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The Effects of Closed Head Injury on the Learnability of Blissymbols

Andrea J. Rabish

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The Effects of Closed Head Injury

on the Learnability of Blissymbols

(TITLE)

BY

Andrea J. Rabish

THESIS

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Abstract

This study attempted to determine the effects of cognitive-communicative functioning in individuals who have sustained closed head injury on learnability of Blissymbols. Two features of Blissymbols, translucency and complexity, were examined to find their effects on Blissymbol learnability. Another focus of the study was to determine the effects of translucency and complexity interaction on learnability. The final research question concerned the relationship of cognitive-communicative functioning and Blissymbol learnability. Nine Subject, each rated with the Ranch Los Amigo Scale of Cognitive Functioning, participated in a task that required learning forty Blissymbols in a paired-associative learning task. The subjects were divided into three groups; Group One contained Level III/IV subjects, Group Two contained Level V/VI subjects, and Group Three contained Level VII/VIII subjects. Forty Blissymbols utilized in this study encompassed four conditions: 1) high translucency-high complexity (HTHC), 2) high translucency-low complexity (HTLC), 3) low translucency-high complexity (LTHC), and 4) low translucency-low complexity (LTLC). Each condition was represented by ten symbols. Subjects were required to point to each symbol five times as the label was called orally.

Results showed a significant main effect for translucency, indicating that more high translucency symbols were learned than low translucency symbols. The effects of complexity and the translucency by complexity interaction were not found to be significant. No significant within group differences were found. Differences between trials were significant and post hoc analyses revealed that the means in Trials One and Two were significantly lower than Trials Three, Trials Four, and Trials Five. Limitations and implications of this investigation were discussed.

Running Head: AAC/CHI

Key Words: Augmentative and alternative communication (AAC), closed head injury (CHI), Blissymbols, levels of cognitive functioning, paired-association task, learnability.

Dedication

To Jeannette Mason, a woman ahead of her time, a grandmother who always accepted me for who I was and who I aspire to be. Thank you for encouraging me to reach for the stars because the most frightening part was finding the ability that exists within myself to reach them.

Acknowledgments

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at a moment's notice.

I want to extend my appreciation to the faculty and fellow students at Eastern Illinois University who kept me sane throughout my years as a student. Thank you for the good times and even the not-so-good times. I learned a great deal from everyone.

Finally, my family deserves the greatest thanks of all. I am very grateful for all their love and support. The only way I can show my family my appreciation is to simply say "I love you".

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Introduction

Each year approximately 70,000 to 90,000 people sustain injuries to the head which result in permanent damage (ASHA, 1989). Traumatic brain injury (TBI) affects 1 in 500 individuals a year; the survival rate of severe traumatic brain injury is about fifty percent. Survivors of TBI may require long-term medical care and rehabilitation efforts lasting 5 or more years (ASHA, 1989). Among survivors, 12 to 26% make good overall recovery, 15 to 19% have moderate disabilities, 7 to 14% have severe disabilities, and 2 to 5% remain in a vegetative state (Anderson & McLaurin, 1980).

A transistory period of muteness is experienced by many patients with TBI (Beukelman & Mirenda, 1992). Currently, there is little documentation related to how many patients emerge from this nonspeech period and how many remain nonspeaking, thus becoming long term candidates for augmentative and alternative communication (AAC) (Beukelman & Mirenda, 1992; Blackstone, 1989; Yorkston, Honsinger, Mitsuda, & Hammen, 1989). The challenges confronting speech-language pathologists who serve individuals with TBI and are nonspeaking are apparent. Many professionals now specialize in certain disciplines of communication disorders. This is frequently the case for professionals who provide services to patients with traumatic brain injury. Although current research estimates that roughly 10 to 50% of the population with TBI are nonspeaking (Beukelman & Mirenda, 1992; Blackstone, 1989; Yorkston, Honsinger, Mitsuda, & Hamman, 1989), a professional whose expertise is in TBI may not possess extensive background nor training in the field of augmentative and alternative communication with its fast pace of both nontechnological and technological development (Beukelman & Mirenda, 1992; Blackstone, 1989; Yorkston, Honsinger, Mitsuda, & Hamman, 1989). As a result, the patient who is nonspeaking may be referred to another professional for augmentative and alternative communication evaluation and device training. Conversely, those specializing in AAC may not be fully cognizant of the range of cognitive deficits secondary to TBI and the effect of such deficits on issues such as AAC symbol learning and use (Yorkston, 1992). As recently as 1987, it has been documented that nonspeaking patients with TBI are sometimes dismissed as untestable and, therefore, appropriate AAC treatment procedures to address their communicative needs have never been implemented (DeRuyter & Kennedy, 1991). A profusion of professional knowledge overlap in TBI and AAC is lacking, as is dual TBI/AAC research.

Effective treatment of cognitive-communicative deficits has been only minimally researched (Ylvisaker &

Urbanczyk, 1990). Studies addressing the communicative needs of the patient who is brain injured and nonspeaking are even less well documented (Beukelman & Mirenda, 1992). Basically, only demographic data-based information and a few isolated group longitudinal research studies exist on patients who are nonspeaking following TBI (Beukelman & Mirenda, 1992; DeRuyter & Lafontaine, 1988; Dongilli, Hakel, & Beukelman, 1991; Ladtkow & Culp, 1992).

In literature related to TBI, several suggestions are offered about AAC symbol set/system selection, type of AAC system selection, and time of AAC introduction and training (Beukelman & Mirenda, 1992; Ladtkow & Culp, 1992). These suggestions, while potentially partially or totally well founded, were developed more on the basis of "clinical insight" regarding how the cognitive-communicative deficits might call for certain AAC symbol selections and/or approaches more so than on empirical research (Ladtkow & Culp, 1992). Although the rationale behind some of these perceptions are unclear, these valuable clinical perceptions must be taken into consideration. There are conflicting opinions, for example, on the timing of AAC introduction with little or no research to qualify these suggestions (Beukelman & Mirenda, 1992). Current research indicates that pictures and words are the most frequently used symbol sets/systems offered to patients with TBI who are nonspeaking (Ylvisaker & Urbanczyk, 1990). Yet, DeRuyter and Kennedy (1991) found that about 44% of patients with TBI who are nonspeaking discard or limitedly utilize their AAC systems after one year of rehabilitation discharge. There must be a reason for such rejection given that the alternative is that communicative needs are not met. Possibly the symbol sets/systems are ineffective since both words and pictures represent a closed collection of symbols (i.e., a miscellaneous assortment of symbols with no clearly defined rules for expansion), not a generative system (i.e., a system which allows change and expansion through application of clearly defined rules).

In light of the memory and learning deficits that exist in patients who are nonspeaking following traumatic brain injury, other types of symbol sets/systems require exploration in the pursuit of an effective communication system. Blissymbolics is one such set of AAC symbols which seems to warrant investigation. In an individual case study with a young adult who was nonspeaking following traumatic brain injury, Ross (1979) found that Blissymbols was a valuable tool in the patient's total rehabilitation.

In the overall field of AAC, not specifically related to TBI, Blissymbolics has probably been the most researched aided symbol system (Archer, 1977; Clark, 1981; Fuller, 1988; Hehner, 1980; Helfman, 1981; Luftig & Bersani, 1985a, 1985b; Nail-Chiwetalu, 1991; Silverman, McNaugton, & Kates, 1978). Blissymbolics is a generative system which allows the user unlimited expression of ideas and accommodates sophisticated language output. In recent years, there has been an explosion of research addressing the "learnability" of Blissymbols. This learnability concept originally developed out of research on iconic aspects of various symbol systems. After several indepth studies, investigators found that translucency (i.e., an obvious relationship between a symbol and its referent when the referent is revealed) has a positive effect on learnability of Blissymbols. In addition, the aspect of symbol "complexity" (the amount of strokes or semantical concepts involved in the symbol) was also found to contribute to the effects of symbol learning. Several researchers undertook investigations which jointly studied the effects of Blissymbol "translucency" and "complexity". No study has yet, however, investigated the power of translucency and complexity on Blissymbol learning for individuals with TBI.

The intention of this research is to examine the effects of high-low translucency and high-low complexity on Blissymbol "learnability" for individuals with closed head injury (CHI). Specifically, the following research questions have been addressed:

1. Does translucency affect associative learning of Blissymbols by individuals who have sustained closed head injury?
2. Does complexity affect associative learning of Blissymbols by individuals who have sustained closed head injury?
3. Does the interaction of translucency and complexity affect associative learning of Blissymbols by individuals who have sustained closed head injury?
4. What is the relationship between cognitive-communication functioning level and/or the severity of injury and the associative learning of Blissymbols by individuals who have sustained closed head injury?

Review Of The Literature

Traumatic brain injury is caused by various types of insults to the head which may include gunshot wounds, traffic accidents, falls, assaults, and blows to the head. These brain traumas are most often divided into two categories, closed and open head injuries. Open head injuries are associated with penetration of the cortex by foreign matter resulting in focal damage of the brain. Nonpenetrating injuries which usually result in cerebral dysfunction are classified as closed head injuries (CHI). These two types of brain trauma have different implications in both symptomatology and sequelae. Open head injuries, typically unilateral, often yield idiosyncractic symptoms due to the size and location of the penetrated area of the brain (Grafman & Salazar, 1987). More diffuse deficits are frequently associated with CHI due to the brain being bilaterally insulted (Grafman & Salazar, 1987). Commonly, the term "traumatic brain injury" (TBI) encompasses both closed head injury (CHI) and open head injury. Earlier investigations of TBI often did not distinguish between the two. Therefore the assumption is that when the term TBI is used the reference is made to both types of brain injury. However, closed head injury will be the focus of this study and literature review. This literature review will: (a) summarize issues related to CHI and its stages of recovery,

(b) address issues related to augmentative and alternative communication, and (c) highlight the relationship between CHI and AAC.

Closed Head Injury

When consciousness is lost after a severe blow to the head, all faculties of cognitive function may be suspended or paralyzed. The period of coma is assessed to evaluate its depth and duration. The Glasgow Coma Scale (GCS) is commonly utilized during the acute early stages by medical professionals to determine the severity of injury (Teasdale and Jennett, 1974). The scale assesses three types of behaviors - eye opening, motor ability, and verbal response. Each behavior is rated according to the GCS via a numerical score which yields a total sum ranging from 3 to 15. Coma is defined by a GCS score of 8 or less and is indicated by a patient's inability to open the eyes, follow a command, or verbalize. A score of 9 or more is a rough indicator of coma termination. While the GSC cannot predict the level of outcome, it does have predictive value regarding survival rate, with higher scores indicating higher chances of survival (Baxter, Cohen, & Ylvisaker, 1985; Bigler, 1990; Bond, 1983; Eisenberg & Weiner, 1987; Teasdale and Jennett, 1974; Rosen, 1986).

Once a patient emerges from coma, impaired memory, motor difficulties, inhibited cognitive-communication skills, confusion, and cognitive disorganization are but a few of the multiple problems that may exist (Schwartz-Cowley & Gruen, 1986; Schwartz-Cowley & Stepanik, 1989). Currently, there is considerable literature disagreement pertaining to the cognitive deficits and disordered communication skills evidenced by persons with CHI. Perhaps this is due, at least in part, to the numerous deficits that occur at various stages of recovery. Schwartz-Cowley and Stepanik (1989) have also suggested that terminology confusion is embedded in ambiguous vocabulary; the descriptors of cognitive and linguistic behaviors are not always defined in the same manner by professionals in the CHI field. More specifically, the terminology used to refer to the language deficits of persons with CHI are commonly aphasia related. However, research demonstrates that only a small percentage of persons with CHI display true symptoms of aphasia (Beukelman & Miranda, 1992; Heilman, Safran, & Geschwind, 1971; Jordan, Ozanne, & Murdoch, 1988; Ladtkow & Culp, 1992; Sarno, Buonaguro, & Levita, 1986). The communication deficits among persons with CHI should be referred to as residual, since they result from ineffective cognitive functions typically associated with neurological damage. These deficits differ from aphasia symptomatology and are referred to in the literature as cognitive-communication deficits. Consequently, different approaches to classifying and describing communication deficits for the population of CHI are necessary in order to guide proper remediation processes.

Studies pertaining to the extent of aphasia found in the population of individuals with closed head injuries varies in percentage from a low of 2.4% to a high of 28%. Stepanik and Roth (1985), in a two year study of head injury in the rehabilitation unit of a hospital, found an 18% to 28% incidence level of aphasia. Sarno, Buonaguro, and Levita (1986) noted a 28% aphasia incidence among patients at approximately 45 weeks post-injury. However, a mere 2% incidence of "classic aphasia" among CHI was reported by Heilman, Safran, and Geschwind in 1971. The MIEMSS Shock Trauma Center and Montebello Rehabilitation Hospital in Baltimore compiled statistics on 614 patients with CHI and related a similar 2.4 % incidence of classic aphasia. Jordan, Ozanne, and Murdoch (1988), using a comprehensive profile of communication disorders in subjects with CHI, found that 20% of subjects scored well within normal limits on the authors' Neurosensory Center Comprehensive Examination for Aphasia. However, The Boston Naming Test did reveal deficits in patients' naming abilities, deficits possibly related to word retrieval problems separate from aphasia implications. Therefore, one might conclude that aphasia is a separate disorder that only a small percentage of the individuals with CHI display in their symptomatologies.

Stages of Cognitive-Communication Behavioral Recovery

The rate of cognitive-communication recovery can dramatically differ among patients with CHI. However, three general phases of cognitive-communication recovery experienced by every patient during rehabilitation are well recognized in the literature. Szekeres, Ylvisaker, and Holland (1985) define these stages of recovery as the "early", "middle", and "late" phases (Beukelman & Mirenda, 1992; Ladtkow & Culp, 1992). Remediation efforts during the early phase focus on sensory and sensorimotor stimulation to increase patient arousal to the environment. Middle phase intervention focuses on attempting to minimize confusion by utilizing highly structured environmental compensations. Retraining of cognitive-communication is initiated to gradually develop more appropriate cognitive and behavioral adaptations. Developing appropriate and functional pragmatic skills to facilitate daily activities is the focus of the late stage with the ideal goal being community re-entry.

Hagen, Malkmus, & Durham (1979) created The Rancho Los Amigos Scale Levels of Cognitive Functioning (RLAS) which charts patterns of behavioral change noted across eight behavioral response levels. This descriptive device, widely used with adolescents and adults, was intended to be utilized by all disciplines working with individuals who have sustained TBI/CHI. Hagen et al., (1979) developed this scale in order to create a descriptive picture of behavioral changes and an estimation of the level of cognitive function through systematic observation, while also providing assistance in identifying appropriate treatment approaches. A summary of the RLAS is presented in Appendix H.

Cognitive-Communication Deficits Associated with CHI

Three general aspects of cognitive-communicative functioning which are typically targeted during rehabilitation related to CHI are component processes, component systems, and functional-integrative performances. These aspects, as outlined by Szekeres, Ylvisaker, and Holland (1985) and Ladtkow and Culp (1992), provide a conceptual framework of abilities and disabilities during each CHI phase of recovery. Component processes include the typical pattern of change in the behaviors of attention, perception, memory/learning, organization reasoning, and problem solving/judgment. Component systems, on the other hand, include behaviors of the working memory, long-term memory, response system, and executive system. Functional-integrative performance includes pragmatic behavior (DeRuyter & Kennedy, 1991; Kuck & Ruff, 1990).

Visual scanning, visuoperception, and visuospatial problem solving deficits may contribute to learning difficulties during the remediation process (Conder et al., 1988; Klonoff & O'Brien, 1989). For the purposes of this study, the aspects of cognition and recovery that will be examined are memory and learning.

Memory/memory deficits.

