more spontaneous responses and more multi-word combinations in the manual sign+speech+GRS condition than she did in the sign+speech alone condition.

An earlier study by Luftig and Bersani (1986) provided further evidence for the potential benefits of multimodal instruction. Blissymbols and ASL signs were used in an investigation of the interference effects of learning with dual systems. The results supported the hypothesis that learning the two systems would not lead to interference. These results directly addressed one of the potential disadvantages of learning through multimodal instruction mentioned previously, and the authors concluded that the two systems appeared to be "sufficiently dissimilar and therefore may not cause learning and memory confusion in learners" (p. 518).

The limited evidence suggests a possible advantage of using multiple modes of communication, at least for some individuals. Further research is required in this area to support a position that multimodal communication can be useful, and to establish the long-term effects of using multiple communication systems with individuals with intellectual disabilities and communication disorders.

Summary and Conclusions

A comparison of the characteristics of ASL and GRSs revealed different cognitive processing, memory, and motoric demands that may affect acquisition, processing, and comprehension. Evidence suggests that the degree of iconicity of both signs and symbols is directly related to the cognitive processing and memory demands placed on the user (Beykirch et al., 1990; DePaul & Yoder, 1986; Lieberth & Bellile Gamble, Luftig, 1983; Luftig & Lloyd, 1981; 1991; Sevcik et al., 1991). Studies have demonstrated that the translucency of a sign or symbol may be used as a predictor of its learnability, at least for some individuals; therefore, the more closely a symbol or sign visually represents a referent, the easier it may be to learn (Luftig, 1983; Luftig & Bersani, 1985; Sevcik et al., 1991). Manual sign languages, by virtue of the fact that they are temporally based and dynamic, may present increased learning difficulty in that demands are placed on recall memory. Graphic representational systems, which are static in nature, may facilitate increased comprehension due to the "increased inspection time" available for the individual.

Few studies have investigated the comparable learnability of GRSs and manual sign language systems. Furthermore, limited information is available on the effects of combining GRSs with manual signs for intervention, particularly with individuals who may require such systems for functional communication. This is an area clearly in need of research, since both GRSs and manual signs are regularly used with individuals who have various intellectual, physical, and language disabilities (Beukelman & Mirenda, 1998).

The purpose of the present study was to investigate the efficacy of ASL-only versus ASL+PCS instruction to teach new ASL vocabulary to deaf students with intellectual disabilities. No research to date has examined the impact of PCS use on the acquisition of ASL signs. Given the high percentage of deaf children identified with additional disabilities that make ASL learning difficult, the current study was intended to stimulate further investigation into communication intervention strategies with this complex population.

CHAPTER 3

Method

Participants

Two children, Maria and Alex (pseudonyms), were selected from the B.C. Provincial School for the Deaf (South Slope) for participation in the study. Letters of explanation for the study were sent to the parents of each child, and signed consent forms were obtained. At the time of the investigation, Maria was 8 years old and Alex was 12. Both were receiving educational instruction in both ASL and Pidgin Signed English. In addition to deafness, Maria had been diagnosed by a provincial child development team at age 6 with pervasive developmental disorder (PDD), and Alex had been identified by a psychologist as having "substantial" learning delays in the moderate-severe range. In addition, both participants were nominated by at least one teacher as having unusual difficulty acquiring new ASL vocabulary. Educational reports confirmed the following for both Maria and Alex: (a) severe or profound bilateral, prelingual sensorineural hearing loss (e.g., 71 decibel or greater loss), (b) vision within normal limits (with or without glasses), (c) no functional speech, and (d) receptive and expressive vocabularies of at least 200 ASL signs, as reported by their teachers.

Initial Assessments

The MacArthur Communicative Development Inventory (MCDI): Words and Gestures (Fenson et al., 1993) was completed by each participant's parent and special education resource teacher to reflect the size and composition of their expressive and receptive ASL vocabularies, both at home and at school. This vocabulary inventory, normed on hearing children and adapted in this study for sign language, was employed to estimate the size of the participants' sign lexicons. Results for Maria indicated a receptive vocabulary size of 350-450 signs and an expressive vocabulary of 350-420 signs. Results for Alex indicated a receptive vocabulary of

200-320 signs and an expressive vocabulary of 120-240 signs. In addition, the Carolina Picture Vocabulary Test (CPVT) for Deaf and Hearing Impaired Children (Layton & Holmes, 1985) was administered to both participants. This test, which was standardized for the deaf population, was designed to assess the receptive sign vocabularies of deaf and hard of hearing individuals and is suitable for individuals with severe to profound prelingual hearing loss. Results from this assessment indicated that both participants had receptive sign vocabularies equivalent to deaf children <4 years of age (i.e., the lowest score possible on the test).

Although caution should be used in comparing the language acquisition of hearing and deaf children, it is generally accepted that the acquisition and development of ASL (i.e., by deaf children of deaf parents) parallels that of hearing children acquiring spoken languages (Meier & Newport, 1990; Siedlecki & Bonvillian, 1993; Tabor, 1988). For hearing children, a vocabulary size of over 400 words is considered average at 2.5 years of age (Moskowitz, 1978). Thus, given the chronological ages of the two participants, the results from both the MCDI and the CPVT suggest that both Maria's and Alex's receptive and expressive lexicons were considerably smaller than those of typical children. This provides support for the contention that they both experienced significant language delays.

Finally, the participants were assessed using the Brigance Diagnostic Inventory of Early Development-Revised (Brigance, 1991) to determine developmental age estimates. All sections of the Brigance were administered except for Preambulatory Motor Skills and Gross Motor Skills and Behaviors, which were not considered to be relevant to the present study. During assessment, instructions were delivered and responses were expected via ASL signs. Table 2 provides a summary of the areas assessed and the developmental age equivalents for each participant. This assessment provides a profile of the abilities of each participant and indicates their overall patterns of development.

Table 2

Summary Participant Developmental Age Equivalents on the Brigance Diagnostic Inventory of Early Development-Revised (Brigance, 1991).

Developmental Area	Skills Assessed	Maria Age Equivalent (year;month)	Alex Age Equivalent (year;month)
Fine Motor Skills and Behaviours	general eye/finger/hand skills	<6;0	2;0-6;0 (scattered)
	block tower building	>5;0	1;6
	pre handwriting	>6;0	4;0
	cutting with scissors	>7;0	
Self help Skills	feeding/eating	6;0	3;0-5;0
	dressing/undressing	>5;0	4;0
	fastening/unfastening	3;0-6;0	3;0 (scattered)
	grooming	6;0-7;0	3;0-4;0
Speech and Language (modified for sign language)	prespeech - receptive	>6;0	0;6-1;0
	general development	1;6-2;6 (scattered)	1;6-2;6(scattered)
	mean length of utterance	<2;6	<2;0
	personal data response	2;6	2;6
	verbal direction	2;0-3;0	no response
	picture vocabulary	>5;0	2;9 (scattered)
General Knowledge and Comprehension	emerging literacy	3;0	2;6
	body parts receptive/expressive	2;6-4;0	1;6-2;0
	colors - matching	>4;0	2;0
	colors - names	4;0-5;0	<2;0
	shapes	5;0-6;6	<3;6-5;6
	quantitative concepts	2;0	<2;0
	directional concepts	2;0	2;0
	classifying	3;0-4;4	3;0
	problem solving	3;0	<3;0
General Social/ Emotional Development	general	4;0-5;5	3;6 (scattered)
	play skills	scattered up to 5;6	1;0 (scattered)
	work related skills	scattered up to 6;0	1;0 (scattered)
Readiness	same/different discrimination	>6;3	<5;3
	recites alphabet	5;3	<5;3
	matches letters	>5;6	not attending
	points to and names letters	5;3-5;9	<5;3
	word recognition	none	<5;3
	writing	5;3 (prints first name)	5;3 (prints first name)
Basic Math	number concepts	>6;3	not applicable
	rote counting	5;3-6;0	not applicable
	reads numerals	5;3	not applicable

As demonstrated by the disparity found between their chronological ages and their approximate developmental age equivalents (Table 2), both of the participants employed in this study demonstrated global delays in their language, learning, and general functioning abilities. Maria's chronological age at the time of the study was 8.0 years, while her approximate developmental age equivalent across all areas on the Brigance Inventory of Early Development was 4 years 7 months. Similarly, Alex had a chronological age of 12.0 years and an average developmental age equivalent of approximately 3.0 years across all areas on the Brigance. Thus, although the specific label "intellectual disability" was not assigned to either Maria or Alex as a component of their formal diagnoses, it is clear from these scores that both experienced "substantial learning delays in the moderate-severe range" which were attributable to intellectual disability.

Research Design

An adapted alternating treatments design (AATD) as described by Sindelar, Rosenberg, and Wilson (1985) was used to compare the acquisition of target ASL vocabulary words using two instructional methods: ASL+PCS and ASL-only. This design addresses the comparative effectiveness of teaching conditions or methods, where "differences are demonstrated when acquisition of one [set] is more rapid than acquisition of the other, and the effect is consistent across subjects, or behavior" (p. 70). Each of the two instructional conditions was associated with unique, independent, and equivalent target ASL vocabulary sets. The independent variables were the two intervention conditions: ASL+PCS and ASL-only. The dependent variable was the number of correct, unprompted productions of the target ASL signs, which were solicited using scripted probe questions during structured probe trials (i.e., expressive vocabulary). Sign productions were considered correct when they were produced accurately or approximated such that they could be readily understood by the assessor. Following a demonstration of the effectiveness of one condition over the other, the more effective intervention condition was implemented for all of the target words in a second experimental phase (i.e., Phase 2).

Symbol Sets and Vocabulary

American Sign Language. The target signs for the selected vocabulary were taken from the American Sign Language Dictionary (Sternberg, 1987). ASL signs were chosen for this study because of their use widespread use within the Deaf community (Humphrey & Alcorn, 1995).