Parente and Anderson-Parente (1989) and Braddeley (1984) have developed a model of memory to which memory deficit in persons with CHI can be applied. The human memory is a complex system made up of several interlinking memory subsystems. In order to simplify this complex system, three components of memory come into play (Braddeley, 1984). The three components are sensory memory, short-term or working memory, and long-term or secondary memory. Sensory memory encompasses sensory information such as visual, auditory, olfactory, and tactile senses which can be stored for short periods (Braddeley, 1984). Short-term or working memory refers to the ability to hold a limited amount of information for a limited time period (Honsinger & Yorkston, 1991). Long-term, or secondary memory, refers to the ability to memorize, store, and retain information over long periods of time. Long-term or secondary memory has the capability to allow storage of many types of information such as occurs in procedural memory. Procedural memory is made up of automatic behavioral sequences, such as motor skills, conditioned response, and/or performances on certain tasks (Honsinger & Yorkston, 1991). Each of these components interact with one another, drawing upon certain procedures such as retrieval (the ability to access the information) and storage (the ability to hold the information).

The components of sensory memory information can be held to be processed by the working memory. This first stage is called information processing and involves holding information for encoding and organization. Information is encoded for storage and retrieval by use of rehearsal. This information is further processed by working memory into units. Most individuals have the capacity to process seven units, plus or minus two. When information in short-term or working memory is acted upon, it is transferred to long-term, where its permanence and availability depends on the strength of the encoding via rehearsal and related reference cues.

Rosen (1986) suggested that the components of memory loss in persons with CHI include impairments of short-term or working memory, long-term or secondary memory, the retrieval process, and the storage process. Several studies involving serial digit span assessment have shown impaired working memory in individuals with CHI within a 24 hour period of injury (Becker, 1975; Mandleberg, 1975, 1976; Mandleberg & Brooks, 1975; Ruesch, 1944). Ruesch (1944) tested the average forward and backward span of 53 individuals with closed head injury and found spans of 5.8 and 3.6 respectively, within 24 hours of trauma center admission. Re-examination of the patients four to twelve weeks post-injury revealed forward spans of 6.2 and backward of 4.0. Foder (1972) replicated the study and found relatively unimpaired, stable immediate recall within 24 hours post-injury. Similarly, Croholm and Jonsson (1957) found no significant differences in the digit span of 20 individuals with CHI who were one week post injury and 20 subjects in a control group. Becker's 1975 assessment of patients with mild CHI who were tested shortly after admission and re-examined ten weeks post-injury revealed a significant improvement in digit span. Several other studies support similar findings that indicate digit memory is not an area of great deficit for patients with CHI (Mandleberg, 1975, 1976; Mandleberg & Brooks, 1975).

Learning/learning deficits.

Previous research (Braddeley, 1984; Honsigner & Yorkston, 1991; Levin & Grossman, 1976; Parente' &

Anderson-Parente', 1989; Schacter & Crovitz, 1977) assumes that learning has a dependent relationship with memory system. The following section will review the literature regarding learning and learning deficits associated with CHI. Learning is the ability to store information successfully in long-term memory using reference cues to ensure retrieval. It appears that information has the potential for being transferred into working memory which is necessary for the performance of cognitive tasks. This process can then be utilized repeatedly.

According to Szekeres, Ylvisaker, and Holland's (1985) description of recovery and Hagen's (1982) description of cognitive functioning levels, new learning is possible in Rancho Los Amigo Levels of Cognitive Functioning VII/VIII. This period is equivalent to the late stages of recovery. Storage-retrieval tasks have been utilized to explore memory deficits which may hinder new learning. Levin and Peters (1976), for example, assessed recognition memory for nouns through the presentation of word lists. A single patient with CHI, one year post-injury, was compared to six control subjects. In an immediate recall condition, the patient with CHI performed errorlessly, while the controls were 95% accurate. However, after a 30 minute delay, the CHI patient's performance decreased to 50%, while the controls' performances only decreased by 10%, suggesting recognition memory deficit was magnified with longer retention. The Levin and Peter's (1976) results should be viewed cautiously for two reasons. First, since the subjects were required to recall the word lists through verbal means, expressive knowledge, as well as recognition memory, was being utilized. Second, groups were not matched in number of subjects nor on other variables to ensure reliability.

Brooks (1972) similarly examined recall for both verbal and visual materials using an immediate and 30 minute delay in individuals with CHI compared to control group subjects. Results revealed that the control subjects performed significantly better than the subjects with CHI in both conditions, with the subjects with CHI learning proportionally less than the controls in the delayed condition. Other studies revealed that both visual memory and paired-associative learning tasks proved to be two types of strengths in the learning capabilites in patients with CHI. Hannay, Levin, and Grossman (1979) assessed continuous visual memory in persons with CHI using line drawings in 20 "new" and "old" reappearing drawings. False/errors were infrequent in subjects with CHI and were confined to those with the most severe injuries. In a paired-association task, Tulfing and Pearlstone (1966) verbally presented four pairs of commonly associated words and four pairs of unrelated words to young subjects with normal cognition, participants who were elderly, and individuals with CHI. The young subjects performed significantly better on the paired-associative tasks. However, no differences were found between the participants who were elderly and those with CHI. Clear evidence of "forgetting" the stimuli was noted one week post initial presentation across all groups for both the recognition and recall tasks. There was no evidence indicating a difference in the amount of "forgotten" stimuli between the subject groups.

Augmentative and Alternative Communication Use

The exploration of cognitive-communication, learning, memory, and other typical deficits in persons with CHI have important implications for augmentative and alternative communication (AAC) use in this population. DeRuyter and Kennedy (1991), Beukel and Mirenda (1992) and Ladtkow and Culp (1992) have suggested that cognitive-communication deficits must clearly be identified to determine their influence on AAC system selection and usage. Therefore, the profile and data baseline information regarding persons with CHI who could utilize AAC will be explored.

Initially, most individuals who sustain a severe brain injury experience a nonspeaking transitory period. In Augmentative Communication News, Keenan (1989) reported following 100 patients with traumatic brain injury from admission to discharge. At admission, all the patients were nonspeaking and at discharge half of the patients remained nonspeaking.

Other studies of the population of nonspeaking persons with TBI revealed that 68% have a closed head injury, 22.2% are globally brain injured, and 9.5% have experienced an open head injury (DeRuyter & Lafontaine, 1987; DeRuyter & Kennedy, 1991). Males dominated the nonspeaking population with TBI by comprising 70% of the sample (DeRuyter & Becker, 1988; DeRuyter & Lafontaine, 1987). DeRuyter and Lafontaine (1987) also noted that 84% of the persons who are nonspeaking should be considered permanent augmentative communication users while the remaining 15% might make temporary use of AAC systems and techniques. DeRuyter and Lafontaine (1987) collected data on 63 individuals with TBI who were using augmentative devices. Of this group, approximately 78% were utilizing direct selection with another 15% making use of scanning. The majority of individuals using direct access did so through a finger point (71% to 75%), while others used head or eye movements (28.6%). Approximately 76% of the augmentative devices in use were found to be "simple" while dedicated devices made up only 19%. Of the simple devices, 54% were word communication boards, of those communication boards 35%

used pictures and 11% used alphabet, and the remaining 23% were comprised of other systems. Sharp Memo Writers were the most frequently used dedicated devices. DeRuyter, Lafontaine, and Becker (1988) demonstrated that persons with TBI predominantly use word and alphabet based augmentative systems. DeRuyter, Lafontaine, and Becker also suggested that impairments in auditory comprehension or processing would necessitate the use of systems with very simple language structures to minimize confusion.

The relationship of level of cognitive functioning (RLAS) on the Rancho Los Amigos Scale and augmentative system usage should definitely influence AAC selection. DeRuyter and Kennedy (1991) have suggested that a yes/no system can be used at the RLAS III, the introduction of a communication board can be introduced at RLAS V, and dedicated devices can be introduced at RLAS VI. Still further, multipurpose systems can be implemented at RLAS VII. AAC training with a system is suggested to begin early in rehabilitation in a structured environment (Cope & Hall, 1982; DeRuyter & Kennedy, 1991).

In spite of training, long-term use of AAC devices has not been found; only 56% of augmentative communication users with TBI were found to be actually using their systems one year after discharge, 24% had totally discarded their systems and 20% were utilizing the implemented system only in certain environments (DeRuyter & Kennedy, 1991). For reasons that are unclear, potential AAC users feel dissatisfied with their systems. In review of the minimal amount of information available on augmentative and alternative communication use with individuals with traumatic brain injury, few choices appear to be provided. Blackstone (1989) postulated that service providers specializing in augmentative and alternative communication and serving the CHI population may lack the level of experience necessary to understand the population's complex cognitive-communicative deficits and characteristics. Those specializing in traumatic brain injury may also lack current information about augmentative and alternative communication or fail to recognize the role that they play in facilitating the recovery of speech and communication skills (Blackstone, 1989).

This specialty/lack of specialty issue may account for the lack of research in AAC use in individuals with traumatic brain injury. It may also reflect on the current confusion regarding most appropriate symbol sets or systems. However, Ross (1979) has investigated the implementation of a different symbol set than that which is typically used with persons with TBI. The purpose of his research was to examine the suitability, effects, and problems encountered in the introduction of Blissymbols to one individual who was both nonspeaking and TBI. Auditory attention was assessed as being good. The Minnesota Test of Differential Diagnosis of Aphasia (MTDDA) revealed no evidence of impairment in comprehension of sentences, paragraphs, directions, and serial item identification, and satisfactory performance in reading. Over a four month period, therapy was conducted once or twice per week for 30 to 40 minutes per session. Blissymbol introduction and training began and attention was drawn to features which might aid in association of the symbols with verbal meanings and recall. Location of symbols on a board was then practiced. Finally, symbols were put into simple sentences with known words, followed by the formulation of novel sentences using new symbols. After training, the patient greatly extended her ability to communicate, becoming an effective communicator even to individuals with little knowledge of Blissymbols. Communication speed of whole sentence constructions was noted to steadily increase. She became a topic initiator, asked questions, and expressed her opinions. Six months following the introduction of the Blissymbols, the subject suffered a debilitating illness. One year later, however, she began Blissymbol communication again and retained a functional knowledge of Blissymbols.

Review of Blissymbols

Charles K. Bliss developed an ideographic writing system called Blissymbolics as an attempt to break down international communication barriers. He was inspired by mathematical logic and Chinese pictographic writing. Blissymbolics is a generative system from which any word can be formed. Blissymbolics is a both semantically and conceptually based system which allows the learner to acquire few symbols (approximately 100 basic elements) that exist. Then utilizing variations of size, position, numbers and combinations of symbols, an infinite number of productions and concepts can be created (Archer, 1977; Clark, 1981; Helfman, 1981).

Initially, the Blissymbol system was not widely accepted. In 1971, Shirley McNaughton, of the Ontario Crippled Children Centre in Toronto, discovered Blissymbolics while searching for a more adequate augmentative and alternative communication system for use with children with cognitive impairments (Archer, 1977; Hehner, 1980; Helfman, 1981; Silverman, McNaugton, & Kates, 1978). Use of this symbol system resulted in a significant communication improvement for numerous children once it was adopted by the Centre. In 1975, an organization called the Blissymbolics Communication Institute (presently, The Easter Seal Communication Institute) was formed to train teachers in the application and utilization of Blissymbols. Presently, Blissymbolics is one of the more popular symbol systems utilized by individuals who are nonspeaking (Clark, 1984; Fristoe & Lloyd, 1979; Luftig & Bersani, 1985c). Blissymbols has the potential for use across a broad range of populations who experience difficulty in communicating including those with CHI.

Although there is wide use of Blissymbols with many populations of individuals with severe communication disorders, there is not a wealth of empirical data related to one key aspect of its success, "learnability". Most research regarding learnability is quite recent. Initially, extensive research in Blissymbolics learnability was conducted by examining persons with normal cognitive functioning (Fuller, 1987). Blissymbol learnability by populations with various disabilities has not yet been as thoroughly investigated. The population of individuals with CHI who are nonspeaking has been virtually unstudied in many aspects of AAC, including Blissymbol learnability. Many features of all symbol systems, including Blissymbols, may influence symbol learnability. Some critical variables which have been identified to effect the learning of Blissymbols include iconicity (i.e., transparency and translucency) and complexity. Two aspects of Blissymbol learnability (translucency and complexity) will be addressed in this investigation.

Iconicity Of Blissymbols

Lloyd and Fuller (1990) have defined iconicity as the amount of visual representation a symbol has to its referent. Three aspects of iconicity are represented, with transparency having the most obvious relationship, translucency having some perceived relationship, and opaqueness having no relationship.

Several researchers have found that iconicity is a factor that facilitates the learning of symbol systems like Blissymbols. Fristoe and Lloyd (1977, 1979), for example, demonstrated that visual representation (iconicity) of AAC symbols facilitates learning and memory because of the association in the relationship. They further noted that some symbols were more transparent than others. Studies that followed supported the notion that iconicity was a factor in the initial learning of unaided symbols for persons with cognitive impairments and persons with normal cognitive functioning (Brown, 1977; Griffith, 1980; Griffith & Robinson, 1980). Recently, iconicity research has focused on aided symbol sets/systems such as Blissymbolics.

Transparency.

Some investigations have addressed the transparency aspect of the aided symbol and its relationship to acquisition of a system. Transparency can be defined as the "guessability" of a symbol which depicts the shape, motion, or function of a referent and its meaning when the referent is not present or known (Bellugi & Klima, 1976; Bloomberg, Karlan, & Lloyd, 1990; Brown, 1978; Fristoe & Lloyd, 1978; Lloyd & Fuller, 1990).

Luftig and Bersani (1985a) completed a study in which 95 college student subjects were required to guess, through writing, the meaning of Blissymbols presented to them via videotape. The scoring system used was liberal. The participants' guesses were considered correct when symbols were analyzed in terms of the proportion of times they were guessed correctly by the participants. The authors' suggested that transparency was not an important variable in learning when compared to translucency. Other investigators have supported the contention that translucency has a stronger psycholinguistic attribute in a paired-association learning tasks (pairing a symbol with its meaning) than transparency (Griffith, 1980; Griffith & Robinson, 1980; Yovetich & Young, 1983).

Translucency.

Numerous investigators have directly studied the aspect of translucency in Blissymbols. Translucency is defined as a semantic, conceptual, or linguistic relationship between a symbol and its referent that can be perceived when a meaning is provided (Bloomberg, Karlan, & Lloyd, 1990; Brown, 1977; Lloyd & Fuller, 1990; Lloyd, Loeding, & Doherty, 1985).

Yovetich and Paivio (1980) concluded that translucency (i.e., "representativeness") has a positive effect on paired-associative learning. Yovetich and Lobb (1981) found similar results for subjects who were college students with normal cognition. Bristow and Fristoe (1982) further explored translucency ratings judged by 3 groups of college students. Each group viewed a film that presented Blissymbols in a different fashion. Presenting the rationale behind Blissymbols increased the perceived translucency, as opposed to an explanation of physical similarities between the symbols and their referents.

Luftig and Bersani (1985a) randomly assigned college scholars to a translucency condition where 197 Blissymbols were rated. A seven-point scale was used to rate perceived translucency (i.e., "relatedness") prior to viewing the symbol and its meaning. The mean rating was 3.94, which highly correlated with the Yovetich and Paivio (1980) and Yovetich and Lobb (1981) studies and further supported that translucency is an important factor in paired-association learning tasks. The results of the Lutfig and Bersani study also revealed that no significant difference of rating scores between grammatical word classes of the symbols existed. In the series of investigations on transparency and translucency conducted by Lutfig and Bersani (1985a, 1985b, 1985c), they also examined another feature of symbols that affects learning, complexity. Complexity is a variable that has only recently been investigated.