Picture Communication Symbols. Picture Communication Symbols (PCS; Mayer-Johnson, 1995) were selected as the graphic representational system (GRS) for the study. PCSs were chosen because they have been found to be one of the most easily learned GRSs (Mirenda & Locke, 1989; Mizuko 1987), and because both participants had had some exposure to PCSs in their educational programs during the academic year in which the study was conducted. Specifically, Maria had been exposed to PCSs through her educational program (e.g., visual schedules, reading activities, sequencing tasks) for two years prior to the study, and Alex had been exposed to for nine months. However, neither participant had been exposed to any of the specific PCSs used in this study. See Appendix A for PCSs used with Maria and Appendix B for PCSs used with Alex during the research.

Vocabulary sets. Two equivalent and independent groups of ASL vocabulary words that were not within the participants' current signing repertoires (as reported on the MCDI and the CPVT) were selected for each participant after consultation with their resource teacher. The equivalence of the signs in each set was established by (a) comparing their motor scores on a feature rating scale for manual sign difficulty adapted from Musselwhite and St. Louis (1988), (b) comparing their iconicity scores according to a procedure adapted from Luftig, Page, and Lloyd (1983), and (c) selecting words that were semantically equivalent (i.e., were in the same semantic categories). Because Maria's pre-intervention vocabulary included most common nouns, the two sets consisted of verbs and descriptors (i.e., adjectives, prepositions) in order to meet the final criterion. Maria's vocabulary sets consisted of a total of 9 words (2 verbs and 7 descriptors) in each intervention condition. Alex's sets consisted of 7 words (1 verb and 6 descriptors) in each intervention condition, to accommodate his shorter attention span.

The Musselwhite and St. Louis (1988) scale assigns scores of 0-2 for individual signs according to handedness, physical contact, symmetry, handshape, and movement, where 2=feature is present, 1=feature is partially present, and 0=feature is not present. Iconicity was determined in a manner adapted from that used by Luftig et al. (1983). Five adults with no ASL experience were asked to guess the meanings of all target signs, presented one at a time. All signs were first demonstrated but no labels or explanations were provided. Those guessed correctly after the initial exposure were considered to be transparent and assigned a score of 2. Signs guessed incorrectly after the initial exposure were demonstrated again, along with explanations of the relationship between the sign and the referent (e.g., "This is the sign for 'beside.' One hand moves outward to show placement *beside* another item."). Those guessed correctly after the second exposure with explanation were considered to be translucent and were assigned a score of 1. Signs guessed incorrectly after the second exposure with explanation were considered to be opaque and were assigned scores of 0. Table 3 summarizes the motor feature and iconicity scores for all target words.

Signs were randomly assigned to two vocabulary sets for each participant such that each set contained vocabulary items rated for iconicity as 0, 1, and 2, and the overall iconicity scores were equivalent within 1 point. In addition, the total motor feature scores for signs in both sets of each participant were equivalent within 3 points, to ensure that their motoric overall difficulty was similar. Tables 4 and 5 illustrate the overall scores and totals for the ASL target vocabulary and the assignment of vocabulary to the two intervention conditions for each participant.

Table 3

Summary of Motor and Iconicity Scores for Target ASL Vocabulary Words

ASL Sign	1-hand?	physical contact?	symmetry?	simple handshape?	simple movement?	iconicity?	Total
above	0	0	1	2	1	2	6
all	0	2	1	2	1	0	6
before	0	0	0	2	0	0	2
behind	0	2	0	2	0	1	5
beside	0	1	1	2	0	1	5
between	0	2	0	2	0	1	5
build	0	2	2	2	1	1	8
climb	0	0	2	2	2	2	8
dark	0	0	2	2	2	0	6
different	0	2	2	2	2	0	8
empty	0	2	0	1	0	0	3
few	2	0	0	1	2	1	6
float	0	0	2	2	2	2	8
full	0	2	0	2	0	1	5
hard	0	2	2	1	0	0	5
hide	0	2	0	0	0	1	3
in front	2	0	0	2	2	1	7
lead	0	2	0	2	0	1	5
light	0	0	2	1	1	0	4
many	0	0	2	2	2	0	6
on	0	2	0	2	1	1	6
ride	0	2	0	2	0	1	5
rough	0	2	0	2	1	1	6
smooth	0	0	2	2	2	1	7
soft	0	0	2	2	2	1	7
thirsty	2	0	0	2	2	2	8
under	0	0	0	0	0	2	2
weak	0	2	0	2	0	1	5
wet	0	1	2	2	2	0	7

Note. 0 = sign does not have this feature (e.g., no physical contact, opaque)
1 = sign partially has this feature (e.g., medium difficulty movement, translucent)
2 = sign has this feature (e.g., two-handed, transparent)

Table 4
Maria: Target ASL Vocabulary Scores

Group A: ASL-Only					Group B: ASL+PCS				
Target Word	Semantic Category	Iconicity Score	Motor Feature Score	Total	Target Word	Semantic Category	Iconicity Score	Motor Feature Score	Total
float	verb	2	6	8	build	verb	1	7	8
different	adjective	0	8	8	smooth	adjective	1	6	7
many	adjective	0	6	6	rough	adjective	1	5	6
lead	verb	1	4	5	ride	verb	1	4	5
behind	preposition	1	4	5	between	preposition	1	4	5
hard	adjective	0	5	5	thirsty	adjective	2	6	7
weak	adjective	1	4	5	all	adjective	0	6	6
above	preposition	2	4	6	light	adjective	0	4	4
few	adjective	1	5	6	empty	adjective	0	3	3
Totals		8	46	54	Totals		7	45	51

Table 5

Alex: Target ASL Vocabulary Scores

Group A: ASL-Only					Group B: ASL+PCS				
Target Word	Semantic Category	Iconicity Score	Motor Feature Score	Total	Target Word	Semantic Category	Iconicity Score	Motor Feature Score	Total
climb	verb	2	6	8	float	verb	2	6	8
smooth	adjective	1	6	7	soft	adjective	1	6	7
on	preposition	1	5	6	wet	adjective	0	7	7
many	adjective	0	6	6	above	preposition	2	4	6
rough	adjective	1	5	6	between	preposition	1	4	5
hard	adjective	0	5	5	empty	adjective	0	3	3
under	preposition	2	0	2	few	adjective	1	5	6
Totals		7	33	40	Totals		7	35	42

Setting, Materials, and Personnel

All experimental sessions were conducted in a resource classroom located at South Slope Elementary School. This was a quiet room with no visual stimuli that might have been distracting to the participants. A video camera was set up in the corner of the room prior to each session and all intervention and probe sessions were videotaped. One participant and an instructor were present for each session. They sat opposite each other at a small table, and a large plastic barn (Fisher Price) was placed on the table. Figurines (e.g., a farmer, plastic sheep and horses, a toy truck) related to the instructional scripts were situated out of view of the participant and retrieved as needed during the sessions. In addition, 2"x 2" PCSs without printed words that corresponded to the target ASL+PCS vocabulary items were used during instructional sessions related to this condition (see appendices A & B). The PCSs were attached at chest-level to a velcro cloth apron worn by the interventionist so that ASL signs, PCSs, and facial expressions were displayed within the same visual field.

Two female interventionists were involved in instruction and data collection. Both were Certified Teachers of the Deaf with additional specialization in the area of special education. Both were familiar with the target ASL vocabulary words and were trained to deliver the signed scripts accurately and consistently. Prior to the study, one interventionist had known Maria for almost three years and Alex for less than one year, through their educational programs. The other interventionist was somewhat familiar with Maria, but had not been involved with Alex prior to the study.

Two training sessions related to the delivery of the intervention and probe sessions occurred prior to the start of the study. Both interventionists were required to achieve scores of 90% accuracy or better during training on all probe and intervention trials. The same score sheets used to quantify procedural reliability during the study were used during training.

Procedure

Baseline. To ensure that the participants were unfamiliar with the target ASL vocabulary, baseline measurements were taken over three sessions. No exposure to PCSs for the target signs occurred during baseline. In order to test for expressive production of the target signs, the interventionist manipulated the activity materials in a standardized manner according to a written script and asked the participant a designated probe question to elicit the target ASL sign. For example, plastic figurines were used to model a girl climbing a ladder, and the participant was asked "girl do?" to elicit the signed target "climb." Each unprompted response was marked as either correct (+) or incorrect (-). All responses were followed with a "thumbs up" response and a preferred edible reinforcer, if necessary, to maintain the participants' attention.

Phase 1. The instructional procedures were adapted from those used by Iacono, Mirenda and Beukelman (1993). Based on the two equivalent sets of target vocabulary, theme-based scripts were created for each participant (one set for each intervention condition) to incorporate the target ASL signs in an interactive manner with concrete props. Scripts were written and presented in Pidgin Sign English using ASL signs. The mean length of utterance (MLU) within each script was kept to 3-4 signed utterances and was within the comprehension ability of the participants, according to the resource room teacher who knew them best. In addition, the facial and body expressions associated with each target sign were specified in the scripts, to insure consistency across interventionists. Appendix C contains an example of an intervention script for the ASL-only condition and Appendix D contains an example of an intervention script for the ASL+PCS condition. The target ASL vocabulary words are in italics with the signed exposures enumerated in parentheses.

The figurines (i.e., props) used varied from session to session in order to increase generalization across situations and characters. Examples of appropriate props were specified in the scripts for each target (e.g., "people and two fence pieces", or "animal and truck"). Props were presented after the completion of each sign.

During intervention trials, participants were prompted (hand-over-hand) to produce each target sign or action, as required by the script. If a participant produced a sign or manipulated a prop incorrectly a second hand-over-hand correction prompt was administered. During probe trials, the interventionist manipulated the activity materials in a standardized manner according to the script and asked the participant a designated probe question to elicit the target ASL sign, in a manner identical to baseline. Each unprompted response was marked as either correct (+) or incorrect (-). All responses were followed with a "thumbs up" response and a preferred edible reinforcer, if necessary, to maintain the participants' attention.