Complexity of Blissymbols

Lutfig and Bersani (1985a, 1985b) defined component complexity according to the Hehner (1980) definition as the number of concepts, symbols, or components which comprise the symbolic make-up of a given symbol. The Lutfig and Bersani (1985a) study, discussed previously, demonstrated that complexity negatively correlated with translucency. The results led to the hypothesis that with increased complexity, translucency decreases. Lutfig and Bersani (1985a, 1985b) further investigated these effects on the paired-association learning of Blissymbols, predicting another negative correlation between translucency and complexity. Sixty-five college students with normal cognitive functioning were randomly assigned to four different test conditions. The four conditions were High Translucency-Low Complexity (HTLC), High Translucency-High Complexity (HTHC), Low Translucency-High Complexity (LTHC), and Low Translucency-Low Complexity (LTLC). Each symbol appeared on a computer screen for 3 seconds and subjects were required to verbally respond before the symbol's meaning appeared. High translucency symbols had a more positive effect on learning than did low translucency symbol ratings. Lutfig and Bersani also concluded that high complexity inhibited <u>initial</u> Blissymbol learning with its greatest influence being on low translucency symbols. However, a methodological error was found in the Luftig and Bersani study by Fuller (1985) which posed a problem in the interpretation of their results. After further critical review, Fuller noted that several possible conflicting variables existed in defining component complexity.

Fuller and Lloyd (1987) attempted to define these variables that contribute to, or influence, perceived complexity. Thirty-one college students with normal cognitive functioning rated perceived complexity of 100 symbols appearing on one of ten lists. A seven-point scale was utilized with one point corresponding to simple complexity and seven representing high complexity. Nine variables, two semantically based aspects and seven physically based, were investigated. Results revealed that either number of strokes or semantic elements could be utilized in defining complexity when researching Blissymbols. Fuller and Lloyd (1987) concluded that the number of strokes may be more effective in terms of both time and in avoidance of statistical problems in the calculation of elements.

<u>The Role of Translucency and Complexity</u>

The relationship and influence of translucency (high and low) and complexity (high and low) on a paired-associative learning of Blissymbols was re-investigated by Fuller (1987). Fuller compared 13 adults with normal cognitive functioning utilizing a spoken response mode to 12 children with normal cognitive functioning also utilizing a spoken response mode. These two subject groups were, in turn, compared to 12 children with normal cognitive functioning who utilized a pointing response mode. Translucency was defined by the subject ratings outlined by Lloyd and Karlan (1987) while complexity was defined by the number of strokes. Symbols considered to be high in complexity consisted of eight or more strokes with symbols with one to five strokes being considered to be low. Results revealed that high translucency significantly aided the learning of Blissymbols as opposed to low translucency. This was a finding similar to previous results which indicated that among college students more high translucency symbols were learned than low translucency symbols (Lutfig & Bersani, 1985b). Complexity, when isolated, could not be determined due to the lack of statistical significance of Complexity X Group interaction. However, significant statistical evidence showed that high complexity aided learning in low translucency as compared to the low translucency - low complexity.

In Fuller's (1987) statistical analysis of interactions a trend was revealed in which the group containing adults learned more Blissymbols than the groups containing children. Further, a trend in response mode was discovered indicating that learning was facilitated by pointing more than speaking as a response mode.

Overall, the results did not reveal an independent influence of complexity on the learning of Blissymbols. However, the low translucency-high complexity condition did indicate some influence on learning by children with normal cognitive functioning utilizing spoken mode only. Fuller attempted to explain this finding by saying that the systematic combination of recurring elements provided more information than the low translucency-low complexity condition. These results indicated that possibly two features of Blissymbols have an important and positive effect on the learning process. Since the positive influence of translucency is now a well documented fact, this data can be utilized to determine if adult-based values of translucency and complexity can be generalized to various populations. In turn, some insight for generalizing the strength of translucency on Blissymbols and Blissymbol learning with CHI persons can be achieved. The findings from Fuller's (1988) study showing higher qualitative differences in pointing response modes versus spoken provides additional positive implications for individuals with CHI who are nonspeaking.

Comparative Investigations

Comparative studies involving the use of several symbol sets/systems that examine iconicity, transparency, translucency, and/or learning have been conducted.

Iconicity.

AAC symbol research initially focused on comparing the iconicity of several symbol sets/systems and learning. Clark (1981) compared traditional orthography, Blissymbols, Carrier, and Rebus symbols. In this comparison of ease of learning among 36 nonreading children with normal cognitive functioning, a significantly better performance level with the "partial iconic" (Rebus and Blissymbols) than the "noniconic" symbols (Carrier and traditional orthography) was found. Clark (1981) concluded that the more iconic the symbol, the quicker the symbol acquisition. Limitations of this study included the restricted subject group and restricted pool of symbols that were utilized.

The concept of iconicity and learning was studied in adolescents with severe physical impairments. Hurlburt, Iwata, and Green (1982) analyzed Blissymbols and "pictorial language". The comparisons consisted of use and acquisition rates of 20 symbols chosen for each subject. Utilizing alternating training procedures, results showed that a higher percentage of iconic pictures was retained. Blissymbols had to be retrained four times more than its counterpart. During spontaneous use, subjects tended to utilize more iconic picture responses. This study however displayed the same types of limitations as those previously discussed in the Clark (1981) review.

Transparency.

Musselwhite and Ruscello (1984) compared transparency of Blissymbols, Picsyms, and Rebus with four different age groups without disabilities. These were groups of three year olds, six year olds, nine year olds, and eighteen to twenty-one year olds. Forty symbols were targeted in word, phrase, and sentence tasks. Results indicated that as age increased, there was an improvement in performance on all tasks, with the exception of three year olds who performed slightly better than the six years old in Blissymbols. In the overall comparison of the three symbol systems, fewer Blissymbols were identified accurately than Picsyms and Rebus in terms of transparency. One limitation of the investigation was the forced-choice task that was utilized. Also, the small number of symbols used may not have provided a for fair evaluation/comparison of the symbol sets/systems.

Mirenda and Locke (1989) investigated the abilities of 40 individuals with varying types and degrees of handicapping conditions to recognize a symbol without any previous instruction. Ten objects and eleven sets of (noun) symbols, corresponding to the object, were assessed and compared during several tasks. Each symbol set was assessed to incorporate a hierarchy of difficulty. Results were similar to previous findings in that Blissymbols were less transparent than most of the other systems assessed. In fact, Blissymbols and traditional orthography were found to be statistically equivalent. Several limitations again existed, including the use of nouns only, the small pool of symbols utilized, the vast amount of symbol sets that were used, and the nine different types and varying degrees of handicapping conditions represented by the subject pool.

Translucency.

Recently, comparative studies of translucency in symbol sets/systems have been conducted. Bloomberg, Karlan, and Lloyd (1990) investigated the translucent properties of Blissymbols, PCS, PIC, Picsyms, and Rebus symbols. Symbols included representations of nouns, verbs, and other modifiers. Specifically, the relative translucency within the systems and the varying degrees of translucency across word classes within systems were examined. Fifty students with normal cognitive functioning who were naive to the symbol systems participated in rating symbol translucency on a seven-point Likert scale. Fourteen verbs, fifteen nouns, and twelve modifiers were chosen from a pool of common symbols. The most translucent symbol systems/sets were the Rebus and PCS, regardless of word class. Blissymbols scored consistently lower in all word classes. However, a number of the Blissymbols were rated as highly translucent. The authors did not specify the distribution of the degrees mentioned.

Although Blissymbols may appear to be difficult to grasp during initial lexicon learning, a key factor should be considered before abandoning Blissymbols for some other symbol sets. This factor relates to the Blissymbol user's ability to generate novel messages through symbol use. It is important to be aware that symbol sets which may hold higher iconicity properties may become only a collection of symbols. This limitation is important to consider when implementing any "communication system". Having access to a collection of symbols does not provide an effective means by which to generate new ideas or concepts. Blissymbols was developed specifically to be a generative communication system. Among patients who are nonspeaking following CHI, an effective means of generative AAC communication is needed, considering that most of these individuals possess well-established, "crystallized" cognitive abilities (Cullum, Kuck, & Ruff, 1990). Thus, there is a demonstrated need to investigate learnability of Blissymbols among persons who sustain CHI so that appropriate system selections can be made.

Purpose

The purpose of this study was to determine the effects of translucency and complexity on paired-associative learning of Blissymbols through a pointing response mode by individuals with CHI. The results were compared to the outcome of Fuller's (1987) investigation regarding children and adults with normal cognitive functioning and subsequent similar studies executed by Smith (1991) and Nail-Chiwetula (1991). The investigation examined different levels of cognition and phases of recovery as outlined by Rancho Los Amigo Levels of Cognitive Functioning.

Methodology

Pilot

A pilot study was conducted to gain information on the visual scanning ability of one individual with CHI and to assist in decision making related to material preparation. Four different Blissymbol boards which contained the symbols to be utilized in the main study were used. Each contained varying number of symbols. Four different boards were constructed as follows: (1) a 15 x 12 inch posterboard divided into twenty locations creating five rows by four columns; (2) a 6 x 15 inch board divided into ten locations creating two rows by five columns; (3) a 6 x 12 inch board divided into six locations creating two rows by three columns; and (4) a 6 x 6 inch board divided into four locations creating two rows by two columns. The individual who participated in the pilot met all the criteria outlined in the primary investigation and was functioning at a Level VII on the RLAS.

The study's planned procedure was followed to allow observation of the subject's visual scanning behaviors of the four pilot boards and to determine to what degree, if any, fatigue played a role in the amount of boards used during each trial. Four trials were conducted within one session, and the amount of overall correct responses versus the amount of attempted responses was calculated for each board. It was evident that the board containing the smaller amount of symbols was easier to visually scan than the other boards. The subject's highest score was attained on the board containing six symbols. The subject also demonstrated the ability to cope with several boards within a given trial.

After consultation with five certified speech-language pathologists with experience in either TBI or AAC, the investigator determined that eight symbols per board should be used in the investigation to promote ease of subject visual scanning and to control for fatigue related to the amount of boards scanned within one trial. The cognitive-communicative functioning of RLAS III to VIII was considered when making final board design decisions. Data collected during the pilot study was not statistically analyzed with that obtained in the primary investigation.

<u>Subjects</u>

The pool of potential subjects was sought from communicative disorders program directors at a number of acute, post-acute, and rehabilitation centers in the mid-western states of Illinois and Michigan. Directors at sixteen facilities received a summary of the proposed research. (See Appendices I & J.) Four of the sixteen facilities were able to provide potential subjects. The remaining facilities did not participate due to the inability to provide access to subjects or to inability to locate subjects who met participant requirements.

From the potential subject pool, 17 individuals with CHI who met all participant criteria were selected. All subjects had ratings of III to VIII on the Rancho Los Amigos Scale of Cognitive Functioning Levels. Subjects were assigned to groups according to their level of cognitive-communicative functioning. Group One consisted of six participants (two females, four males) functioning at Level III or IV. Six subjects (three females, three males) functioning at Level V or VI comprised Group Two, and five subjects (one female, four males) functioning at Level VII or VIII served as Group Three. Of these 17 subjects who initiated the study participation, a total of eight withdrew participation during various stages of research completion. One subject at Level V/VI was too young (age 14), and one subject at Level V/VI withdrew participation. Five subjects at Level III/IV discontinued due to one or more of the following reasons: (1) investigator inability to determine subject responses due to inconsistency in subject pointing and/or eye gaze; (2) significant subject latency of response (i.e., greater than 25 seconds per response) which interfered with overall task completion; (3) subject agitation which interfered with overall task completion; (4) subject inattentiveness to the task leading to randomized pointing; and/or (5) subject medical instability disallowing participation.

Data collected from Group One (Level III/IV) consisted of task-completed responses from only one participant; the five additional Group One subjects discontinued at various stages of study completion. This single Group One subject's responses were not utilized in statistical analyses due to sample size incomparability to the other two groups. It was also noted that this subject's responses appeared to be random points to symbols. Responses from a total of nine subjects, four in Group Two (Level IV/V) and five in Group Three (Level VII/VIII), were utilized in the data analyses. Nine represents a substantial reduction of the intended _n_ of 20. The smaller _n_ related to an inability to gain access to facilities, acquire subjects, and/or utilize data within the study's timeline.

Ten of the original seventeen subjects attended rehabilitation programs, while the remaining seven resided in acute/post-acute care hospitals in the mid-western states of Illinois and Michigan. All subjects were screened for (1) visual deficits; (2) hearing deficits; (3) English as their primary language; (4) naivety to Blissymbols; (5) absence of aphasia; and (6) absence of pharmaceutical substance including neuroleptics which influence cognitive-communicative behaviors and levels of awareness. (Appendix I).

Procedures

The majority of participant criterion information was obtained through the subjects, family members, medical reports, and/or the medical staff and professionals who managed the subject's rehabilitation programming. Family members completed a brief questionnaire (Appendix B) in order to provide information regarding the potential participant's possible prior exposure to Blissymbols. A member of the rehabilitation team at each facility was also supplied with a short questionnaire (Appendix B) which elicited the remaining information/criteria.

The visual discrimination task (Appendix D) which was utilized by Fuller (1987) was administered to each subject. Blissymbols which were unrelated to the investigation appeared on fifteen cards with each card comprising four grids. The grid on the left contained the targeted Blissymbol with its matched equivalent randomly appearing among two foils in the remaining three grids. Twelve correct matches of the fifteen presented trials were required to pass the visual discrimination screening.

Forty Blissymbols from the Fuller (1987) study were utilized in order to maintain symbol consistency and to enable data comparison. An equal number of symbols from the categories of high translucency-high complexity (HTHC), high translucency-low complexity (HTLC), low translucency-high complexity (LTHC), and low translucency-low complexity (LTLC) were used. Translucency and complexity values were the same as those determined by Fuller (1987). Low translucent symbols had values of 1.00 to 2.75 and the values of 4.50 to 7.00 defined symbols as highly translucent. Number of strokes determined the value of complexity. Those symbols comprised of one to five strokes were defined as having low complexity while high complexity was determined by eight or more strokes. Each of the categories contained a total of ten symbols. All forty of the symbols were assigned to the same categories as those determined by the Fuller (1987) study. (See Appendix E.) The functionality and appropriateness of the stimuli had previous proven validity for this line of research (Fuller, 1987; Nail-Chiwetula, 1990; Smith, 1992). Five 6 x 12 posterboards were utilized with each board being divided into eight locations, creating two rows by four columns. Each location contained a 3 x 3 inch symbol which was randomly assigned to a location, a practice consistent with that in the Fuller (1987) study.

Each subject was trained independently in a paired-associative learning paradigm using the Fuller (1988) procedure. A standard set of instructions was provided to every subject participating in the investigation. (See Appendix F.)

After the examiner pointed to and labeled each Blissymbol separately on posterboards, the participant was required to point to the appropriate location for each verbally named symbol. A correct response generated a verbal acknowledgment (e.g., "Good" or "Correct"). The correct symbol was identified with a verbal repetition when a response was inaccurate.

The investigation was conducted in two sessions across a twenty-four hour period. Four learning trials comprised the initial session. The initial session lasted approximately 30 to 40 minutes. To test retention of the symbols learned, the investigator returned the next day to repeat one trial.

An accurate pointing or eye gaze response was accepted as correct. The investigator recorded responses, 1 for correct responses and 0 for incorrect/absent responses, on the trial sheet. The total number of accurate responses within each category was calculated generating four scores with the maximum score per category being 10.

Research Design

The primary independent variables were high and low translucency and high and low complexity, while the secondary independent variable was that of level of cognitive functioning. The dependent variable was the number of correct pointing responses.

The research design was a within 2 (Groups) X 2 (Levels of Translucency) X 2 (Levels of Complexity) X 5 (Trials) Factorial Design. The two groups were a between-subjects factor comparing different levels of cognitive functioning; the remainder were within-subject factors.

Reliability

Interjudge reliability was established by a second observer, a certified speech-language pathologist, also scoring the task during administration of the procedures on 20% of the randomly selected subjects from each of the two groups. Interjudge reliability was 80%.

Data Analysis

The raw scores for subjects were utilized in a 2 (Groups) X 2 (Translucency) X 2 (Complexity) X 5 (Trials) analysis that determined the significant effects and interactions. The mean scores were calculated for use in data analyses.