Both intervention conditions (ASL+PCS and ASL-only) were implemented during every Phase 1 session. The order of presentation of the intervention conditions was randomized and counter-balanced across sessions in order to control for order effects. In addition, an attempt was made to alternate interventionists on a daily basis. This was accomplished for Maria but, although each interventionist participated with Alex for half of his sessions, they did not alternate daily because of scheduling constraints. One intervention and one probe session were conducted per day until one of the following criteria was met: (a) a participant achieved scores of 90% or more correct for three consecutive days on one of the two vocabulary sets during probe trials; or (b) 12 school days of intervention had elapsed.

Phase 2. Once each participant reached one of the performance criteria in Phase 1 in one condition, that condition was implemented across the second vocabulary set for five sessions. The scripts from Phase 1 were used during this phase, following the procedures described previously. The purpose of this phase was to determine whether the more effective technique could be used to enhance learning of the second vocabulary set as well.

Data Collection

Data were collected during baseline each day prior to the intervention session, using probe questions related to each intervention script. An example of the probe script is shown in Appendix E. No exposure to PCSs and no prompting occurred during data probes. In order to test for expressive production of the target signs, the instructor manipulated the activity materials according to the scripts and asked the participant the designated probe questions. Responses were coded as correct (+) only if they were produced accurately with an approximation that was readily identifiable as the target sign by the interventionist. The interventionist recorded the data for each probe trial on a data collection form designed for the study. Correct responses were reinforced with a "thumbs up" and incorrect responses were given a neutral "OK."

Reliability

Procedural. All probe and intervention sessions were videotaped. All intervention videotapes and four randomly selected probe sessions were scored by the researcher against the scripts designed for the two sets of vocabulary words, to assess treatment fidelity. These scripts reflected both the completion of each step and the accuracy with which it was followed. A procedural reliability score was calculated using the formula: number of correct steps divided by the number of correct + incorrect steps multiplied by 100. Feedback related to procedural reliability was provided daily to the interventionists and errors were corrected through additional practice using verbal cues and modeling, as needed.

The procedural reliability means for the intervention scripts for Maria were 97.8% for the ASL+PCS condition (range = 88.3-100%) and 98.8% for the ASL-only condition (range = 96.9-100%). The procedural reliability mean during probe sessions for Maria was 100%. The procedural reliability means during intervention sessions for Alex were 97.0% for the ASL+PCS condition (range = 89.7-99.2%) and 98.7% for the ASL-only condition (range = 92-100%). The procedural reliability mean during probe sessions for Alex was 100%.

Intrarater. Each interventionist reviewed one randomly selected videotape of the probe sessions for each of baseline, Phase 1, and Phase 2 and independently re-scored all participant responses. Comparisons were made between the interventionists' original and second recordings. A reliability score was calculated using the formula: number of agreements divided by the number of agreements + disagreements multiplied by 100. For Maria, the mean intrarater reliability was 100%, and for Alex the mean intrarater reliability was 96.4% (range = 92.9-100%).

Interrater. The researcher viewed four additional randomly selected videotapes of the probe sessions across all phases, and re-scored all participant responses. Comparisons were made between the interventionist's and the researcher's scorings for each session. A reliability score was calculated using the formula: number of agreements divided by the number of agreements + disagreements multiplied by 100. The mean interrater reliability for Maria was 100%; for Alex, interrater reliability was 96.4% (range = 92.9-100%).

CHAPTER 4

Results

Session-by-Session Analysis

It was hypothesized that the ASL+PCS condition would result in a greater number of correct responses related to the target ASL vocabulary than would the ASL-only condition. The frequency of correct sign productions in each condition over all three experimental phases is illustrated in Figure 1 (Maria) and Figure 2 (Alex). Inspection of baseline data indicates that neither participant was initially familiar with the target ASL vocabulary. Further, visual inspection of the data reveals overall increases in unprompted productions of the target ASL vocabulary for both participants in both instructional conditions. Visual comparisons between Figures 1 and 2 depict a quantitative difference in the number of correct ASL sign productions across participants. Maria reached criterion (i.e., 90% or more correct over 3 consecutive sessions) in the ASL+PCS condition in 10 sessions of the intervention. However, Alex did not reach this criterion; thus, Phase 2 was implemented with Alex after 12 instructional sessions had elapsed.

Figure 1 illustrates that, for Maria, instruction related to the target ASL vocabulary in both instructional conditions resulted in a gradually increasing number of correct responses during probe sessions.

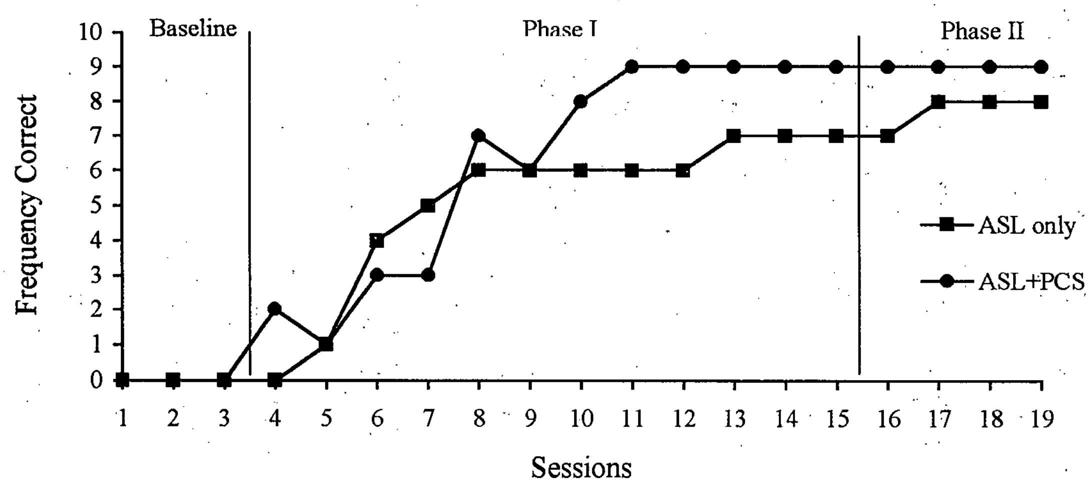


Figure 1. Maria's correct productions of target ASL vocabulary across baseline, Phase 1 and Phase 2 sessions, in two instructional conditions.

A slight difference in the acquisition curve across instructional conditions can be detected through visual inspection of Figure 1, with correct responding in the ASL+PCS condition increasing more rapidly beginning with session 9. After this session, Maria's data show a difference in accuracy across conditions, as demonstrated by the rising slope in the ASL+PCS condition. In this instructional condition, Maria achieved 90% accuracy in session 10, 100% in session 11, and maintained this accuracy level for the remaining probe trials.

Inspection of Phase 2 data reveals that: (a) Maria's production of the target vocabulary in the ASL+PCS condition remained stable at 100% and (b) the accuracy of the target signs that were previously in the ASL-only condition showed a slight increase, leveling off at the 90% level in session 17. One vocabulary item in the ASL-only condition (i.e., "few") was never produced accurately.

Figure 2 illustrates that, for Alex, instruction of the target ASL vocabulary resulted in a gradually increasing number of correct responses in both conditions during probe sessions.

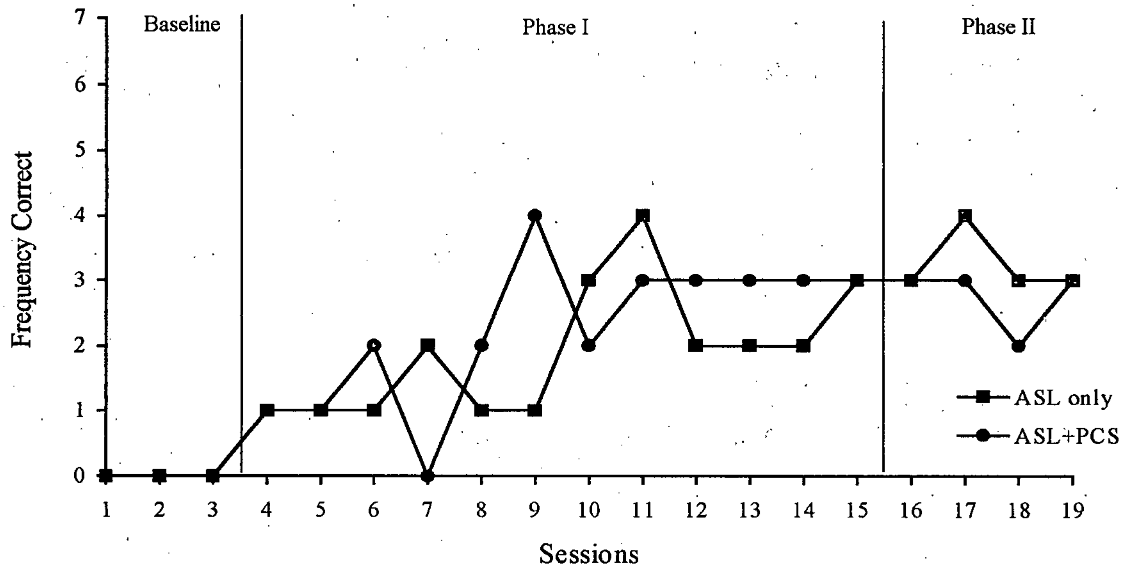


Figure 2. Alex's correct productions of target ASL vocabulary across baseline, Phase 1 and Phase 2 sessions, in two instructional conditions.

Phase 1 sessions reveal considerable variability in Alex's acquisition of ASL vocabulary in both conditions, with the highest number of correct sign productions at 4 out of a possible 7. Visual analysis reveals no consistent differences between the two instructional conditions although, from sessions 10-17, his accuracy within the ASL+PCS condition appeared to stabilize.