Results

The purpose of this investigation was to examine Blissymbol learnability of individuals with CHI. A paired-associative learning paradigm was used. The primary independent variables were translucency and complexity while the secondary independent variable was the level of cognitive functioning. The dependent variable was the number of correct responses on the Blissymbol pointing task. The specific research questions were:

1. Does translucency affect associative learning of Blissymbols by individuals who have sustained closed head injury?
2. Does complexity affect associative learning of Blissymbols by individuals who have sustained closed head injury?
3. Does the interaction of translucency and complexity affect associative learning of Blissymbols by individuals who have sustained closed head injury?
4. What is the relationship between cognitive-communication functioning level and/or the severity of injury and the associative learning of Blissymbols by individuals who have sustained closed head injury?

The two conditions of translucency and complexity were within-subjects variables while the group condition was a between-subjects variable. Table 1 displays the mean and the standard deviation for each condition (HTHC, HTLC, LTHC, LTLC) for each of the four learning trials and the one retention trial, as well as the mean of means for the summed learning blocks, 1-4, for all subjects (Group Two plus Group Three). Table 2 and Table 3 present similar information for Group Two (Level V/VI) and Group Three (Level VII/VIII) respectively.

Insert Table 1, 2, and 3 here

Translucency

Evidence relating to the first research question, "Does translucency affect associative learning of Blissymbols by individuals who have sustained closed head injury?", was achieved by completing a multivariate analysis of variance (MANOVA). This analysis revealed a highly significant main effect for the variable of translucency ($F = 51.04$; $p < 0.001$). The group by translucency interaction was not significant. This finding reveals that regardless of the level of cognitive-communicative functioning the main effect of translucency held. A second MANOVA was computed for the total population of the Combined Subjects for the variable of translucency. This MANOVA also revealed a highly significant main effect for translucency [F = 59.08; p < 0.001). For both the learning trials and the retention trial, more high translucency Blissymbols were acquired and retained than low translucency symbols. Table 4 and Table 5 display these MANOVAs.

Insert Table 4 and 5 here

The effect of translucency on Blissymbol learning is also evident upon visual examination of data displayed in Figure 1 which shows the combined learning trial means for symbols learned for translucency by complexity, and in Figure 2 which displays similar information for retention. This graphed data, just as that in the MANOVAs, clearly indicates that translucency has a powerful effect on both the learning and retention of Blissymbols by individuals who have sustained closed head injuries. More high translucency symbols are learned and retained than low translucency symbols.

Complexity

The second research question examined the affects of complexity on paired-associative learning of Blissymbols. This question was studied by utilizing a multivariate analysis of variance (MANOVA). There was no significant main effect for the complexity condition [F = 2.05; p > 0.001]. The group by complexity interaction was also not significant. The variable of complexity was analyzed a second time for Combined Subjects. This MANOVA again yielded no significant main effect [$F = 2.22$; $p > 0.001$] for complexity. Neither the learning nor retention trial was significantly affected by complexity, nor was there a group by complexity interaction. Table 6 and Table 7 illustrate these MANOVAs.

Insert Tables 6 and 7 here

Visual examination of Figure 1 and Figure 2 reveals evidence of the no significant effects for the complexity variable on the learnability of Blissymbols in both the combined learning trials and the retention trial. For both the graphs and the MANOVAs, no significance for the variable of complexity was indicated.

Translucency X Complexity

The third research question was "Does the translucency by complexity interaction affect associative learning of Blissymbols by individuals who have sustained CHI?". No significant translucency by complexity interactions were reflected in the results of a MANOVA [$F = 1.52$; $p > 0.001$], nor group by translucency by complexity analyses. The data was further analyzed for the translucency by complexity interaction variable for Combined Subjects and yielded no statistical significance for either the learning trials or the retention trials [$F = 1.67$; $p > 0.001$]. These MANOVAs are exhibited in Table 8 and Table 9.

Insert Table 8 and 9 here

Again visual inspection of Figure 1 and Figure 2, reflects the relationship of translucency by complexity for the learning trials and the retention trials. This visual examination indicates the power of translucency on Blissymbol learning but does not reveal significance for complexity, nor translucency by complexity.

Groups

The final research question was, "What is the relationship between cognitive-communication functioning level and/or the severity of injury and the associative learning of Blissymbols by individuals who have sustained closed head injury?". No significant difference was found between Group Two and Group Three [$F = 2.22$; $p > 0.001$]. Variability in the performance of one individual in Group Two and one individual in Group Three, along with the study's small _n_ may have influenced lack of statistical significance for group comparisons. See Table 10.

Insert Table 10

Visual examination of Figure 1 and Figure 2 indicates a group difference in the amount of symbols learned for both combined learning trials and retention trials. Graphed data indicates a trend for Group Three subjects to learn more symbols than Group Two subjects, but the MANOVAs revealed that the differences were not statistically significant.

To further examine the ability of individuals with CHI to learn and retain Blissymbols, a multivariate analysis of variance (MANOVA) was computed for the Combined Subjects across the five trials (four learning and one retention). Trial effects reached statistical significance [$F = 7.96$; $p < 0.001$] for the within-subject effect analysis (Table 11). A second MANOVA was performed for the total population of the Combined Subjects; this analysis also revealed a significant effect [$F = 8.04$; $p < 0.001$] across trials (Table 12).

Insert Tables 11 and 12

The effects of trials on learnability are further illustrated by examining Figure 3 which plots the means of symbols correct by conditions across trials for the Combined Group (Group Two and Group Three), in Figure 4 which indicates the means of symbols correct by conditions across trials for Group Two (Level V/VI), and in Figure 5 which displays the means of symbols correct by conditions across trials for Group Three (Level VII/VIII).

Since a main effect existed for the trials factor, the simple effects were analyzed by applying a post hoc analysis of Tukey's Honestly Significant Difference Test (Shearer, 1982). Results of the pairwise comparison indicated that the mean of Trial One was significantly less than the means of Trial Three, Trial Four, and Trial Five [$p < .01$]. Another significant difference was revealed as the mean for Trial Two was significantly lower than the means of Trial Three, Trial Four, and Trial Five [$p < .05$]. Further post hoc analysis, Scheffe test, was applied to examine the most prominent significant differences. This non-pairwise comparison revealed that the means of Trials One and Two were significantly lower than Trial Three, Trial Four, and Trial Five. These post hoc analyses, of both a pairwise and non-pairwise nature, clearly illustrate a learning effect which occurs after Trial Two and is then maintained across the remaining trials. Post hoc analyses results support the graphed data which indicate an upward learning curve for each group (Group Two, Group Three, and Combined Groups).

Discussion

The purpose of this study was to examine the effects of the features of high-low translucency and high-low complexity on the "learnability" of Blissymbols by individuals with closed head injury (CHI). When an AAC approach is chosen, symbol learning becomes a significant area of concern (Brown, 1977; Bloomberg, Karlan, & Lloyd, 1990; Clark, 1981; Fristoe & Lloyd, 1977, 1979; Griffith, 1980; Griffith & Robinson, 1980; Hurlburt, Iwata, & Green, 1982; Luftig & Bersani, 1985b; Musselwhite & Ruscello, 1984), since symbol learning directly impacts on system use. Another purpose of this study was to investigate the relationship between learnability, both quantitatively and qualitatively, and the level of cognitive-communication. The issue of when to introduce symbol systems in the CHI rehabilitative process continues to be a critical one (Beukelman & Mirenda, 1992; Ladtkow & Culp, 1992).

Translucency

This study continues to support the observation that translucency influences Blissymbol learnability (Fuller, 1987; Nail-Chiwetula, 1991; Smith 1990). Translucency positively impacted on symbol learning by this study's CHI population. The feature of high translucency positively affected learning in both the learning trials and retention trial. A quantitative translucency difference of symbols learned and retained existed. That is, a larger amount of high translucency symbols were learned than low translucency symbols. This finding remains consistent with the results of previous studies (Fuller, 1987; Luftig & Bersani, 1985b; Nail-Chiwetalu, 1991; Smith, 1990). The consistency of findings that translucency has a main effect on Blissymbol learning would suggest that the translucency of symbols should, indeed, influence choices of which symbols to introduce for initial learning for various populations of potential AAC clients.

Complexity

The influence of complexity on Blissymbol learnability is still unclear. No significance was found during this study's analyses to indicate that the feature of complexity influences learning when examined as a separate entity. That is, a main effect for complexity did not exist in this study. This finding differs from the findings of the Fuller (1987) study on children with no cognitive impairments and the Nail-Chiwetalu (1991) study on children with cognitive impairments but is consistent with the results of the Smith (1990) study. Complexity alone, then, may or may not play heavily into decisions of initial symbol introduction, since it is still unclear whether more complex or less complex symbols are most easily learned and retained by specific populations.

Translucency X Complexity

When examining this study's interaction between the two features, translucency and complexity, complexity did not facilitate learning in any of the four conditions. No significant data was obtain to support any interactive effects. This finding is not similar to the results of either the Fuller (1987) or Nail-Chiwetalu (1991) study. Results of the Smith (1990) study suggested that high complexity influenced learning in the high translucency learning condition, but the overall translucency by complexity interaction was not significant.

When discussing the differences in the influences of complexity and the interaction of translucency and complexity among the Fuller (1987), Nail-Chiwetalu (1991), Smith (1990), and the present study, two variables should be considered. First, each of the studies contained certain methodological differences and, second, each contained population differences. Although the first of these variables slightly diminishs the strength of a line of replicative studies, the second is usually expected, and, indeed, planned for, to test the generalizability of previous findings with new populations. Methodological adaptations are often essential as population changes occur in that each population is idiosyncratic. Similarly certain adjustments become essential in clinical issues of symbol learning to accommodate for individual client-centered variables such as communicative skills/deficits, age, intelligence, and physical ability. It should be noted that the 40 symbols and task procedures used in this study were consistent with those utilized by Fuller (1987), Nail-Chiwetalu (1991), and Smith (1990). The only true methodological variations had to do with the arrangement of the 40 symbols on the five stimulus boards and the study's small n.

Levels of cognitive-communication

An individual's level of cognitive-communication, as suggested by literature (Buekelman & Mirenda, 1992; Ladtkow & Culp, 1992; Szekeres, Ylvisaker, & Holland, 1985), is clearly related to learning in terms of a quantitative measure. This is evidenced by the graphs presented in Figure 1, Figure 2, and Figure 6. Overall, individuals comprising Group Three (Level VII/VIII) learned more symbols than Group Two (Level V/VI) in each symbol condition. The lack of statistical significance for group differences may have been influenced by the small n of the two groups. Both groups contained one subject whose performance was considerably different than others in the group.

Of extreme clinical relevance is the apparent similarity in quality of learning between the groups. Both groups clearly exhibited similar new learning of symbols from the four symbol conditions and similar stability in retention. This is illustrated in Figure 3, Figure 4, and Figure 5. Additionally, both groups had retention scores that were equivalent to or higher than their combined learning trial scores. Since all subjects from both groups were documented to be naive to Blissymbols, this learning and retention appears to be of new material. Study results, then, seem to shed some doubt on previous reports that individuals with CHI cannot participate in new learning until they reach Level VII/VIII. In this Blissymbol study, new learning was demonstrated by Level V/VI subjects. Ladtkow and Culp (1992) have suggested that the AAC devices which are offered to patients in mid-level recovery stages should be centered around symbol sets to which individuals might likely have had previous exposure (e.g., pictures, words, or alphabet sets). While an alphabet set has a generative component, other symbol choices suggested in this cluster seem to offer only closed set options. Blissymbols, on the other hand, offer generative components.

Other Variables

Naturally other variables may influence symbol learnability by individuals with CHI. Included in these are onset and severity of injury, duration of coma, duration of hospitalization, duration of rehabilitation, type and frequency of services received, chronological age, race/ethnic background, occupation, educational level, and/or other premorbid factors. The heterogeneous nature of this population must be considered as it relates to learnability of any graphic symbol system.

Symbol variables.

Two factors that could potentially have influenced learnability of the symbols in this and similar studies were previously suggested by Fuller (1987). The first is related to the presence or absence of recurrent morphological features within symbols. Symbols in the low translucency-high complexity group were found to contain more recurrent elements (or recurrent morphemes) than those in the low translucency-low complexity group. In the absence or reduction of visual relationship between a symbol and its referent when the referent is established (i.e., in low translucency conditions) recurring morophological features were postulated to facilitate the learning process. This speculated influence was not found to be statistically significant for this study with individuals with CHI.

The second factor potentially impacting on Blissymbol learnability has been suggested to be that of visual salience (Fuller, 1987). In addition to possibly having more recurring morphemes, low translucency-high complexity symbols, by nature of their definition, seem to supply more visual stimulation than those which are low translucency-low complexity. This visual saliency may elicit more subject desire to learn high complexity symbols. Results of the present study leave uncertain the role of complexity in the shaping of Blissymbol learning.

Referent variables.

Fuller (1987) also examined possible referent variables that may influence the ease of LTHC over LTLC learnability. He found that when comparing the forty symbols, each symbol group contained the same approximate amount of nouns and verbs. It would appear then that language form did not have a learnability influence on the forty symbols used in this and the Fuller (1987) study. However, the LTHC symbols simply may have contained what might be judged to be more interesting semantic meanings (e.g., birthday, coke, cookie) than the LTLC group (e.g., grass, off, head). This semantic interest did not appear to influence learning for subjects in the present investigation.

Indications for Application of Blissymbols

The results of this study offer some direction for AAC intervention for individuals with CHI. In a very recent CHI sourcebook (Ladtkow & Culp, 1992), specific devices and symbol systems or sets are identified to be utilized the CHI population. Blissymbols is not mentioned as a symbol system of choice. As this study indicates, individuals with CHI (Level V-VIII) are able to learn this graphic system by utilizing a paired-associative task. Blissymbols may be a valid system of consideration when implementing AAC with the CHI population. Blissymbols possess a generative quality as opposed to other graphic symbol sets. Ease of initial symbol acquisition of highly translucent symbols, along with the facilitative factor of increased speed of communication (Ross, 1979), makes Blissymbols a viable choice.

Ladtkow and Culp (1992) have indicated that with patients in the early stage of recovery (Level I-III), AAC techniques may not be utilized for traditional AAC purposes. During this stage, the main focus of symbol use intervention typically surrounds establishing a consistent response, acquiring ability to follow one-step commands, establishment of reliable yes/no, and differentiation between objects (Beukelman & Mirenda, 1992; Ladtkow & Culp, 1992). Blissymbols may work as well as any symbol system during this early recovery stage, and may give the patient an initial exposure to Blissymbols for later Blissymbol skill building.

Ladtkow and Culp (1992) have indicated that while in the middle recovery stage (Level IV-V) the patient with CHI who is still functionally nonspeaking may utilize AAC as a purposeful mode of communication, as intended. Blissymbols may be implemented into the overall treatment plan for patients in the midstage of recovery. Results of the present study have suggested that translucency may facilitate initial symbol acquisition for patients at both mid- and high stages of recovery.

Regarding the late stage of recovery (Level VI-VIII), Ladtkow and Culp (1992) have suggested that high-technology AAC techniques may be used. The patient who is in the late recovery stage and functionally nonspeaking has good potential for becoming a more sophisticated AAC user. Blissymbols, it would seem, may be utilized as a primary communication mode, may be integrated with other systems, or may be used to facilitate repairs of communication breakdowns that occur in other modes.

Limitations of the study

One limitation of this study is the generalizability of the paired-associative learning paradigm to real life learning situations. In reality, there are several ways in which to learn, including categorization and sequencing. The paired-associative task may not facilitate optimal learning for all individuals with CHI.

The amount of Blissymbols used in the study may be a limitation for actual use with the individuals with CHI. Forty symbols may be too large an amount for individuals with CHI functioning at Levels III/IV but may be too small an amount for individuals with CHI functioning at Levels VII/VIII.

This research is limited in generalizability of results to the CHI population as a whole due to the small n and the investigator's inability to obtain all the pertinent demographic information (e.g., patient age, educational level, onset of CHI). Results of this research with adults may also not be generalized to adolescents or pediatrics with CHI. It is unknown whether these younger groups possess similar Blissymbol learnabilities.