Phase 2 was implemented with the ASL+PCS condition applied to all signs, even though Alex did not show clear evidence that this condition was more effective. Phase 2 data reveal considerable variability, and he did not reach criterion for any new signs during this Phase.

It should be noted that Figures 1 and 2 imply that once a participant produced a target ASL sign correctly, he or she continued to produce it correctly across subsequent sessions. However, this was not necessarily the case, especially for Alex, who demonstrated considerable inconsistency in this regard. For example, he correctly produced the sign "wet" during session 3, but did not produce it correctly again until session 8. Thus, additional analyses were conducted with regard to the accuracy of individual signs.

Frequency of Correct Responses

The total number of correct productions of each target vocabulary word within each instructional condition was calculated for each participant. Figure 3 illustrates the percentage correct for Maria in the ASL-only and ASL+PCS conditions, across Phases 1 and 2.

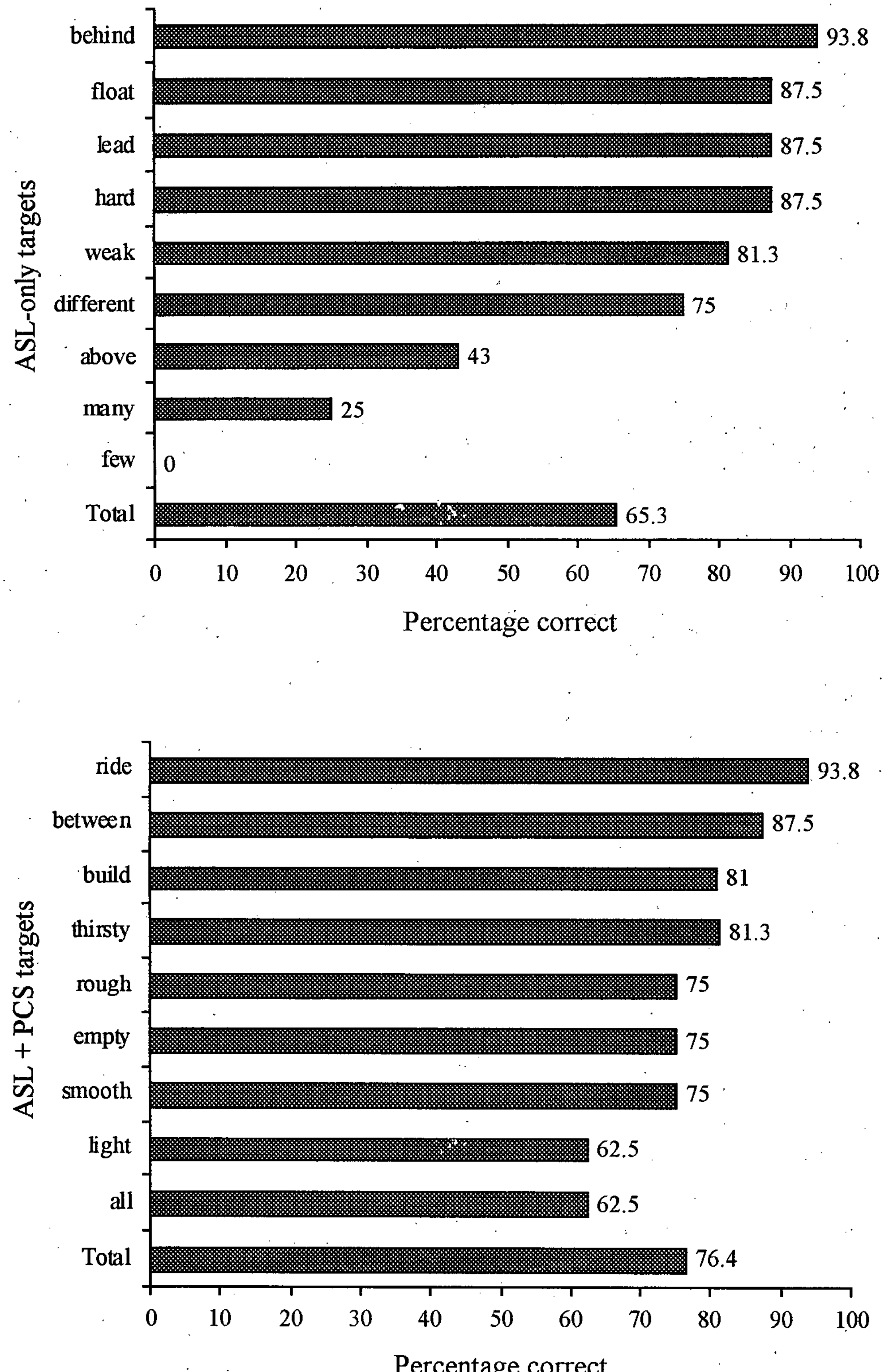
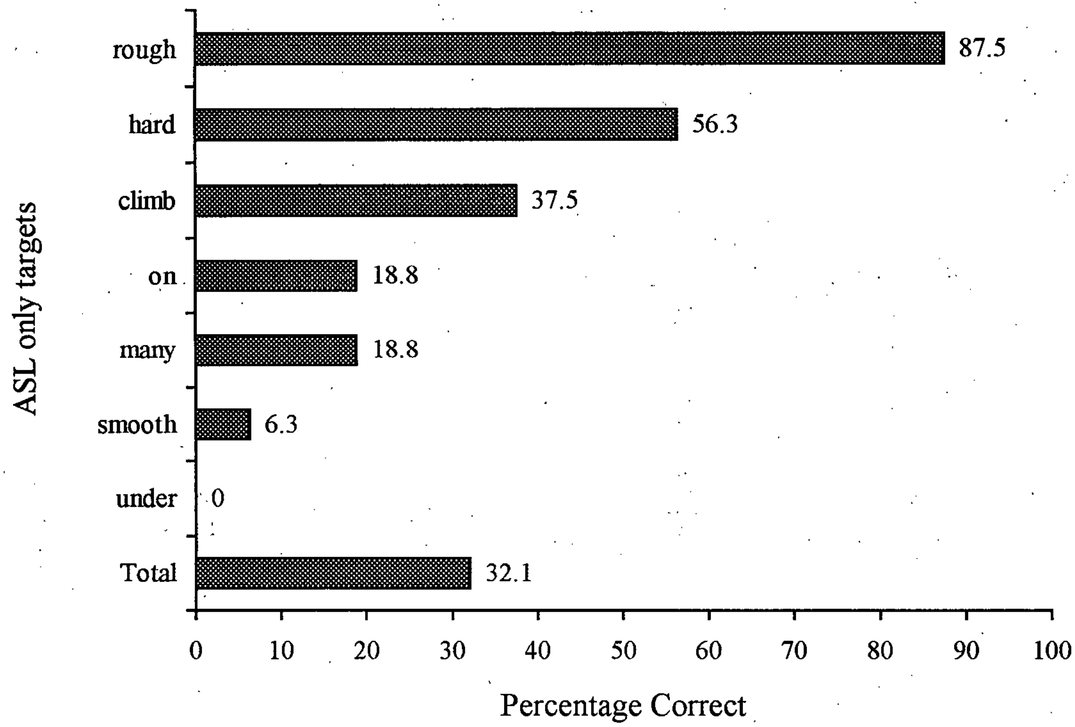


Figure 3. Maria's frequency of correct productions of each target ASL vocabulary word in ASL-only and ASL+PCS instructional conditions.

In total, Maria produced 94 correct responses (65.3%) in the ASL-only condition and 111 correct responses (77.1%) in the ASL+PCS condition, for a difference of 11.8% in favor of ASL+PCS. Comparison of Maria's performance across instructional conditions reveals both quantitative and qualitative differences. Maria produced more correct ASL signs in the ASL+PCS condition and demonstrated more consistent accuracy in this condition. All of the target signs in the ASL+PCS condition were produced correctly, whereas only 8 of the 9 target signs were produced in the ASL-only condition.

Figure 4 illustrates the percentage correct for each target vocabulary item in both instructional conditions for Alex across Phases 1 and 2.



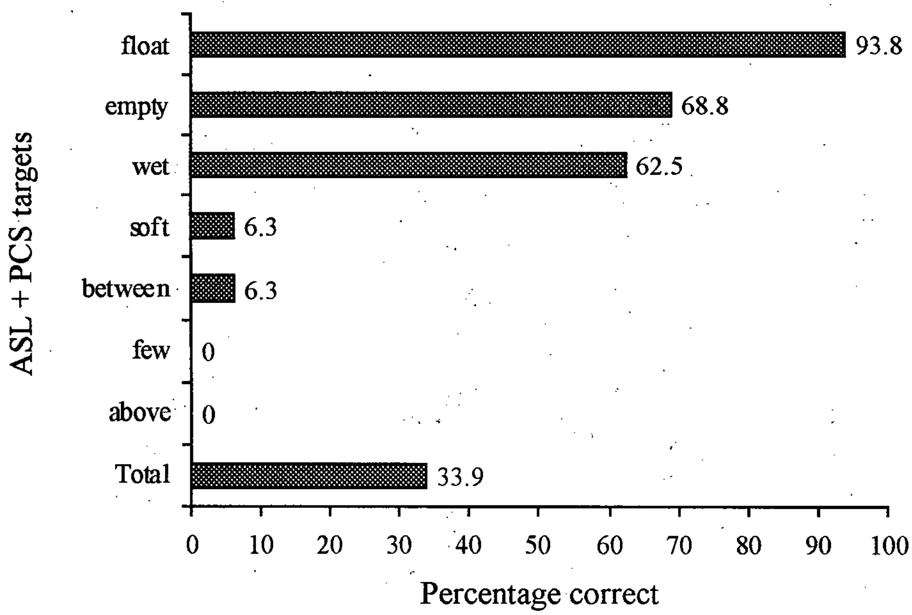


Figure 4. Alex's frequency of correct productions of each target ASL vocabulary item in ASL-only and ASL+PCS instructional conditions.

Overall, Alex correctly produced 36 correct responses (32.1%) in the ASL-only condition and 38 correct responses (33.9%) in the ASL+PCS condition, for a difference of only 1.8% between the two conditions, in favor ASL+PCS. Comparison of Alex's performance in both conditions reveals that he produced more target signs correctly in the ASL-only condition (i.e., 6 of 7 targets produced) compared with the ASL+PCS condition (i.e., 5 of 7 targets produced). Alex's correct responding in the ASL-only condition was marginally more consistent than in the ASL+PCS condition. Overall, the results for Alex did not indicate a clear difference between instructional conditions.

Analysis of Order of Acquisition and ASL Target Vocabulary Features

The results suggested that instruction had a positive effect on the acquisition of novel ASL signs for both participants. For Maria, the ASL+PCS instructional condition appeared to be somewhat more effective than the ASL-only condition while, for Alex, there were no apparent differences across the two conditions. This was contrary to the hypothesis of the study. Thus, further analyses appeared warranted in an attempt to account for the results in terms of specific characteristics of the target signs. Motor feature scores, iconicity scores, and a combination of these two scores were each analyzed to ascertain their influence on acquisition of the ASL target items.

Order of acquisition and motor feature scores. According to the feature rating scale adapted from Musselwhite and St. Louis (1988), the signs that were easiest motorically were those that were (a) one-handed, (b) symmetrical (i.e., if two-handed), (c) involved physical contact, (d) required a simple handshape, and (e) required simple movements. Target signs with these features were given higher motor feature scores (i.e., higher scores represented motorically easier targets). The highest possible motor feature score was 10.

For each participant, the target signs were arranged in the order of acquisition for each condition. A sign was considered to have been acquired if it was produced accurately across three consecutive probe trials. When more than one target sign met the acquisition criterion during the same probe session, it was assigned the same number. Table 6 displays Maria's target signs in their order of acquisition, with their corresponding motor feature scores.

Table 6
Order of Acquisition and Motor Feature Scores for Maria

Group A: ASL Only			Group B: ASL+PCS		
Target Sign	Acquisition Order	Motor Feature Score	Target Sign	Acquisition Order	Motor Feature Score
behind	1	4	ride	1	4
float	2	6	between	2	4
lead	2	4	build	3	7
hard	2	5	rough	4	5
weak	3	4	empty	4	3
different	4	8	light	5	4
above	5	4	all	5	6
many	6	6	thirsty	5	6
few	Not acquired	5	smooth	6	6

Table 6 reveals no apparent relationship between motor feature scores and the order of target sign acquisition for Maria. In the ASL-only condition, Maria first acquired a target sign whose motor complexity score was 4 (i.e., "behind") and next acquired one easier sign (i.e., "float") with a score of 6 and two moderately difficult signs (i.e., "lead" and "hard") with scores of 4 and 5, respectively. The target sign that was easiest in terms of motoric complexity (i.e., "different," with a score of 8) was acquired fourth, followed by a more difficult sign (i.e., "above," with a score of 4). Thus, Maria acquired three of the most motorically difficult target signs (i.e., those with scores of 4) prior to the easiest one (i.e., with a score of 8). She never acquired "few," which scored 5.

Within the ASL+PCS condition, Maria acquired the easiest target third (i.e., "build," with a score of 7). She acquired the most motorically difficult sign (i.e., "empty," with a score 3) in the fourth position, together with "rough," which scored 5. Her final acquisitions all had scores of 6 (i.e., "all," "thirsty," and "smooth"). A consistent pattern of acquisition based on motor feature scores was not evident in either instructional condition for Maria.

displays Alex's target signs in their order of acquisition, with corresponding motor feature scores.

Table 7

Order of Acquisition and Motor Feature Scores for Alex

Group A: ASL Only			Group B: ASL+PCS		
Target Sign	Acquisition Order	Motor Feature Score	Target Sign	Acquisition Order	Motor Feature Score
rough	1	5	float	1	6
hard	2	5	empty	2	3
on	3	5	wet	3	7
climb	4	6	soft	Not acquired	6
many	Not acquired	6	between	Not acquired	4
smooth	Not acquired	6	above	Not acquired	4
under	Not acquired	0	few	Not acquired	5

Motor feature scores for Alex's acquisition of target ASL vocabulary in the ASL-only instructional condition revealed that he acquired the three most difficult signs (rated 5) prior to one easier sign (rated 6). Alex never acquired "many" (score of 6); "smooth" (score of 6); nor "under," the most difficult sign in this condition (score of 0). In the ASL+PCS instructional condition, Alex first acquired a sign with a score of 6 (i.e., "float") followed by the most difficult sign in this condition (i.e., "empty," with a score of 3), and then the easiest one (i.e., "wet," with a score of 7). He never acquired "soft" (score of 6), "between" (score of 4), "above" (score of 4), or "few" (score of 5). Overall, there was no consistent pattern of acquisition based on motor complexity for the ASL+PCS instructional condition for Alex.

Order of acquisition and iconicity score. The iconicity rating procedure resulted in the assignment of scores of 2 to the ASL target signs determined to be transparent (i.e, guessed without explanation), scores of 1 to those determined to be translucent (i.e., guessed after explanation), and scores of 0 to those determined to be opaque (i.e., not guessed after explanation). Thus, the higher scoring ASL target signs were considered to be more transparent and easier to learn. For each participant, the target signs were arranged in the order of acquisition for each condition. A sign was considered to have been acquired if it was produced accurately across three consecutive probe trials. When more than one target sign met the acquisition criterion during the same probe session, it was assigned the same number.

Table 8 displays Maria's target signs in their order of acquisition, with their corresponding iconicity scores.

Table 8

Order of Acquisition and Iconicity Scores for Maria

Group A: ASL Only			Group B: ASL+PCS		
Target Sign	Acquisition Order	Iconicity Score	Target Sign	Acquisition Order	Iconicity Score
behind	1	1	ride	1	1
float	2	2	between	2	1
lead	2	1	build	3	1
hard	2	0	rough	4	1
weak	3	1	empty	4	0
different	4	0	light	5	0
above	5	2	all	5	0
many	6	0	thirsty	5	2
few	Not acquired	1	smooth	6	1

In the ASL-only condition, Maria acquired a translucent sign first (i.e., "behind"). This was followed by one transparent sign (i.e., "float") together with both a translucent (i.e., "lead") and an opaque sign (i.e., "hard"). One of the two transparent signs (i.e., "above") was acquired fifth. In the ASL+PCS condition, four signs with scores of 1 (i.e., translucent) were acquired prior to the three signs with scores of 0 (i.e., opaque); however, the sign with the highest iconicity (i.e., "thirsty") was not acquired until the fifth position. These results do not suggest a pattern of vocabulary acquisition based on iconicity within the ASL-only condition. However, there does appear to a pattern of translucent signs being acquired prior to opaque signs in the ASL+PCS condition. Table 9 illustrates the order of acquisition of target ASL signs and their corresponding iconicity scores in both instructional conditions for Alex.

Table 9

Order of Acquisition and Iconicity Scores for Alex

Group A: ASL Only			Group B: ASL+PCS		
Target Sign	Acquisition Order	Iconicity Score	Target Sign	Acquisition Order	Iconicity Score
rough	1	1	float	1	2
hard	2	0	empty	2	0
on	3	1	wet	3	0
climb	4	2	soft	Not acquired	1
many	Not acquired	0	between	Not acquired	1
smooth	Not acquired	1	above	Not acquired	2
under	Not acquired	2	few	Not acquired	1

In the ASL-only condition, no clear pattern of acquisition based on iconicity was apparent. Alex acquired a translucent sign first (i.e., "rough"), followed by an opaque sign (i.e., "hard). He never acquired one of the two transparent signs (i.e., "under"). In the ASL+PCS condition, Alex acquired one of the transparent signs first (i.e., "float"), followed by two opaque signs (i.e., "empty" and "wet"). One of the two transparent signs (i.e., "above") was never acquired. Overall, there was no clear evidence that iconicity affected the acquisition of ASL signs in either condition for Alex.

<u>Order of acquisition and motor feature + iconicity scores</u>. Since analyses of the order of target vocabulary acquisition based on motor feature scores and iconicity scores were not

productive in explaining the results, a decision was made to combine the two scores to examine their potentially cumulative effect on acquisition. Because the highest possible motor feature score was 10 and the highest possible iconicity score was 2, the highest possible combined score was 12. A score of 12 suggested that a sign should be both motorically easy to produce and highly iconic (i.e,., transparent). Thus, signs with the highest scores were considered to be easiest to acquire.

Table 10 displays the order of acquisition of the target signs in each condition and their corresponding motor feature + iconicity scores for Maria.

Table 10

Order of Acquisition and Motor Feature + Iconicity Scores for Maria

Group A: ASL Only			Group B: ASL+PCS		
Target Sign	Acquisition Order	Motor Feature + Iconicity Scores	Target Sign	Acquisition Order	Motor Feature + Iconicity Scores
behind	1	5	ride	1	5
float	2	8	between	2	5
lead	2	5	build	3	8
hard	2	5	rough	4	6
weak	3	5	empty	4	3
different	4	8	light	5	4
above	5	6	all	5	6
many	6	6	thirsty	5	8
few	Not acquired	6	smooth	6	7

In the ASL-only condition for Maria, two signs had combined scores of 8 and were thus considered to be the two easiest targets to acquire. One of these signs (i.e., "float") was acquired second, while the other (i.e., "different") was acquired fourth. The four target signs with scores of 5 were considered to be the most difficult; one of these was acquired first and the remaining three were acquired second or third. In the ASL+PCS condition, two target signs had scores of 8; one of these (i.e., "build") was acquired third and the other (i.e., "thirsty") was acquired fifth. The most difficult ASL sign in this condition (i.e., "empty," with a score of 3) was acquired prior to several higher scoring signs (i.e., "light," "all," and "thirsty"). The combination of motor feature and iconicity scores did not appear to result in a pattern with regard to the order of acquisition consistent with that reported in the literature.