Another limitation of this research may be the methodological alterations made in order to adapt to the population, as discussed in chapter three. Procedures utilized in this research (i.e., presentation of eight symbols on each of five boards) more closely assimilate those of Smith (1990) and of Nail-Chiwetalu (1991) than those of Fuller (1987), who used 40 symbols on each board. However, it is important to alter the methods to accommodate population idiosyncraticies, as discussed previously.

Future studies

One direction that could be taken in subsequent similar research is to replicate the study with a larger n, as well as with adolescents and/or pediatrics who have sustained CHI, or with other related populations (e.g., those who have sustained open head injury). Further, research could investigate the learnability of Blissymbols with individuals functioning at Level III/IV by utilizing a smaller amount of symbols.

Other avenues of research that could be taken with the CHI population in the area of AAC might include examining the size, positioning, style, and/or amount of stimulus materials containing Blissymbols and different types of graphic symbol sets presented to various Level of TBI population. Information gained in such research would facilitate comparison of different symbol sets and could lead to comparison of varying symbol systems tied to types of AAC devices (e.g., low to high technologies).

Future research to further investigate symbol and referent variables that may positively or negatively influence symbol learning is warranted. This information would be valuable for facilitating learning and teaching techniques of symbol systems/sets.

Table 1. Means and Standard Deviations for Learning and Retention by Condition Across Blocks for Combined Groups, Group Two and Group Three (N=9)*

BLOCKS	LOW TRANSLUCENCY		HIGH TRANSLUCENCY		MEAN
	LOW COMP	HI COMP	LOW COMP	HI COMP	
1	$\bar{X}$= 4.444 SD= 2.007	$\bar{X}$= 4.444 SD= 2.242	$\bar{X}$=7.778 SD=1.986	$\bar{X}$=7.444 SD=2.242	$\bar{X}$=6.02
2	$\bar{X}$= 3.778 SD= 2.489	$\bar{X}$= 5.222 SD= 2.774	$\bar{X}$=7.889 SD= 2.028	$\bar{X}$=8.333 SD=1.658	$\bar{X}$=6.30
3	$\bar{X}$= 4.667 SD= 2.179	$\bar{X}$= 5.667 SD= 2.345	$\bar{X}$= 8.889 SD=1.9652..	$\bar{X}$=8.333 SD=2.291	$\bar{X}$=6.389
4	$\bar{X}$= 5.333 SD= 2.915	$\bar{X}$= 6.111 SD= 2.261	$\bar{X}$=8.389 SD= 1.537	$\bar{X}$=8.667 SD=2.291	$\bar{X}$=7.25
Mean	$\bar{X}$= 4.56	$\bar{X}$= 5.44	$\bar{X}$= 8.31	$\bar{X}$=8.17	$\bar{X}$=6.62
R	$\bar{X}$= 5.556 SD= 2.555	$\bar{X}$= 5.333 SD= 2.646	$\bar{X}$= 8.222 SD= 1.641	$\bar{X}$=8.444 SD=1.667	$\bar{X}$=6.388

* The maximum score for each block by condition is 10.

Table 2. Means and Standard Deviations for Learning and Retention by Condition Across Blocks For Group Two (N= 4)*

BLOCKS	LOW TRANSLUCENCY		HIGH TRANSLUCENCY		MEAN
	LOW COMP	HI COMP	LOW COMP	HI COMP	
1	$\bar{X}$=3.750 SD=2.217	$\bar{X}$=4.250 SD=2.754	$\bar{X}$= 7.000 SD= 2.449	$\bar{X}$=5.75 SD=1.708	$\bar{X}$=5.1875
2	$\bar{X}$=2.500 SD=2.082	$\bar{X}$=4.250 SD=2.754	$\bar{X}$= 6.750 SD= 2.630	$\bar{X}$=7.500 SD=2.082	$\bar{X}$=5.25
3	$\bar{X}$=3.750 SD= 2.062	$\bar{X}$=5.500 SD=2.887	$\bar{X}$= 8.000 SD= 2.708	$\bar{X}$=7.750 SD=2.630	$\bar{X}$=6.25
4	$\bar{X}$=3.750 SD= 2.754	$\bar{X}$=4.500 SD= 2.380	$\bar{X}$= 8.250 SD= 2.217	$\bar{X}$= 7.750 SD=3.304	$\bar{X}$=6.06
Mean	$\bar{X}$=3.44	$\bar{X}$=4.63	$\bar{X}$= 7.75	$\bar{X}$=7.19	$\bar{X}$=5.75
R	$\bar{X}$=5.000 SD= 3.367	$\bar{X}$=4.000 SD= 3.367	$\bar{X}$= 7.000 SD= 1.326	$\bar{X}$= 7.750 SD= 1.708	$\bar{X}$=5.93

* The maximum score for each block by condition is 10.

Table 3. Means and Standard Deviations for Learning and Retention by Condition Across Blocks for Group Three (N=5)*

BLOCKS	LOW TRANSLUCENCY		HIGH TRANSLUCENCY		MEAN
	LOW COMP	HI COMP	LOW COMP	HI COMP	
1	$\bar{X}$=5.000 SD=1.871	$\bar{X}$=4.600 SD=2.074	$\bar{X}$= 8.400 SD= 1.517	$\bar{X}$=8.800 SD=1.643	$\bar{X}$= 6.7
2	$\bar{X}$= 4.800 SD=2.490	$\bar{X}$=6.000 SD=2.328	$\bar{X}$= 8.800 SD= .837	$\bar{X}$=9.000 SD=1.000	$\bar{X}$=7.15
3	$\bar{X}$=5.400 SD= 2.191	$\bar{X}$= 5.800 SD= 2.168	$\bar{X}$= 9.600 SD= .894	$\bar{X}$=8.800 SD=2.168	$\bar{X}$= 7.4
4	$\bar{X}$= 6.600 SD= 2.608	$\bar{X}$= 7.400 SD= 1.140	$\bar{X}$= 9.400 SD= .548	$\bar{X}$= 9.400 SD= .894	$\bar{X}$=8.2
Mean	$\bar{X}$= 5.44	$\bar{X}$=6.10	$\bar{X}$= 9.05	$\bar{X}$= 8.95	$\bar{X}$=7.385
R	$\bar{X}$= 6.000 SD= 2.000	$\bar{X}$=6.400 SD= 1.517	$\bar{X}$= 9.200 SD= .447	$\bar{X}$= 9.000 SD= 1.732	$\bar{X}$= 7.65

* The maximum score for each block by condition is 10.

Table 4. Multivariate anaylsis of Variance (MANOVA) for Translucency Effect, By Group

Source	SS	df	MS	F	Prob.
WITHIN CELLS	63.70	7	9.10		
TRANS	464.40	1	464.40	51.04	*.000
GROUP BY TRANS	.00	1	.00	1.18	.987 (ns)

Signficance is indicated by .001 level of confidence

Table 5. Multivariate Anaylsis of Variance (MANOVA) for Translucency Effect (Groups Combined)

Source	SS	df	MS	F	Prob.
WITHIN CELLS	63.70	8	7.96		
TRANS	470.45	1	470.45	59.08	* .000

Signficance is indicated by .001 level of confidence

Table 6. Multivariate Anaylsis of Variance (MANOVA) for Complexity

Source	SS	df	MS	F	Prob.
WITHIN CELLS	10.44	7	1.49		
COMPLEX	3.06	1	3.06	2.05	.195 (ns)
GROUP BY COMPLEX	.17	1	.17	.12	.743 (ns)

Signficance is indicated by .001 level of confidence

Table 7. Multivariate Anaylsis of Variance (MANOVA) for Combined Subjects X Complexity

Source	SS	df	MS	F	Prob.
WITHIN CELLS	10.61	8	1.33		
COMPLEX	2.94	1	2.94	2.22	.175 (ns)

Signficance is indicated by .001 level of confidence

Table 8. Multivariate Anaylsis of Variance (MANOVA) for Group x Translucency x Completity

Source	SS	df	MS	F	Prob.
WITHIN CELLS	25.38	7	3.63		
TRANS BY COMPLEX	5.25	1	5.52	1.52	.257 (ns)
GROUP BY TRANS BY COMPLEX	.23	1	.23	.06	.807 (ns)

Signficance is indicated by .001 level of confidence

Table 9. Multivariate Anaylsis of Variance (MANOVA) for Combined Subjects x Translucency x Complexity

Source	SS	df	MS	F	Prob.
WITHIN CELLS	25.61	8	3.20		
TRANS BY COMPLEX	5.34	1	5.34	1.67	.233 (ns)

Signficance is indicated by .001 level of confidence

Table 10. Repeated Measures MANOVA with Group Summary Table for Combined Learning Trials and Retention Trials

Source	SS	df	MS	F	Prob.
WITHIN CELLS	21.29	7	3.04		
TIME	5.14	1	5.14	1.69	.235 (ns)
GROUP BY TIME	.03	1	.03	.01	.930 (ns)

Signficance is indicated by .001 level of confidence

Table 11. Multivariate Anaylsis of Variance (MANOVA) for Trial Effect

Source	SS	df	MS	F	Prob.
WITHIN CELLS	29.96	28	1.07		
TRIAL	34.09	4	8.25	7.96	*.000
GROUP BY TRIAL	5.05	4	1.26	1.18	.342 (ns)

Signficance is indicated by .001 level of confidence

Table 12. Multivariate Anaylsis of Variance (MANOVA) for Trial (Combined Subjects)

Source	SS	df	MS	F	Prob.
WITHIN CELLS	35.01	32	1.09		
TRIAL	35.19	4	8.80	8.04	.000