Table 11 displays the order of acquisition of the target signs in each condition and their corresponding motor feature + iconicity scores for Alex.

Table 11

Order of Acquisition and Motor Feature + Iconicity Scores for Alex

Group A: ASL Only			Group B: ASL+PCS		
Target Sign	Acquisition Order	Motor Feature + Iconicity Scores	Target Sign	Acquisition Order	Motor Feature + Iconicity Scores
rough	1	6	float	1	8
hard	2	5	empty	2	3
on	3	6	wet	3	7
climb	4	8	soft	Not acquired	7
many	Not acquired	6	between	Not acquired	5
smooth	Not acquired	7	above	Not acquired	6
under	Not acquired	2	few	Not acquired	6

In the ASL-only condition, Alex's highest-scoring (i.e., supposedly easiest) target sign was "climb," with a score of 8. He acquired three lower scoring (i.e., more difficult) vocabulary words before acquiring "climb". The second easiest sign in this condition was "smooth," (score of 7) and was not acquired at all. In the ASL+PCS condition, Alex first acquired "float," which had the highest combined score (i.e., 8) and was thus considered to be the easiest sign in this condition. However, his second acquisition was the most difficult sign (i.e., "empty," with a score of 3). He acquired "wet" (score of 7) but did not acquire "soft" (i.e., also score of 7). He did not acquire "between" (score of 5), "above" (score of 6), or "few" (score of 6). Overall, this analysis did not provide support for the suggestion that motor feature + iconicity scores might account for the order in which Alex acquired the target ASL signs.

Summary of Results

The results illustrate that instruction was effective in teaching both Maria and Alex several new ASL vocabulary words. Neither participant produced any of the target ASL signs during baseline, and both produced several signs each following instruction. Thus, it can be concluded that instruction directly affected their acquisition of the target items.

Visual inspection of the data indicated that the ASL+PCS condition was somewhat more effective for Maria but not for Alex, who demonstrated considerable response variability throughout the intervention. There was also a quantitative difference between the two participants, with Maria acquiring more target signs than Alex. Analyses of motor feature scores, iconicity scores, and motor feature + iconicity scores did not appear to be related to expected patterns of acquisition order.

CHAPTER 5

Discussion

Overview of Results

American Sign Language (ASL) is the language used by the majority of Deaf people in North America. It is also the predominant language of instruction and communication within the B.C. Provincial School for the Deaf. For deaf children with intellectual disabilities, the transient and dynamic nature of ASL may pose problems with language acquisition. The present study investigated the effectiveness of pairing Picture Communication Symbols (PCS) with ASL to support the acquisition of novel ASL vocabulary words in two deaf children with intellectual disabilities. It was hypothesized that the use of an ASL+PCS presentation would result in a greater number of correct responses than an ASL-only presentation, during a structured learning task. The rationale for this hypothesis was derived from the scant research on the potentially facilitative effect of iconicity on language learning, recognition, and retention (Beykirch et al., 1990; De Paul & Yoder, 1986; Lieberth & Bellile Gamble, 1991; Luftig, 1983; Luftig & Lloyd, 1981). In addition, theoretical support for this hypothesis was derived from the extant literature on symbol acquisition and use for hearing individuals with intellectual disabilities. Support for this hypothesis was partially confirmed with the results for Maria, but not with the results for Alex. For Maria, the addition of PCSs during instruction facilitated, at least to some extent, the acquisition of the target ASL vocabulary words. However, for Alex, the ASL+PCS condition provided no apparent advantage over the ASL-only condition.

Traditionally, visual inspection of data has been employed within single-case research (Barlow & Herson, 1985; Busk & Marascuilo, 1992; Kazdin, 1984; Kratochwill, 1992). However, some researchers have questioned the usefulness of visual inspection, referring to it as “insensitive” (Kazdin, 1984) because of the potential that this method of analysis could lead to different interpretations across observers. While several statistical procedures may be applied to single-case research designs (e.g., time series analysis, randomization tests, split-middle technique; Kazdin, 1984), visual analysis was determined to be sufficient for the present study for two primary reasons. First, initial visual inspection of each participant's data revealed clear differences with regard to the participants' ability to produce the target vocabulary words. Second, differences between instructional conditions, although modest, were clearly visible for Maria. Although a high level of variability was demonstrated between conditions for Alex; it was nonetheless clear that differences between the instructional conditions were negligible and not clinically significant. Thus, although a statistical analysis might have provided supplemental information, it was unlikely that this information would have clarified or refined the conclusions with respect to the relative "educational value" of the intervention techniques used in the study.

Following an initial visual analysis of the data, it was postulated that specific characteristics of the selected ASL vocabulary words may have influenced acquisition. Therefore, subsequent analyses included examination of the order of acquisition of the target ASL signs in relationship to motor features scores, iconicity scores, and a combination of the two. Results from these analyses revealed that neither participant demonstrated an obvious pattern of acquisition of the ASL vocabulary in relationship to any of these three constructs. Several factors may help to explain the variability of the results both within and between participants. These factors include: a) developmental differences between the participants, b) characteristics of the selected ASL vocabulary (e.g., iconicity, motor features, and semantic categories), and c) limitations of the research design.

Developmental Factors

The participants in this study were selected because they both had a severe-profound prelingual hearing loss and intellectual disability. Both participants had significant learning delays and unusual difficulty acquiring new ASL vocabulary. They were considered to be representative of the highly heterogeneous population of deaf and hard of hearing children identified with additional learning challenges (Gallaudet University, 1995-96). One explanation for the inter-participant variability with regard to acquisition of the target ASL signs in the present study may be related to their developmental differences. Individual differences related to development have been suggested as important consideration for designing language interventions (Iacono, 1992; Iacono & Waring, 1995).

Developmental Age Equivalents

In order to determine developmental age approximations for each participant, mean scores for each developmental area on the Brigance Inventory of Early Development-Revised (Brigance, 1991) were calculated. Scores were taken at face value, with the highest score in an identified age range used in each calculation. If a participant demonstrated "no response," scores were omitted from the calculation for the area . The resulting scores must be interpreted with caution due to participant variability during the testing and the nature of the calculations used (i.e., scores may be inflated, since the high end of each age range was used). On this basis, Maria's mean developmental age equivalent was estimated at 4.9 and Alex's was estimated at 3.3. Differences in the age equivalent estimates for the two participants probably reflect differences in their overall cognitive development, language development, and memory capacity.

Developmental Language Differences

A related explanation for the variability between participants in this study is the differences in their language development. The target ASL vocabulary words selected for both participants were based on their vocabulary profiles from the MacArthur Communicative Development Inventory (MCDI): Words and Gestures (Fenson et al., 1993) and the Carolina Picture Vocabulary Test (CPVT) for Deaf and Hearing Impaired Children (Layton & Holmes, 1985).

These tests were employed in an effort to insure the selection of two equivalent and independent groups of vocabulary that were unknown to the participants. They were also conducted in an effort to determine the participants' receptive and expressive vocabulary levels. Although Maria's target vocabulary sets for the study consisted of more items than Alex's, an attempt was made to match the target vocabulary in complexity both between conditions and between participants.

Both participants had age equivalent scores of <4.0 years on the CPVT, indicating significant language delays. On the MCDI, Maria's sign vocabulary was found to be larger than Alex's, both receptively (i.e., 350-450 words, according to teacher and parents reports) and expressively (i.e., 350-420 words). Alex's receptive vocabulary was between 200-320 words, and his expressive vocabulary was between 120-240 words on the MCDI. Scores on the Brigance Diagnostic Inventory of Early Development-Revised (Brigance, 1991) also suggested developmental language differences between the two participants, with Maria scoring higher than Alex on picture vocabulary (>5:0 vs. 2:9), mean length of utterance (<2:6 vs. <2:0) and verbal/signed directions (2:0–3:0 vs. no response).

The target ASL vocabulary items were selected to accommodate Maria's higher language level, since it was assumed that ASL vocabulary items selected with her in mind would also be relevant and unknown to Alex. This resulted in the selection of vocabulary words that were somewhat abstract (i.e., verbs and descriptors), since Maria already had most common nouns in her lexicon. However, the end result might have been that the semantic features of the selected words were beyond Alex's developmental language ability. In order to explore this notion further, semantic category analyses were performed for each participant's pre-intervention vocabulary words, as reported on the CPVT and the MCDI. MCDI analyses were accomplished by averaging results from the parent and teacher reports. Body parts were omitted from the analysis because, in ASL, body part words are primarily gestured.

Alex demonstrated a receptive sign lexicon comprised of 17.7% of the nouns, 3.8% of the verbs, and 2.8% of the descriptors on the CPVT. Maria demonstrated a receptive sign lexicon comprised of 41.5% of the nouns, 10% of the verbs, and 6.9% of the descriptors on this test. Thus, according to the CPVT, Maria had more nouns, verbs, and descriptors in her lexicon prior to intervention than did Alex. The comparative results from the MCDI are even more revealing. Alex demonstrated knowledge of 44% of the nouns, 32% of the verbs, and 35% of the descriptors on the MCDI, whereas Maria demonstrated knowledge of 70% of the nouns, 71% of the verbs, and 76% of the descriptors tested. The lexical patterns of both participants are consistent with studies of early lexical learning in typical children, which have consistently indicated that, in general, nouns are acquired and produced prior to verbs, which in turn are acquired and produced prior to descriptors (Naremore, 1984). Although these studies refer to the first 50 words acquired by hearing children, a similar pattern of vocabulary acquisition can be assumed for deaf children, since ASL is acquired in much the same way as spoken language (Meier & Newport, 1990; Siedlecki & Bonvillian, 1993; Tabor, 1988). In addition, differences between the participants' language abilities may be indicative of different language experiences, exposure, and learning styles, although this is difficult to ascertain. Iacono (1992) suggested that "individual differences across individuals and stages of language learning in studies using AAC techniques to facilitate language may reflect differences in subjects' language learning styles" (p. 36).

<u>Memory</u>

Another possible explanation for inter-participant differences in vocabulary acquisition is related to the issue of memory function. Bristow and Fristoe (1984) stated that "a recognition task is generally regarded as being less demanding and more sensitive than a recall memory task…" (p. 146). For the purposes of the present study, it was assumed that pairing PCSs with the target ASL vocabulary would ease the recall memory demands of ASL, since PCSs, which require recognition memory, are static and thus provide additional inspection time for symbol processing. This assumption was made in light of previous research on the memory demands of ASL and GRSs (e.g., Bristow & Fristoe, 1984; Iacono, 1993; Light & Lindsay, 1991; Sevcik et al., 1991). This research has supported the notion that certain linguistic skills, memory skills, and mental transformations may be required before ASL signs can be processed accurately (Sevcik et al., 1991; Siedlecki & Bonvillian, 1993). For example, in order to produce an ASL sign, a signer must be able to retain an image of the pattern in short-term memory (Bristow & Fristoe, 1984; Emmorey, 1993; Emmorey et al., 1993).

Directly relevant to this study is research about the relationship between short-term memory capacity and intellectual disability. This research suggests that the more profound the intellectual disability, the more limited the short-term memory capacity (Drew et al., 1992; Evans & Bilsky, 1979). According to the Brigance scores obtained for Alex, he demonstrated a more severe intellectual disability than did Maria. He may have experienced more difficulty recalling the target ASL vocabulary from memory as a result, thus accounting in part for his relatively poor performance.

It is also important to note that the addition of PCSs during instruction added one additional step to the memory and processing demands of the task. In the ASL-only condition, participants were expected to attend to only one ASL sign, whereas in the ASL+PCS condition, they needed to attend to both the ASL sign and the corresponding PCS symbol. Thus, the ASL+PCS task became one that demanded twice the attention and twice the memory. The additional cognitive and processing skills required by the addition of the PCSs might have exceeded Alex's capacity.

Social-Emotional Development

A further explanation of the variability between participants may be found within the context of their sociocommunicative abilities. Alex's age equivalent score in the "general social emotional development" area of the Brigance, which includes, general social skills, play skills, and work skills, was 1.9 years. This was considerably lower than Maria's age equivalent score of 5.7 years. In fact, throughout the investigation, behavioral and attention concerns were evident for Alex. He frequently engaged in non-compliant behavior during the intervention and probe sessions; these included getting out of his seat, avoidance of eye contact, and inappropriate manipulation of the experimental materials. Although the PCSs were placed within his visual field, he often looked away, distracted by the video camera, and required prompts to re-focus. In fact, one of the instructional sessions was terminated because of his behavior. In addition, throughout the investigation, Alex did not appear motivated to participate or cooperate and rarely initiated communication. Alex's attentional and behavioral issues were of such concern that edible reinforcers for correct responses were introduced during the third session of Phase 1 to provide additional motivation. Alex's overt inappropriate behavior during the investigation was interpreted as indicative of his lack of interest in the activity and/or his attempts to escape from it. This may have occurred because the activity was too difficult for him, as discussed previously.

Vocabulary Factors

The study of sign characteristics and their influence on sign acquisition has resulted in a significant body of literature in this area (Dennis et al., 1982; Doherty, 1985; Klima & Bellugi, 1979; Kohl, 1981). It has been suggested that specific characteristics of signs directly influence both the learning process and sign production (Boyes-Braem, 1973; Doherty, 1985; Klima & Bellugi, 1979; Kohl, 1981). Many of these characteristics were taken into account for the present study during the selection of target ASL vocabulary and the assignment of vocabulary items to the two intervention conditions. Specific attempts were made to insure that the two vocabulary sets for each participant would be equivalent in difficulty. The fact that analyses of motor feature and iconicity scores for the target ASL vocabulary in relation to the order of acquisition did not produce results that support present theories of acquisition requires explanation.

Motor Features

Orlansky and Bonvillian (1984b) suggested support for the motor feature impact on sign learning. The production features of signs that are considered to impact on learning have been identified in several studies and have been used as criteria in the selection of initial sign lexicons (Dennis et al., 1982; Doherty, 1985; Kohl, 1981). The motor complexity of signs has been identified as one such feature. In the present study, an attempt was made to equate the target ASL vocabulary items with regard to motor complexity across the two instructional conditions. Motor complexity was measured using a feature rating scale for manual sign difficulty adapted from Musselwhite and St. Louis (1988). The adaptations included the exclusion of two factors, visibility and repetitiveness, from the rating scale for this study, because they were thought to be irrelevant given the vocabulary selected, and because of the scarcity of research on the influence of both. Target signs were assigned scores of 0-2 based on handedness, physical contact, symmetry, handshape, and movement, and there was no more than a 3-point difference in motor complexity scores across signs in each condition for each participant. It is possible that either the original or the adapted scales were poorly constructed, and that the resulting motor complexity scores did not, in fact, reflect the true motor difficulty of the signs. However, this is unlikely, given the large body of research upon which the scale was based.

Another explanation for the inter-participant variability may have to do with the relationship between intellectual disability and motor development. According to Drew et al. (1992), this relationship is a direct one, such that the greater the degree of intellectual disability, the greater the degree of motor difficulty. Differences between participants in the acquisition of the target ASL vocabulary may be explained in part by differences in their motor ability age equivalents on the Brigance Inventory of Early Development-Revised (Brigance, 1991). Alex scored a consistently lower age equivalent in motor ability (M = 3:9) than Maria (M = 6) on this measure. Recall that the issue of "necessary prerequisite motor abilities" was suggested as a possible reason for the poor outcomes in the longitudinal study by Bryen et al. (1988). Thus, it is possible that the motor requirements of some signs were too complex for Alex's motor ability and thus too difficult for him to produce with recognizable accuracy.

Iconicity

Previous research (e.g., Beykirch et al., 1990; DePaul & Yoder, 1986; Lieberth & Bellile Gamble, 1991; Luftig, 1983; Luftig & Lloyd, 1981) has suggested a direct relationship between iconicity and manual sign learnability, such that more iconic (i.e., transparent) signs are learned more easily than less iconic (i.e., opaque) signs. However, this study found no clear relationship between manual sign iconicity and the ASL vocabulary words learned by either participant. There are three possible explanations for these unexpected results: (a) iconicity was not an influential construct in the acquisition of ASL vocabulary, (b) the rating scale used to evaluate ASL sign iconicity in this study was imprecise, inappropriate, or both; and (c) a failure to control for PCS iconicity confounded the results. Each of these will be addressed in the sections that follow.

Iconicity not an influential construct. In an extensive review of the literature on manual sign learnability, Doherty (1985) reported at least "partial support to the [iconicity] facilitation hypothesis" (p. 117) on the basis of previous research. However, research investigating the facilitative effects of iconicity on sign learning have involved highly variable populations, and no studies to date have employed deaf children with intellectual disabilities such as the participants in the present study. As suggested by Orlansky and Bonvillian (1985), although "we all agree that iconicity is of *some* importance in facilitating sign language acquisition, professional judgments of just *how* important appear to be influenced by several factors, including (a) the age of the subjects studied; (b) the types of disabilities, if any, present in the subjects; (c) whether investigations are conducted under controlled experimental conditions or…in the natural home setting; and (d) the theoretical orientation of the investigator." (p. 407). In an earlier study (Orlansky & Bonvillian, 1994b) these authors also noted that their participants (i.e., hearing children of deaf parents) "appeared capable of learning iconic and noniconic signs with about equal facility" (p. 290). Similarly, De Paul and Yoder (1986) suggested that ". . . the narrow focus on iconicity may be misguided, especially given the equivocal results with regard to learning in younger and mentally retarded [sic] populations…" (p. 9). Together, these researchers provide at least two plausible explanations for the fact that the present study failed to provide support for the facilitative effects of iconicity on ASL sign learning -- namely, the uniqueness of the population from which the participants were drawn and the structured experimental context in which the study was conducted.

<u>Iconicity not accurately measured.</u> An alternative explanation for the results is that iconicity was not accurately measured prior to intervention. Using a procedure adapted from Luftig et al. (1983), a systematic attempt was made to match iconicity within the two instructional sets of ASL vocabulary words for each participant. For the purpose of this study, the iconicity scores for the signs were determined by testing hearing adults with the Luftig et al. procedure since, in all but one study cited in the literature review on iconicity, hearing subjects were used. However, previous research has suggested that iconicity is "experience-bound" (DePaul & Yoder, 1986); thus, it cannot be assumed that the experiences of hearing adults are comparable to those of children with deafness and intellectual disabilities. This concern was also expressed by Sevcik et al. (1991), who noted that, "if individuals do not have a particular semantic concept within their

linguistic repertoires, then that meaning would not be able to be employed to facilitate the learning of a symbol" (p. 163). In retrospect, the iconicity scores for the target ASL signs probably should have been determined using children of approximately the same developmental ages as the participants. Future research should address this issue in order to ensure that iconicity scores are valid and that signs are well-matched across instructional conditions.

Iconicity of PCSs as a confounding variable. The iconicity of the PCSs used in the ASL+PCS condition was not evaluated in this study. This was not done because PCSs have been found in previous research to be among the most iconic of the symbol sets currently in use in North America (Bloomberg et al. 1990; Mirenda & Locke, 1989; Mizuko, 1987; Mizuko & Reichle, 1989). However, there was a high degree of variability among the PCSs used in the study in terms of iconicity relative both to each other and to the manual signs with which they were paired in the ASL+PCS condition. This, in turn, might have affected learning in both participants. For example, the ASL vocabulary words which Maria produced most consistently in the ASL+PCS condition were associated with PCSs that appear to be quite transparent (i.e., "ride," "between," "build," and "thirsty;" see Appendix A). Those which she produced less frequently, such as "rough," "empty," and "smooth," appear to be paired with PCSs that are more opaque. Alex produced the ASL signs for "float," "empty," and "wet" with the highest consistency; the PCSs for all of these except "empty" appear to be quite transparent (see Appendix B). He did not produce two ASL vocabulary words associated with PCSs that appear to be more opaque (i.e., "few" and "soft"), but neither did he produce the signs for "between" or "above," which are associated with PCSs that appear to be quite transparent. Although there is some inconsistency in this error analysis, it does appear that the iconicity of the PCSs relative to their ASL signs might have confounded the results.