Signficance is indicated by .001 level of confidence

Figure 1. Group Comparison

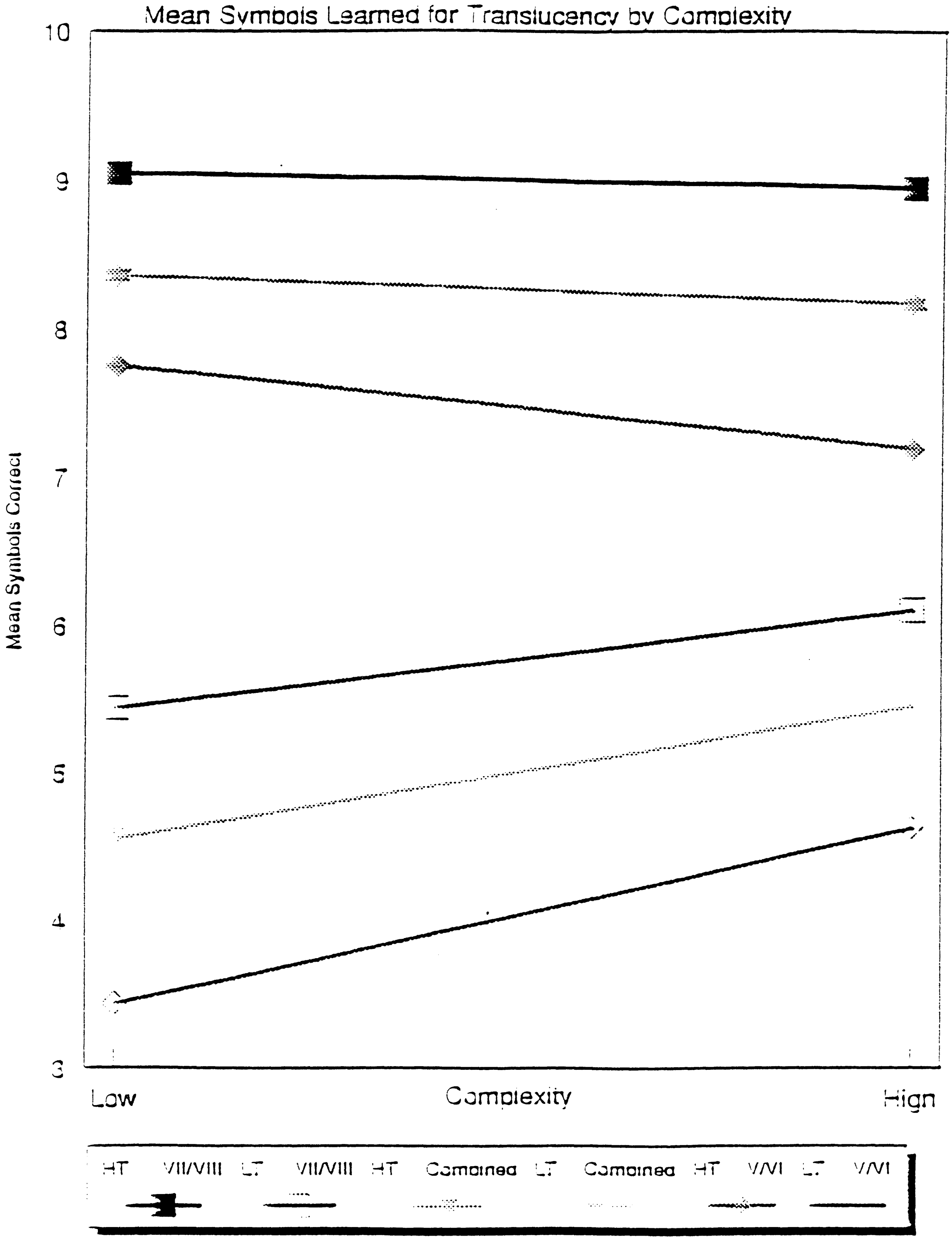


Figure 2. Group Comparison
Mean Symbols Retained for Translucency by Complexity

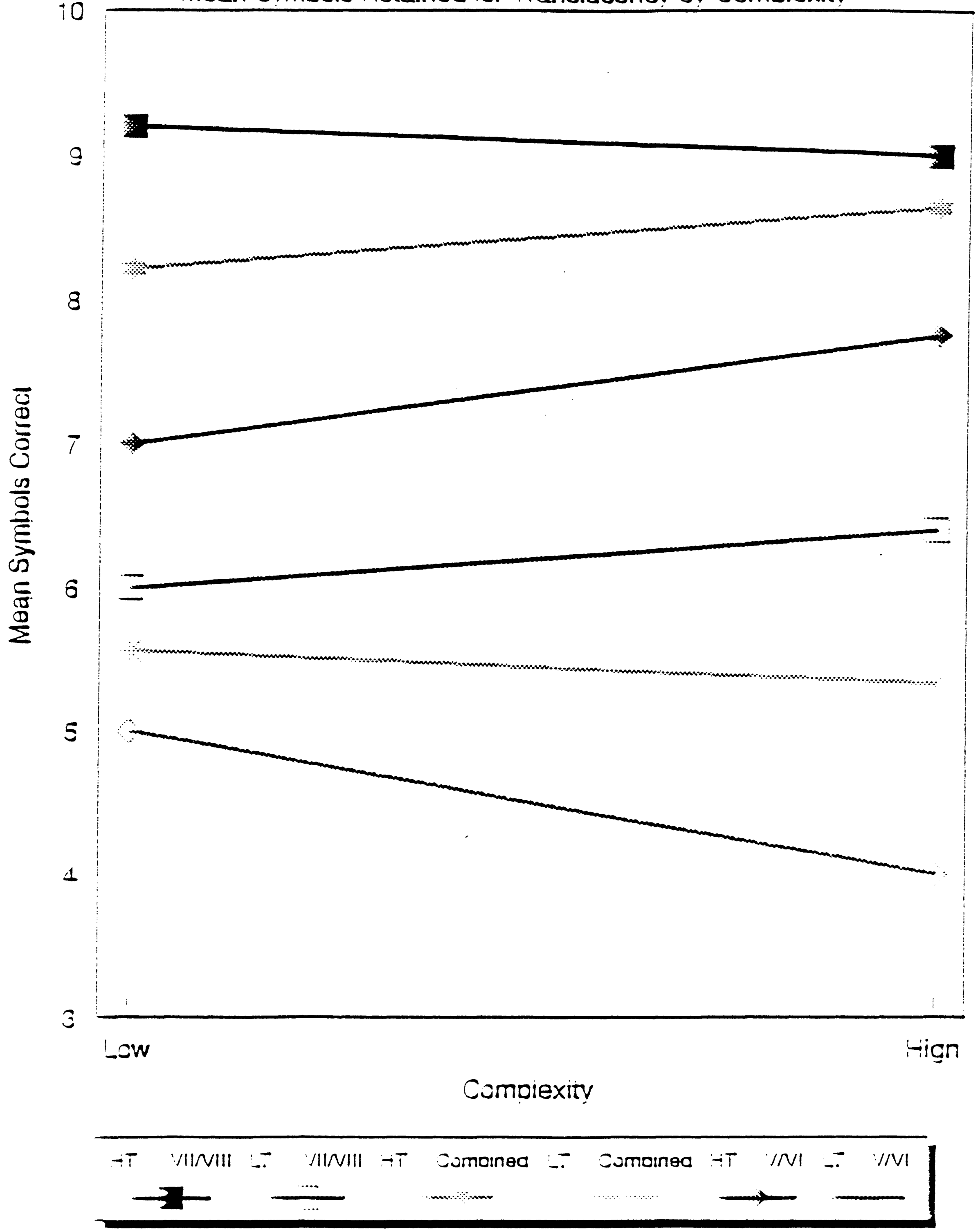
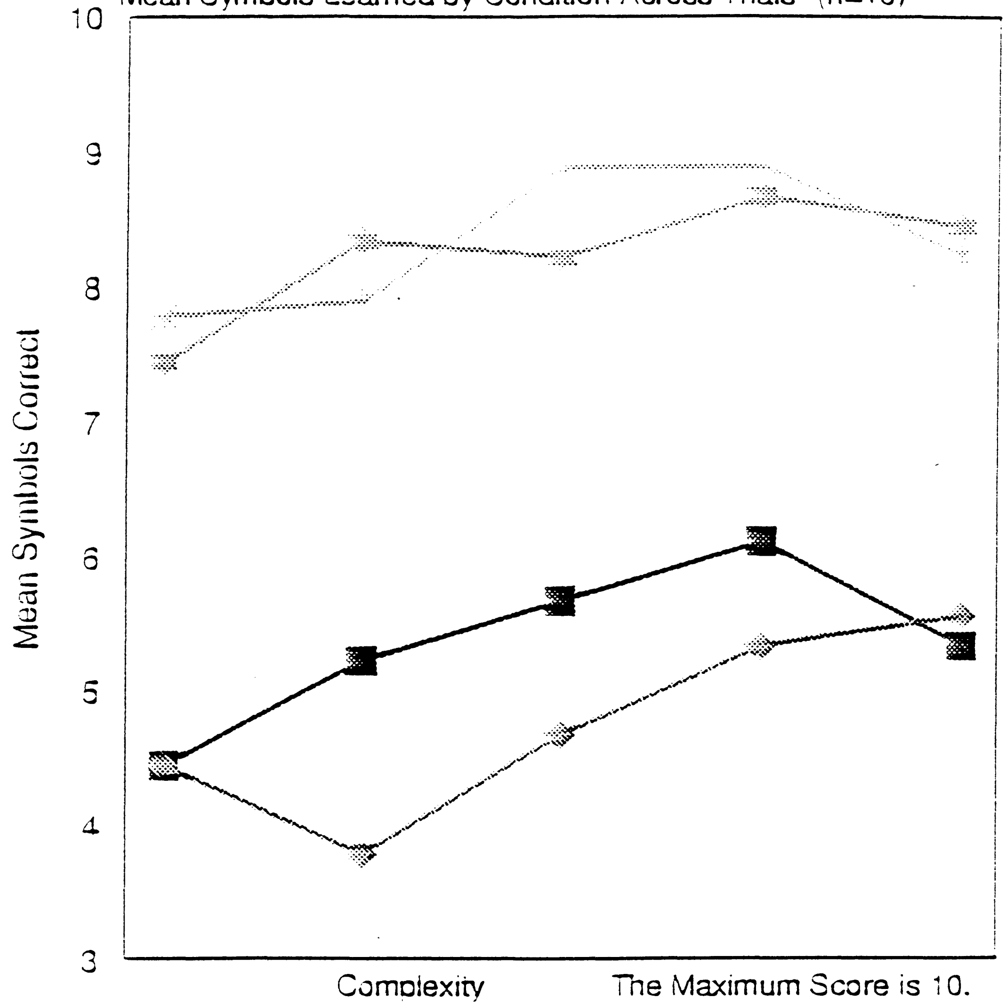


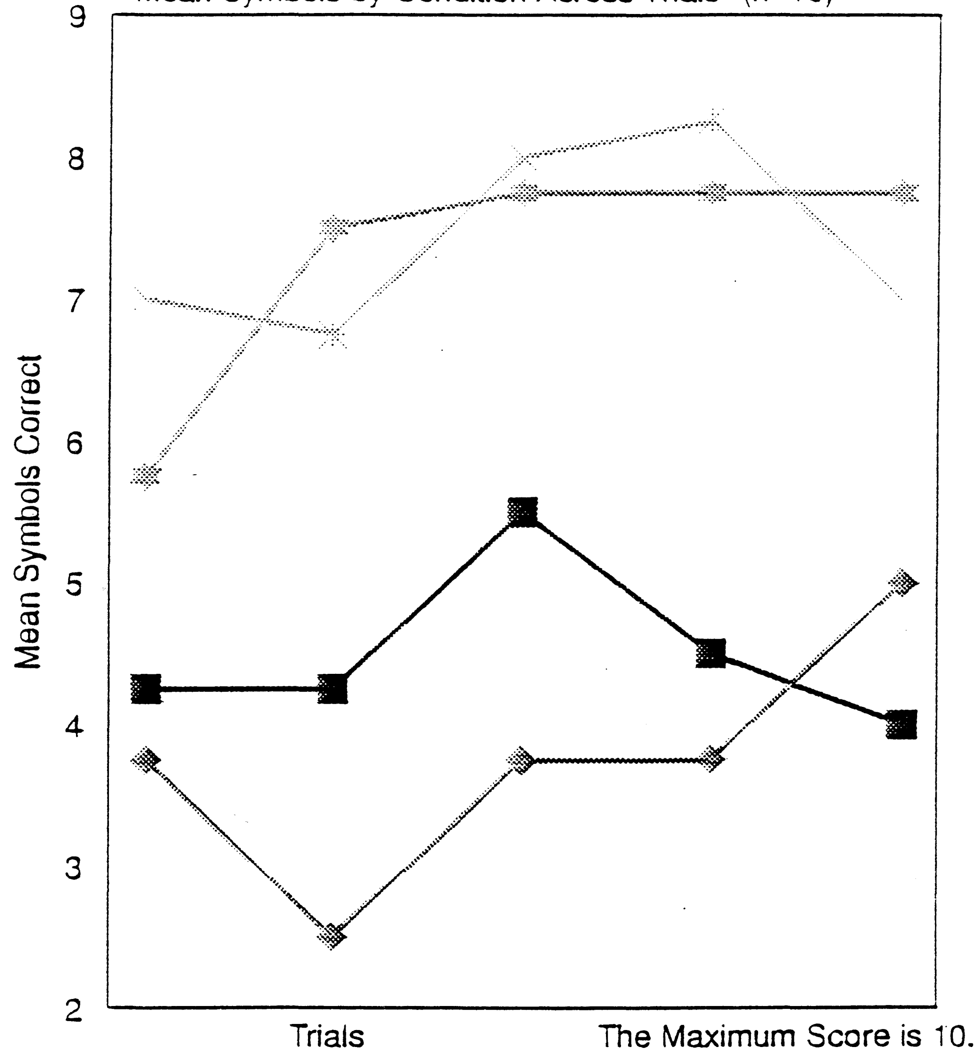
Figure 3. Combined Groups(Groups Two and Three)

Mean Symbols Learned by Condition Across Trials *(n=10)



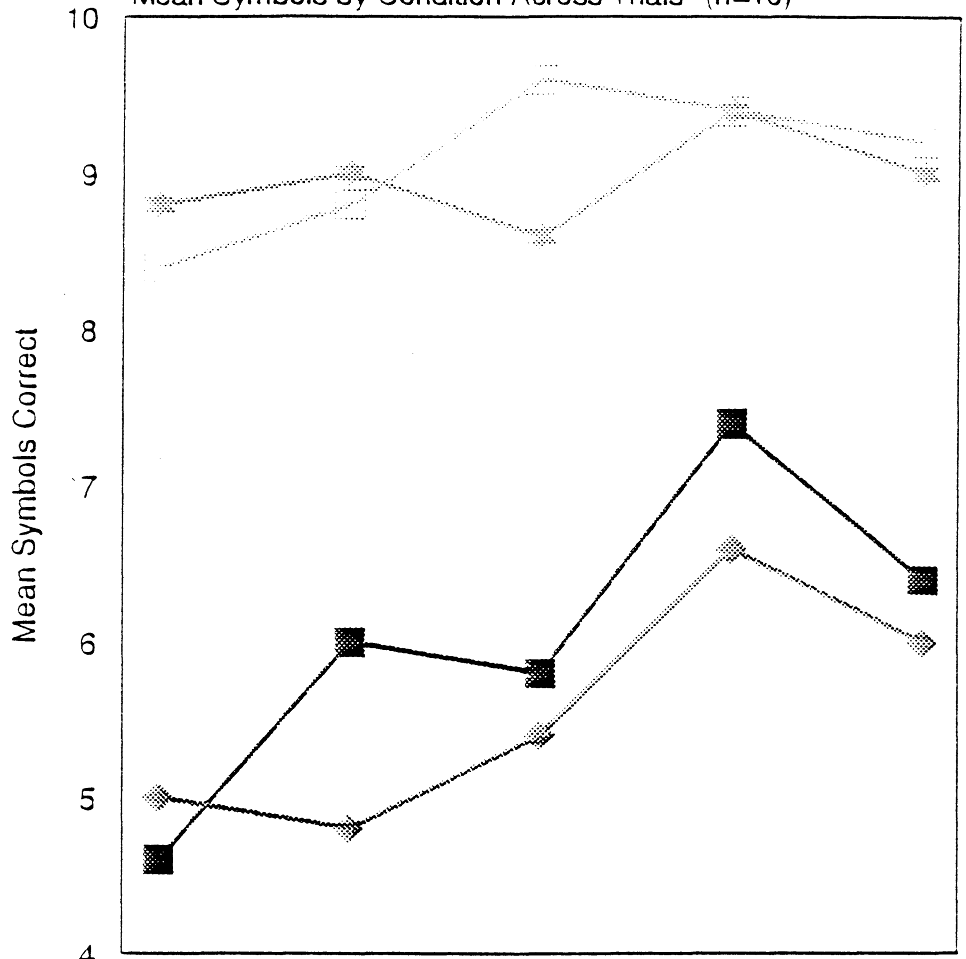
	1	2	3	4	R
LTHC	4.44	5.22	5.67	6.11	5.33
LTLC	4.44	3.78	4.67	5.33	5.56
HTHC	7.44	8.33	8.22	8.67	8.44
HTLC	7.78	7.89	8.89	8.89	8.22

Figure 4. Group Two (Level V/VI)
Mean Symbols by Condition Across Trials *(n=10)



	1	2	3	4	R
LTHC	4.25	4.25	5.50	4.50	4.00
LTLC	3.75	2.50	3.75	3.75	5.00
HTHC	5.75	7.50	7.75	7.75	7.75
HTLC	7.00	6.75	8.00	8.25	7.00

Figure 5. Group Three (Level VII/VIII)
Mean Symbols by Condition Across Trials *(n=10)

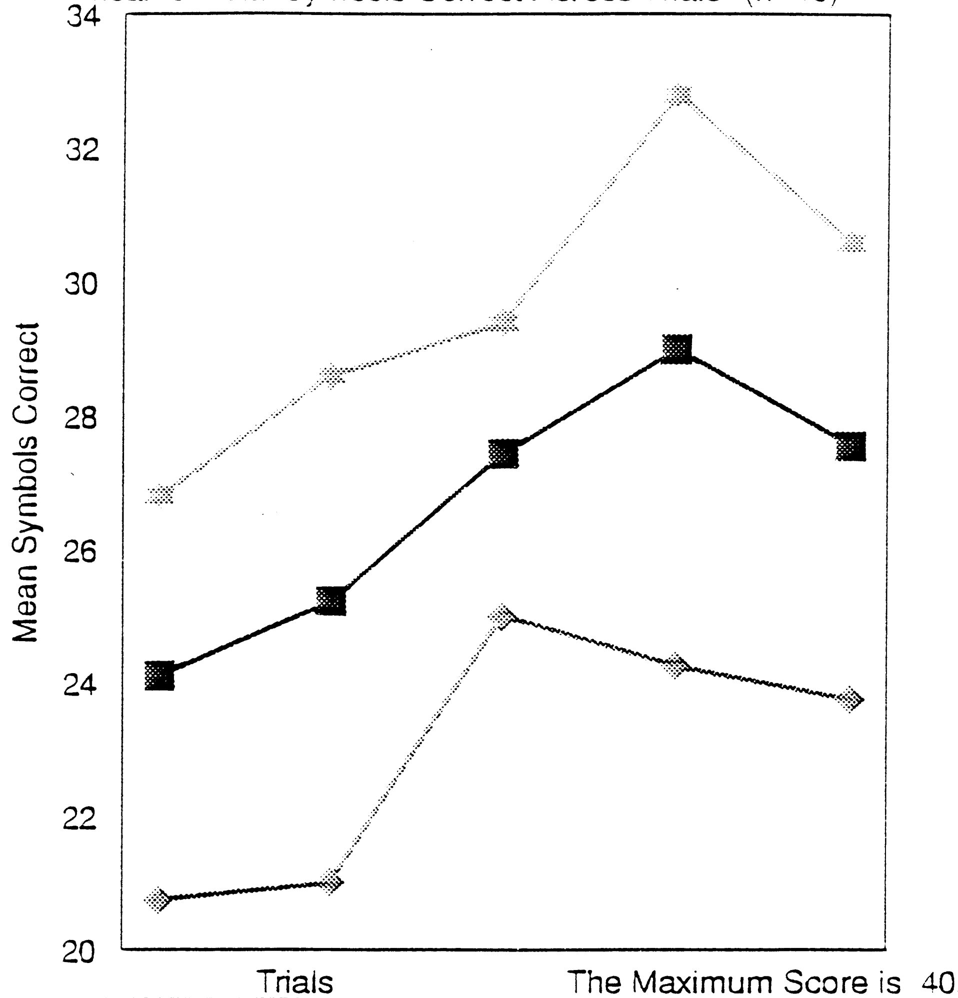


The Maximum Score is 10.

	1	2	3	4	R
LTHC	4.6	6.0	5.8	7.4	6.4
LTLC	5.0	4.8	5.4	6.6	6.0
HTHC	8.8	9.0	8.6	9.4	9.0
HTLC	8.4	8.8	9.6	9.4	9.2

Figure 6. Group Comparison

Mean of Total Symbols Correct Across Trials *(n=40)



	1	2	3	4	R
GROUP	24.11	25.22	27.44	29.00	27.56
V/VI	20.75	21.00	25.00	24.25	23.75
VII/VIII	26.80	28.60	29.40	32.80	30.60

Appendices

Appendix A

Summary of Subjects

Pat Letter	Rancho Level	Location
1	Withdrew	Michigan
2	RLAL 5/6	Michigan
3	RLAL 5/6	Michigan
4	Withdrew	Michigan
5	Withdrew	Michigan
6	Withdrew	Illinois
7	RLAL 5/6	Illinois
8	Withdrew	Illinois
9	Withdrew	Illinois
10	Withdrew	Illinois
11	Withdrew	Illinois
12	RLAS 7/8	Illinois
13	RLAS 7/8	Illinois
14	RLAS 7/8	Illinois
15	RLAS 7/8	Illinois
16	RLAS 5/6	Illinois
17	RLAS 7/8	Illinois

Appendix B

Demographic Information and Questionnaires

Patient Code___

Demographic Information Form for Medical Staff Member

Sex: M F

Birthdate: ___/___/___

Age: ________

Uncorrected visual deficits present? Y N

Hearing within normal limits? Y N

Rancho Los Amigo Level of Cognitive Functioning:

____

Galveston Orientation and Amnesia Test grade: 1 2 3

Tool utilized to discriminate that aphasia is not present?