Limitations of the Study

ASL Vocabulary Sets

As discussed previously, the constructs of motor complexity and iconicity were employed in an effort to insure that the ASL vocabulary words across instructional conditions for each participant were equivalent in difficulty. The procedures employed to evaluate motor complexity and iconicity of the target signs may have been inaccurate, although they were based on or adapted from previous research in this area. Without assurance that the vocabulary words are matched in complexity, valid comparisons of one instructional method to another are not possible within an AATD design. As Sindelar et al. (1985) noted, "the major feature of the AATD involves the identification of two equivalent and functionally independent instructional sets" (p. 70).

PCS Vocabulary Sets

The iconicity of the PCSs employed in the present study was not evaluated and thus was not controlled either within or across the vocabulary sets for the two participants. As noted previously, a preliminary error analysis suggested that the iconicity of the PCSs relative to the ASL signs with which they were paired may have confounded the results. Future research in this area should control for both ASL and PCS iconicity both within and across participants.

Interventionist Effects

An attempt was made to control interventionist effects within in the study by alternating interventionists across and within probe and intervention sessions for each participant. This was achieved for Maria but, due to scheduling constraints, it was not achieved for Alex. Although both interventionists completed half of the instructional sessions with Alex, they were not alternated on a daily basis. This may have resulted in differential intervention effects for this participant, although no overt interventionist-specific response patterns were detected upon examination of the data.

External Validity

A small-n research design was selected for this study because the population of individuals with deafness and intellectual disability is quite heterogeneous. In addition, this design was selected on the basis of support in recent research literature for investigations with comparably heterogeneous and complex populations of children (e.g., Iacono et al., 1993; Sindelar et al., 1985). However, the findings should be interpreted with caution, since other individuals both within and across populations (e.g., hearing children with intellectual disabilities, deaf children without intellectual disabilities) may demonstrate different results.

The results of the present study should also be interpreted in the context of a structured learning task, which may not be representative of instructional environments within typical educational settings. The participants interacted with the interventionists in a controlled environment, through a structured learning task with few distractors. Although similar 1:1 instructional situations are often implemented in specialized school settings, they are not generally representative of natural classroom environments.

Educational Implications

The two participants in the present study were selected from the B.C. Provincial School for the Deaf, primarily due to the fact that ASL is the predominant language of instruction and interpersonal communication for teachers and students attending this school. Currently, a large percentage of deaf children with intellectual disabilities attend the school (i.e., approximately 30%), and this has become a growing concern for educators because of the difficulties these children experience acquiring language and general knowledge. In addition, the most recent version of The Annual Survey of Deaf and Hard of Hearing Children and Youth (Gallaudet

University, 1996-97) reported that 64% of the 26,903 D/HH children and youth surveyed had at least a mild functional limitation in the physical, cognitive/behavioral, and/or communication domains. Together, these figures suggest a need for instructional approaches that can accommodate the special needs of deaf children with additional impairments.

Teaching strategies specific to deaf children with intellectual disabilities have rarely been discussed in the literature, and research in this area is scant. Research in this area is critical, since the language and communication options for these children are limited to sign language or some other form of augmentative communication. The results of the present study support the use of structured learning tasks to teach ASL vocabulary to deaf children with intellectual disabilities who have difficulty learning new signs. The results also demonstrate that, for some of these children, an ASL+PCS presentation may be beneficial for sign language learning.

Future Research

The intention of the present study was to explore the relative impact of two instructional techniques for teaching novel ASL vocabulary to individuals with deafness and intellectual disabilities. This research has contributed to the evidence that deaf children with intellectual disabilities present very complex language learning needs. Further research is needed to determine the specific characteristics of ASL vocabulary that impact on learning. Specifically, research related to the motor, memory, and processing requirements of ASL with these individuals may be useful. Future research goals should also include children of various developmental ages, since developmental abilities appeared to play some part in the results for the two participants in this study. Research about the relationship between semantic categories and learning difficulty would also appear to be warranted.

Summary

In summary, this investigation examined the effectiveness of pairing Picture Communication Symbols with American Sign Language vocabulary to teach unknown signs to two deaf children with intellectual disabilities. Children with concomitant deafness and intellectual disability constitute a highly heterogeneous population. The combination of deafness and intellectual disability has a significant impact on learning in general and on language acquisition in particular, since cognitive, motor, and perceptual abilities may all be affected.

The participants in the present study were identified as having significant difficulty learning sign language as a result of their combined deafness and intellectual disability. Despite their learning difficulties, both participants were able to acquire several unknown ASL vocabulary words during the study under both direct instruction conditions. Maria demonstrated acquisition of more target ASL vocabulary words in the ASL+PCS condition than the ASL-only condition. Thus, Maria's data supported the hypothesis of the study, at least in part. Alex acquired fewer ASL vocabulary words than Maria overall and acquired approximately the same number of words in both conditions. Thus, the study's hypothesis was not supported by the data collected for Alex.

The inter-participant variability can be accounted for by: (a) individual developmental differences, (b) problems in assessing the iconicity of the target ASL vocabulary words and the PCSs in order to match them across conditions, (c) motivational aspects of the structured learning activity (for Alex), and/or (d) some combination of these. Nonetheless, what is evident from this investigation is that intellectual disability and individual learning styles should be taken into account in the design of language interventions for children who are deaf (Iacono et al., 1993).

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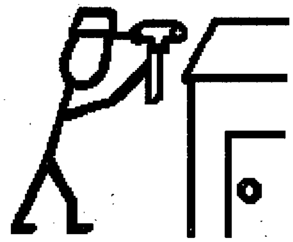
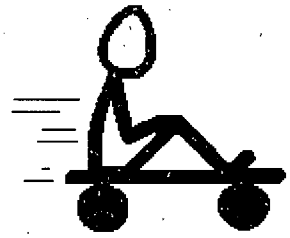
Appendix A

Picture Communication Symbols: Maria

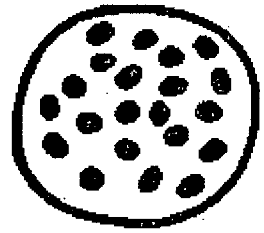
build



ride



all

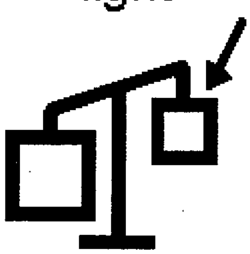


smooth

between

rough

light



thirsty

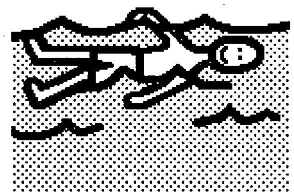
empty

Appendix B

Picture Communication Symbols: Alex

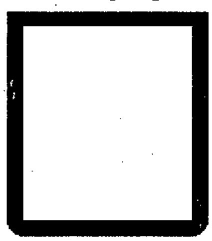
few

float



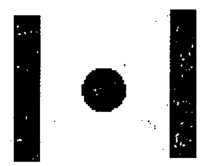
wet

empty



soft

between



above

Appendix C

Sample of ASL–Only Intervention Script

CLIMB		
Script	**Expression**	**Props & Action**
1. **Sign**: “___________*climb.” (1)* 2. **Manipulate**: character climbing. 3. **Sign**: *“climb” (2)* 4. **Sign**: “_____________ do? *Climb”.(3)*	slight squint rhythmic climbing action	**Action:** character climbing up ladder • ladder • character
Prompt &/Or Correct: Participant Signs: *“climb”*		
5. **Sign**: “thumbs up, __________ *climb”. (4)* 6. **Sign**: “___________ *climb.* Show me” (5) 7. **Sign**: *“climb” (6)* 8. **Give:** character to participant.		
Prompt &/Or Correct: Participant Demonstrates character climbing		
9. **Sign**: “thumbs up, __________ *climb” (7)*		

Appendix D

Sample of ASL+PCS Intervention Script

<table>
<tr><th colspan="3">RIDE</th></tr>
<tr><th>Script</th><th>Expression</th><th>Props & Action</th></tr>
<tr><td>1. <u>Sign + PCS</u>: "Truck CL; ______ride" cl; forward(1)
2. <u>Manipulate</u>: character riding in truck.
3. <u>Sign+PCS</u> "ride" (2)
4. <u>Sign</u>: "____________ do? Ride".(3)</td><td>neutral</td><td>Action:
character riding in truck
• truck
• character</td></tr>
<tr><td colspan="3">Prompt &/Or Correct: Participant Signs: "ride"</td></tr>
<tr><td>5. <u>Sign+PCS</u>: "thumbs up, __________ ride".(4)
6. <u>Sign+PCS:</u> "Truck cl; __ride" cl, forward. Show me" (5)
7. <u>Sign</u>: "ride" (6)
8. <u>Give:</u> character truck to participant</td><td></td><td></td></tr>
<tr><td colspan="3">Prompt &/Or Correct: Participant Demonstrates character riding in truck</td></tr>
<tr><td colspan="3">9. <u>Sign+PCS</u> "thumbs up, __________ ride " (7)</td></tr>
</table>

Appendix E

Sample of Probe Script

CLIMB		
Script	**Expression**	**Props & Action**
1 **Manipulate**: character climbing 2. **Sign**: "____________do?".	slight squint rhythmic climbing action	**Action: character climbing up ladder** • character • ladder
Correct Response: ***Climb***		