____

____

Signature/Title

Appendix B (continued)

Demographic Information and Questionnaires
for Family Member

Patient Code___

Do you or anyone in your family use Blissymbols? Y N

Do you or anyone in your family know someone who uses Blissymbols? Y N

Have you ever seen Blissymbols? Y N

If so, explain:

____

____

Is English your primary language? Y N

Do you have any uncorrected visual problems? Y N

Do you have any hearing problems? Y N

Appendix C

Patient and Significant Other Consent Forms

Patient Consent Form

The Effects of Cognitive-Communicative Functioning in Individuals Who Have Sustained Closed Head Injury on Paired- Associative Learning of Blissymbols

Andrea J. Rabish, B.S.
Eastern Illinois University

I understand that the focus of this study is to gain a better understanding of the ability of individuals with closed head injury to learn a graphic symbol system called Blissymbols. This study will involve approximately 30 minutes of my time when I will be pointing to symbols on a posterboard. The first session will involve learning various Blissymbols in four separate trials. The second session which will occur the next day will involve one trial that would test what I have learned.

This data will be reported in a summary of the findings of this study. The information related to my medical chart will also be reported with my name struck from the document. The necessity in medically related information being reported to give the researcher an accurate analysis and interpretation of the data that will be obtained is understood.

No penalty will be excercised if I decide to terminate my participation in this study. The decision of participation or termination will not change/infringe on the quality of care that I receive.

I understand that my participation in this study is strictly voluntary and withdraw is allowed without explanation. Confidentiality will be maintained at all times and the investigator will not reveal my name. All questions or concerns will be answered by the investigator.

______________________________   ____________

Patient's Name Printed   Date

____

Patient's Signature

Appendix C (continued)

Patient and Significant Other Consent Form

Significant Other's Consent Form

The Effects of Cognitve-Communicative Functioning in Individual's Who Have Sustained Closed Head Injury on Paired-Associative Learning of Blissymbols

Andrea J. Rabish
Eastern Illinois University

I understand that the focus of this study is to gain a better understanding of the ability of individuals with closed head injury to learn a graphic symbol system called Blissymbols. This study will involve approximately 30 minutes of my significant other's time requiring pointing to Blissymbols on a posterboard. The first session will involve learning various symbols in four separate trials. The second session which will occur a week later will involve one trial that would test what symbols have learned.

This data will be reported in a summary of the findings of this study. The information related to the medical chart will also be reported with my significant other's name struck from the document. The necessity in medically related information being reported to give the researcher an accurate analysis and interpretation of the data that will be obtained is understood.

No penalty will be excerised if my significant other or I decide to terminate participation in this study. The decision of participation or termination will not change/ infringe on the quality of care that my significant other will receive.

I understand participation in this study is strictly voluntary and withdraw is allowed without explanation. Confidentiality will be maintained at all times and the investigator will not reveal my significant other's name. All questions or concerns will be answered by the investigator.

______________________________ ____________

Patient's Name Printed Date

____

Signature

Appendix C (continued)

Patient and Significant Other Consent Form

Andrea J. Rabish 1 Bluff Ct.
Hometown, USA 50555
(708) 555 - 5555

\- -

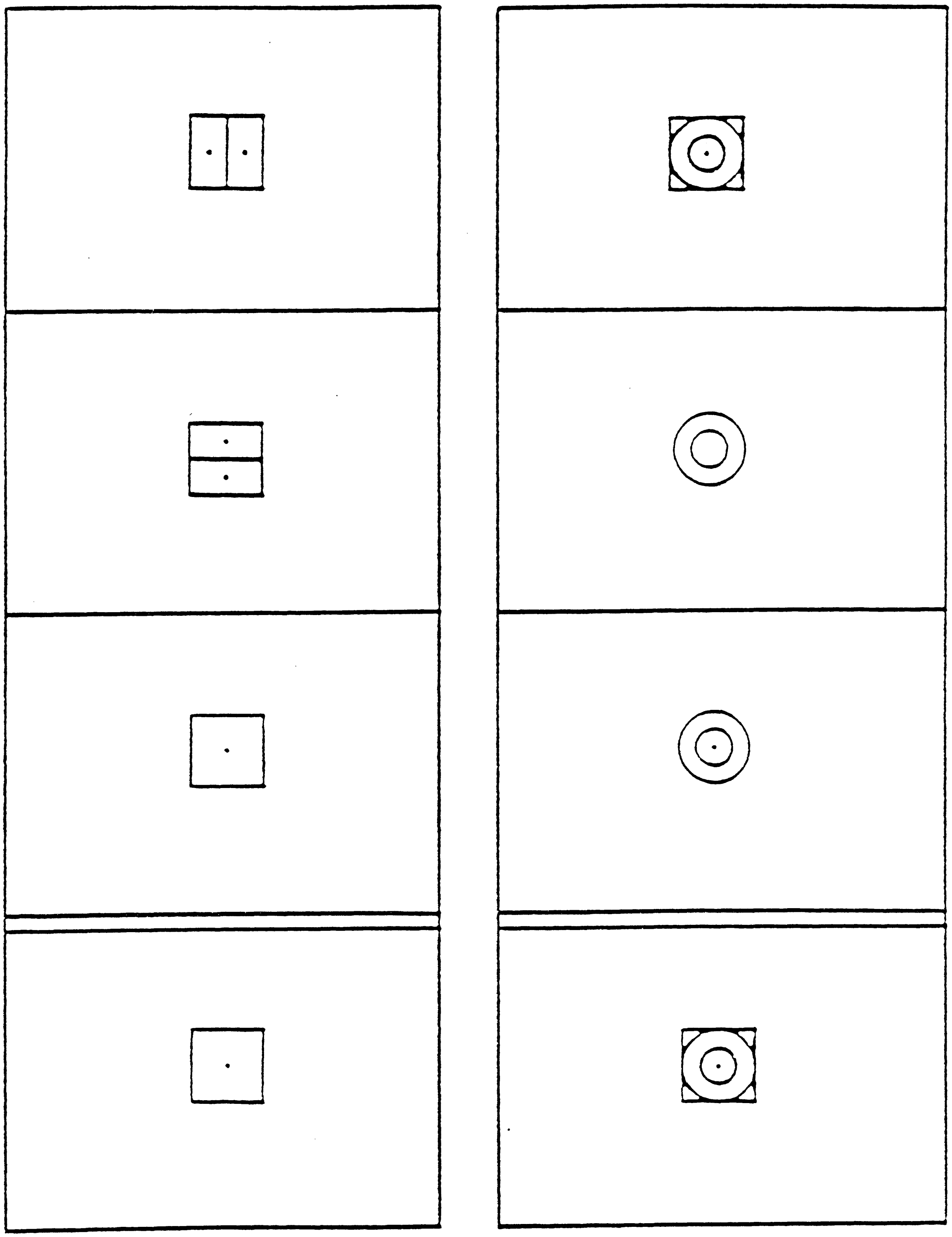
Fill out this part of the form if you want to receive a summary of the findings:

____________________ ______________ ____________

Street Address City State/Zip Code

Appendix D

Visual Discrimination Task

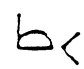


Appendix E

Blissymbols

Low Translucency-Low Complexity Symbols

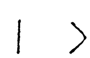
 EAT

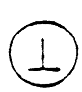
 MUSCLE

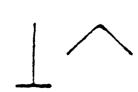
 FOOD

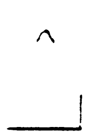
 NAME

 GRASS

 OFF

 HEAD

 POLICEMAN

 LIE

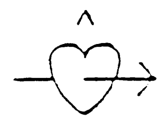
 SMALL

Appendix E

Blissymbols

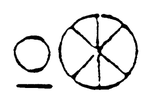
High Translucency-High Complexity Symbols

BRICK



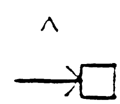
LOVE

BUS



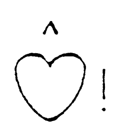
PIZZA

CAR

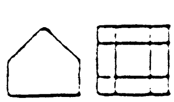


PUSH

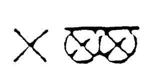
CHIN



SURPRISE



JAIL

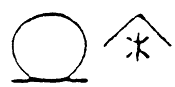


TRAIN

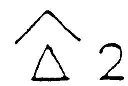
Appendix E

Blissymbols

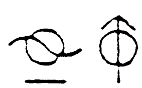
Low Translucency-High Complexity Symbols



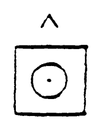
BIRTHDAY



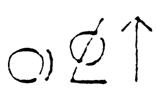
SISTER



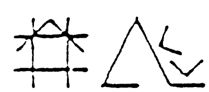
COKE



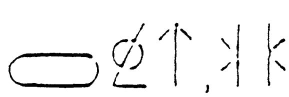
SLEEP



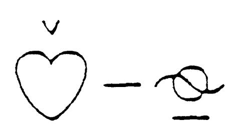
COOKIE



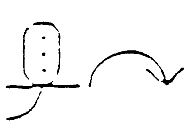
SOCK



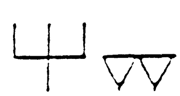
PANCAKE



THIRSTY



POPCORN

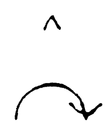
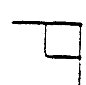


TOOTHBRUSH

Appendix E

Blissymbols

High Translucency-Low Complexity Symbols

	APPLE		GIRL
	BANANA		JUMP
	BOWL		OPEN
	DISH		STAMP
	FLAG		TEETH

Appendix F

Standard Set of Instructions

The following passage contains the standard directions given to a participant before the first session. These directions are further explained when necessary to ensure comprehension.

On the boards in front of you, you will see forty different drawings. Each drawing has a one-word name. First, I will tell you the name for each drawing. Then, your job will be to locate and point to the drawing that you remember or think matches the name I call. If you are correct, I will tell you. If you are incorrect, I will show you the correct drawing. We will be looking at each board four times. So try to remember as many of the names as you can. At first this task may be difficult but it will get easier after awhile. Just try your best. After we look at the boards today, I will return tomorrow to do this one more time. Do you have any questions?

Appendix G

Example of Response Forms for Trials

RESPONSE KEY

Board 1

1. BOWL
2. THIRSTY
3. LIE
4. TRAIN
5. COKE
6. JAIL
7. BANANA
8. TEETH

Board 2

1. CHIN
2. POPCORN
3. EAT
4. COOKIE
5. LOVE
6. FACE
7. BRICK
8. JUMP

Board 3

1. SISTER
2. BIRTHDAY
3. SOCK
4. PUSH

Board 3 (con't)

5. MUSCLE
6. OPEN
7. FOOD
8. PIZZA

Board 4

1. TOOTHBRUSH
2. CAR
3. OFF
4. GIRL
5. BUS
6. SLEEP
7. PANCAKE
8. STAMP

Board 5

1. SMALL
2. NAME
3. POLICEMAN
4. SURPRISE
5. FOOD
6. APPLE
7. GRASS
8. DISH

APPENDIX H

Rancho Los Amigos Levels of Cognitive Functioning

<u>Level I No Response</u>

Patient appears to be in a deep sleep and is completely unresponsive to any stimuli presented to him.

<u>Level II Generalized Response</u>

Patient reacts inconsistently and non-purposefully to stimuli in a non-specific manner. Responses are limited in nature and are often the same regardless of stimulus presented. Responses may be physiological changes, gross body movements and/or vocalization. Often, the earliest response is to deep pain, Responses are likely to be delayed.

<u>Level III Localized Response</u>

Patient reacts specifically, but inconsistently to the stimuli. Responses are directly related to the type of the stimulus presented as in turning head towards a sound, focusing on an object presented as in turning head towards a sound, focusing on an object presented. The patient may withdraw an extremity and/or vocalize when presented with painful stimulus. He may follow simple commands in an inconsistent manner, such as closing his eyes, squeezing or extending an extremity. Once external and body by responding to discomfort, pulling an nasogastric tube or catheter, or resisting restraints. He may show a bias toward responding to some persons (especially family, friends) but not to others.

<u>Level IV Confused/ Agitated Response</u>

Patient is in a heightened state of activity with severely decreased ability to process information. S/He is detached from the present and responds primarily to his own internal confusion. Behavior is frequently bizarre and non-purposeful relative to his immediate environment. S/He may cry out or scream out of proportion to stimuli even after removal, may show aggressive behavior, attempt to remove restraints or tubes or crawl out of bed in a purposeful manner. S/He does not, however, discriminate among persons or objects and is unable to cooperate directly with treatment efforts. Confabulation may be present; s/he may be euphoric or hostile. Thus gross attention is often nonexistent. Being aware of present events, patient lacks

APPENDIX H (continued)

Rancho Los Amigos Levels of Cognitive Functioning

the short-term recall and may be reacting to past events. S/He is unable to perform self-care (feeding, dressing) without maximum assistance. If not disabled physically, s/he may perform motor activities in sitting, reaching and ambulating, but as part of his agitated state and not as a purposeful act or on request necessarily.

Level V Confused/ Inappropriate/ Nonagitated Response

Patient appears alert and is able to respond to simple commands fairly consistently. However, with increased complexity of commands or lack of any external structure, responses are non-purposeful, random, or at best, fragmented toward any desired goal. S/He may show agitated behavior, but not on an internal basis (as in Level IV), but rather as a result of external stimuli, and unusually out of proportion to the stimulus. S/He has gross attention to the environment, but is highly distractable and lacks ability to focus attention to a specific task without frequent redirection back to it. With structure, s/he may be able to converse on a social-automatic level for short periods of time. Verbalization is often inappropriate; confabulation may be triggered by present events. Her/His memory is severely impaired, with confusion of past and present in his reaction to ongoing activity. Patient lacks initiation of functional tasks and often shows inappropriate use of objects without external direction. S/He may be able to perform previously learned tasks when structured for him, but is unable to learn new information. S/He responds best to self, body, comfort, and often family members. The patient can usually perform self-care activities with assistance and may accomplish feeding with maximum supervision. Management on the unit is often a problem if the patient is physically mobile, as s/he may wander off either randomly, or with the vague intention of "going home".

Level VI Confused/ Appropriate Response

Patient shows goal-directed behavior, but is dependent on external input for direction. Response to discomfort is appropriate and is able to tolerate unpleasant stimuli (as NG tube) when need is explained. He follows simple directions consistently and shows carry-over for tasks s/he has relearned (as self-care). S/He is at least supervised with old learning with little or no carry-over. Responses

APPENDIX H (continued)

Rancho Los Amigos Levels of Cognitive Functioning

may be incorrect due to memory problems, but they are appropriate to the situation. They may be delayed to immediate and shows decreased ability to process information with little or no anticipation of prediction of events. Past memories show more depth and detail than recent memory. The patient may show beginning immediate awareness of situation by realizing s/he does not know the answer. S/He no longer wanders and is inconsistently oriented to time and place. Selective attention to tasks may be impaired, especially with difficult tasks and in unstructured settings, but is now functional for common daily activities (30 minutes with structure).
He may show vague recognition of some staff, has increased awareness of self, family, and basic needs (such as food), again in an appropriate manner as in contrast to Level V.

<u>Level VII Automatic/ Appropriate Response</u>

Patient appears appropriate and oriented within hospital and home settings, goes through daily routine automatically, but frequently robot-like with minimal-to-absent confusion, but has shallow recall of what he has been doing. S/He shows increased awareness of self, body, family, foods, people, and interaction in the environment. S/He has superficial awareness of, but lacks insight into his condition, decreased judgment and problem-solving, and lacks realistic planning for his future. S/He requires at least minimal supervision for learning and for safety purposes. S/He is independent in community skills for safety. With structure s/he is able to initiate tasks as social or recreational activities in which s/he now has interest. Her/his judgment remains impaired; such that s/he is unable to drive a car. Pre-vocational or a vocational evaluation and counseling may be indicated.

<u>Level VIII Purposeful/ Appropriate Response</u>

Patient is alert and oriented, is able to recall and integrate past and recent events and is aware of and responsive to his culture. S/He shows carry-over for new learning if acceptable to him and his life role, and needs no supervision once activities are learned. Within his physical capabilities, he is independent in home and community skills, including driving. Vocational rehabilitation, to determine ability to return as a contributor to society (perhaps in a new capacity) is

APPENDIX H (continued)

Rancho Los Amigos Levels of Cognitive Functioning

indicated. S/He may continue to show decreased ability, relative to premorbid abilities, in abstract reasoning, tolerance for stress, judgment in emergencies, or unusual circumstances. Her/His social, but functional in society.

Hagen, C., Malkumus, D., & Durham, P. (1979). Levels of cognitive functioning, in Rehabilitation of the Head Injured Adult: Comprehensive Physical Management. Downey, CA., Professional Staff Association of Rancho Los Amigos Hospital, Inc.

APPENDIX I

Application to Human Research Board

Project Title:

The Effects of Cognitive-Communicative Functioning in Individuals Who Have Sustained Closed Head Injury on Paired-Associative Learnability of Blissymbols.

Rationale for Proposed Reseach:

Individuals who experience severe communication impairments may communivate through the use of various augmentative and alternative communication (AAC) symbol sets/ systems. These sets amd systems often lack a generative component which would allow a user to create novel messages. Blissymbolics, however, is generative and, as such, it has gained recent attention. A critical area of Blissymbol investigation has focused on initial symbol learning. Evidence exists that there is a positive effect of translucency and complexity on initial lixical learning of functioning and/or cognitive impairments (Fuller, 1988; Luftig & Bersani, 1985; Nail-Chiwetula, 1991; Smith & Fuller, 1991; Yoetich & Lobb, 1981; Yoetich & Paivio, 1980). Thus, both translucency and complexity should be examined with other communicatively disordered populations.

The disordered populations who may benefit fromm AAC are diverse in terms of degree of physical impairment, social impairment, cognitivie impairment, and communicative impairment. Each population's ability to benefit from use of any symbol set or system warrants investigation. The least investigated population is individuals who are nonspeaking following closed head injury (CHI). The proposed research is concerned with the effects of Blissymbol translucency andand complexity on the initial learnability of Blissymbols in individuals who have sustained CHI.

Specifically, the purpose of this research is to extend the Fuller (1988) paired-associateve study and yield information on Blissymbol learnability and introduction time while examining the possible relationships between learning and severity of cognitive-communication impairement secordary to CHI. Tulfing and Pearlstone (1966) found that paired-associative Tasks are an effective procedure to utilize when introducing new materials with this population.

APPENDIX I (continue)

Application to Human Research Board

All materials and most procedures will be consistent with the Fuler (1988) study. The participants, type of response mode, and the amount of symbols displayed on a single board will be the only types of modifications made for this investigation. Instead of utilizing adults with normal cognitive funcioning, individuals with CHI will be utilized. In the Fuller (1988) study, two types of response modes, verbal and pointing, were used. Participants in this study will respond by pointing, since 75% of individuals who are nonspeaking following CHI access AAC communication systems by a finger point (DeRuyter & LaFontaine, 1987).

Procedures:

Each subject will be trained independently in a paired-associative learning paradigm using the Fuller (1988) procedure. A standard set of instructions will be provided to every subject participating in the present investigaton.

After the examiner points to and labels each Blissymbol seperately on a posterboard, the participant will be required to point to the appropriate location for each verbally named symbol. A correct response will generate a verbal acknowledgment (e.g., "Good" or "Correct"). The correct symbol will be identified with a verbal repetition when a response is inaccurate.

The investigation will be conducted in two sessions across a twenty-four hour period. Four learning trials will comprise the initial session. It is anticipated that this session will last approximately 30 to 40 minutes. To test retention of the symbols learned, the investigator will return the next day to repeat one trial.

An accurate pointing or eye gazing response will be accepted as correct. The investigator will record responses, 1 for correct responses and 0 for incorrect/absent responses, on the trial sheet. The total number of accurate responses within each category will be calculated generated four scores with the maximum score per category being 10.

Fourty Blissymbols from the Fuller (1988) study will be utilized in order to maintain symbol consistency and to

APPENDIX I (continue)

Application to Human Research Board

enable data comparison. An equal number of symbols will fall into four categories of high translucency - high complexity, high translucency - low complexity, low translucency - high complexity, and low translucency - low complexity. Each of the symbols will be assigned to the same categories as those determined by the Fuller (1988) study. Five 6 x 12 inch posterboards will be divided into eight locations, creating two rows by four columns. Each location will contain a 3 x 3 inch symbol which will be randomly assigned to a location, a practice consistent with the procedure outlined by the Fuller (1988) study.

Subjects:

Participants will include twenty individuals with a primary diagnosis of CHI, as certified by a physician or neurologist. These individuals will be screened for visual deficits; hearing deficits; English as their primary language; naivety to Blissymbols; absence of aphasia; and the absence of pharmaceutical substances including neuroleptics which influence cognitive-communicative behaviors and level of awareness. Group A will consist of 10 participants functioning at levels V and VI, and Group B will contain 10 individuals functioning at levels VII and VIII. Cognitive functioning levels will be determined by the Rancho Los Amigos Levels of Cognitive Functioning Scale.

Procedures of Reruitment:

A pool of potential subjects will be sought from hospital directors of acute and post-acute rehabilitation programs and centers in the mid-western states of Illinois, Indiana, Michigan, and Missouri and in the northeastern areas including New York and Ontario, Canada. From the pool, twenty individuals who meet the participant criteria will be selected.

Procedures of Payment:

No payment will be given.

Confidentiality:

Subjects' names and other identifying information will remain confidential. Individuals will be randomly assigned

APPENDIX I (continue)

Application to Human Research Board

code letters under which the data will be logged. Medical information will also be logged under each subjects' assigned letter. The data and demographical information will be reported and documented only with the use of the subject's assigned letter.

Potential Risks to Subjects:

The risks to participant are considered to be minimal. Subjects and/or parents/legal guardian will sign a consent form(s) in order to voluteer participation in this project. Potential and theoretial risks for the individual to become fatigued or bored may be involved. Motivation will be expected to be inherent but will also be provided through the investigator's verbal responses. The entire procedure is non-invase and only requires a pointing response.
Benefits to be Gained by the Individual and /or Society:

The objective of this investigation is to advance the knowledge base of the AAC symbol systems in the rehabilitation of cognitive-communication impairments related to CHI. Rehabilitation services received by individuals who are nonspeaking folowing CHI should be enhanced.

Investigator's Evaluation of the Risk-Benefit Ratio:

Risks are determined to be minimal wherein relationships between the potential advantage of wider use of AAC in the rehabilitation of cognitive-communicative impairments related to CHI greatly outweigh the potential, theoretical risks of individual fatigue and boredom. This investigator may also identify individuals who are nonspeaking following CHI as potential Blissymbol users and , thus, increase their overall comunicative potential.

Procedures to Obtain Informed Consent:

Potential participants and/or their significant other will be asked if they would like to participate. The investigtor will provide consent forms to the hospital staff to review with participant and/or their significant other. The signature of the participant and/or their significant other will be required for each subject. The investigator's address and telephone number will be provided with the consent forms to enable the participant

APPENDIX I (continue)

Application to Human Research Board

and/or significant other to inquire and express any concerns regarding the investigation (See Appendix C).

The participant criterion for theis investigation will include no visual deficits; no hearing deficits; English as the primary language; naivety to Blissymbols; absence of aphasia; and absence of pharmaceutical substances that hinder cognitive-communicative behaviors and level of awareness. The participants will present a diagnosis of CHI, as certified by a physician or neurologist. Subject eligibility can be met through documentation on the individual's medical chart (See Appendix B).

Written Copy of Informed Consent Form Provided to Subject:

A written sample of informed consent from the participant and/or their significant other is attached to this application (See Appendix C). Information pertaining to the intent and activities will be provided to the participant and/or their significant other. The subject will sign the informed consent form in order to participate, unless it is uncertain as determined by the investigator, the primary speech-language pathologist, and/or the program director of the facility that the individual is unable to grant permission due to any type of severe impairment (e.g. physical, social, or cognitive). If ability to provide informed consent is uncertain, a signature from the the significant other will be required in order to proceed with the paticipant.

Supporting Documents:

Upon approval from the committee on the use of human research subjects, the information of this document will be provided to the director of rehabilitation programs and the director of sppech-language pathologists/ communication disorders specialists in the mid-western states of Illinois, Indiana, Michigan, and Missouri and in the northerneastern areas including New York and Ontario, Canada. Any documents of contact with any subject, significant other, and/or staff member of the hospital and/or rehabilitation programs that are investigation sites will be copied and sent to the Human Subject Office prior to execution of the investigation.

Appendix J

Letter to Potential Investigation Sites

Dear Administrator (s),

The principal investigator, a Communiation Disorders and Sciences graduate student at Eastern Illinois University, is executing research on Blissymbol learnability among patients who sustain closed head injury (CHI). Blissymbols is a graphic augmentative and alternative communication symbol system which is on symbol system of choice for CHI patients who are nonspeaking. Research procedures are detailed on the following pages.

Presently, the investigator is seeking volunteers with a primary diagnosis of closed head injury. According to the condition of this investigation, these volunteers need to be functioning between the _Rancho Los Amigo: Cognitive Functioning Levels_ of V and VIII. The volunteers' participation will contribute greatly to the knowledge of Blissymbol learnability. Results may have applicability to other graphic symbol sets/systems as communication options for individuals who are nonspeaking following closed head injury.

Since the investigation involves only brief interaction on the part of the patients, physical and mental harm are not expected. Each participation's identity will remain anonymous. Participants may withdraw from the study at any time without penalty. The invetigator will be made accessible to the potential subjects and their facility. The enclosed pages include a composite of concerns pertaining to human research subjects.

If you have any interest in participating in this investigation, please contact me at my present address with a list containing potential subjects with ther present level of cognitive functioning according to the _Rancho Los Amigos_ scale. Thank you for you time and consideration.

Sincerely,

Appendix J (continue)

Letter to Potential Investigation Sites

____
Charlotte A. Wasson, M.S., CCC/SLP-L
Assistant Professor and Thesis Chair

____
Andrea J. Rabish, B.S.
Graduate Clinician
Bluff Ct.
Hometown, USA 50555
(708) 555 - 5555

APPENDIX K

Summary of Withdrawn Subjects

Subject Code	Status
Code 1	Rancho Los Amigos Level 3/4 dropped due to the inability to make significant data comparison
Code 4	Rancho Los Amigos Level 3/4 unable to determine responses secondary to inconsistent eye gaze.
Code 5	Rancho Los Amigos Level 3/4 unable to determine responses secondary to inconsistent pointing and/or eye gaze
Code 6	Rancho Los Amigos Level 5/6 unable to utilize data secondary to patient's age which was changed by admissions after testing. (The location did not allow the use of children as subjects.)
Code 8	Rancho Los Amigos Level 3/4 unable to complete testing within 12 hours secondary to response latency.
Code 9	Rancho Los Amigos Level 3/4 unable to complete testing secondary to increased agitation.
Code 10	Rancho Los Amigos Level 3/4 unable to complete testing secondary to decreased medical status.
Code 11	Rancho Los Amigos Level 5/6 Decided to withdraw

Appendix L

Raw Data

High Translucency-High Complexity

Subject Code	TRIAL 1	2	3	4	x	R
Code 2	4	7	10	10	7.75	9
Code 3	5	5	5	3	4.5	6
Code 7	6	8	6	8	7	7
Code 12	9	9	10	10	9.5	10
Code 13	9	8	9	9	8.75	9
Code 14	10	10	10	10	10	10
Code 15	6	8	5	8	6.75	6
Code 16	8	10	10	10	9.5	9
Code 17	10	10	10	10	10	10

Appendix L (continue)

Raw Data

High Translucency-Low Complexity

Subject Code	TRIAL 1	2	3	4	x	R
Code 2	7	7	9	9	8	8
Code 3	4	3	4	5	4	5
Code 7	7	8	9	9	8.25	6
Code 12	10	10	10	10	10	10
Code 13	9	8	10	9	9	9
Code 14	8	8	8	9	8.25	9
Code 15	6	9	10	9	8.5	9
Code 16	10	9	10	10	9.75	9
Code 17	9	9	10	10	9.5	9

Appendix L (continue)

Raw Data

Low Translucency-High Complexity

Subject Code	TRIAL 1	2	3	4	x	R
Code 2	1	3	3	3	2.5	2
Code 3	3	1	3	2	2.25	2
Code 7	7	6	8	7	7	3
Code 12	4	9	7	7	6.75	6
Code 13	5	5	7	8	6.25	8
Code 14	3	4	4	7	4.5	5
Code 15	3	3	3	6	4.5	5
Code 16	6	7	8	6	6.75	9
Code 17	8	9	8	9	8.5	8

Appendix L (continue)

Raw Data

Low Translucency-Low Complexity

Subject Code	TRIAL 1	2	3	4	x	R
Code 2	5	0	2	2	2.25	4
Code 3	1	3	2	1	2.25	1
Code 7	3	2	5	5	3.75	6
Code 12	6	8	8	7	7.25	7
Code 13	6	5	6	9	6.5	7
Code 14	3	5	5	5	4.5	5
Code 15	3	1	2	3	2.25	3
Code 16	6	5	6	7	6	9
Code 17	7	5	6	9	6.75	8

Appendix L (continue)

Raw Data

Total Scores

Subject Code	TRIAL 1	2	3	4	x	R
Code 2	17	17	24	24	20.5	23
Code 3	13	12	14	11	12.5	14
Code 7	23	24	28	29	26	22
Code 12	29	36	35	34	33.5	33
Code 13	29	26	32	35	30.5	33
Code 14	24	27	27	31	27.25	29
Code 15	18	21	20	26	21.25	23
Code 16	30	31	34	33	32	36
Code 17	34	33	33	38	34.5	35

Appendix M

Summary of Potential Investigation Sites

Brain Injury Association of Greater Rochester of Rochester, New York stated the inability to participate and was unable to accommodate my research needs.

Marionjoy of Wheaton, Illinois stated the inability to participate and did not accecpt outside research projects.

Mt. Sinai of Chicago, Illinois stated the ability to participate and was available by the end of the June 1992.

Neurologic Center of Rochester, New York stated the inability to participate and was unable to accommodate my research needs.

Neurorehab Associates of Rochester, New York stated that the information regarding the research was not received.

NHIS/NYS/HIA of Rochester, New York stated the inability to participate and was unable to accommodate my research needs.

Rehabilitation Achievement Center of Lisle, Hazelcrest, and Wheeling, Illinois stated the ability to participate and was available by September 17, 1992.

Rehabilitation Institute of Chicago of Chicago, Illinois stated the inability to participate and does not accept research project outside of Northwestern University or their facility.

Respite Cares of Rochester, New York stated that a speech-language pathology department did not exist at their facility and was unable to participate.

Rochester Rehab Center of Rochester, New York stated that the facility's Board of Human Research did not meet until the end of May and was unable to participate until June. The primary investigator was in Chicago, Illinois after June 1, 1992.

Schwab Rehabilitation Center of Chicago, Illinois stated the ability to participate and was available in September 1992.

Appendix M (continue)

Summary of Potential Investigation Sites

Special Tree, Ltd. of Michigan stated the ability to participate and was available by the end of the May 1992.

St. Mary's Hospital of Rochester, New York stated that the information regarding the research was not received.

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