Louisiana State University
LSU Digital Commons

LSU Historical Dissertations and Theses

Graduate School

1995

The Effect of Developmental Factors on the Use of an Electronic Communication Device.

Judith Danute Oxley
Louisiana State University and Agricultural & Mechanical College

Follow this and additional works at: https://digitalcommons.lsu.edu/gradschool_disstheses

Recommended Citation

Oxley, Judith Danute, "The Effect of Developmental Factors on the Use of an Electronic Communication Device." (1995). *LSU Historical Dissertations and Theses*. 5975.
https://digitalcommons.lsu.edu/gradschool_disstheses/5975

This Dissertation is brought to you for free and open access by the Graduate School at LSU Digital Commons. It has been accepted for inclusion in LSU Historical Dissertations and Theses by an authorized administrator of LSU Digital Commons. For more information, please contact gradetd@lsu.edu.

INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

UMI

A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
313/761-4700 800/521-0600

THE EFFECT OF DEVELOPMENTAL FACTORS ON THE USE OF AN ELECTRONIC COMMUNICATION DEVICE

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Communication
Sciences and Disorders

by
Judith Danute Oxley
B.A.(Hons.) University of Tasmania, 1974
M.A., Louisiana State University, 1988
May, 1995

UMI Number: 9538755

Copyright 1995 by
Oxley, Judith Danute
All rights reserved.

UMI Microform 9538755
Copyright 1995, by UMI Company. All rights reserved.

This microform edition is protected against unauthorized
copying under Title 17, United States Code.

UMI
300 North Zeeb Road
Ann Arbor, MI 48103

© Copyright 1995

Judith Danute Oxley

All rights reserved

DEDICATION

I dedicate this work to my family: to my mother, Beverley Surkevicius, and to the memory of my father, Henrikas Surkevicius, who, together, taught me through their words and example to persevere; and to my husband, James, and my children, Margaret and David, who have supported me in every possible way.

ACKNOWLEDGMENTS

I wish to acknowledge the assistance of my advisor, Dr. Jan Norris, whose guidance in the organization and exposition of this project has been invaluable. It has been a humbling experience sitting down again and again to confront the succession of specters we call revisions. I am deeply grateful for Jan's patient scaffolding in this process, and the time and trouble taken to teach me how to write.

I also wish to acknowledge the assistance of my committee: Dr. Paul Hoffman, for advice on statistics, Dr. Janet McDonald, for helpful suggestions with the design and statistics, and Dr. Janna Oetting, for without whose help in uncovering the mysterious workings of dBase and SPSS-PC file management, I would still be in the company of T.S.Eliot's infamous Macavity and "...engaged in doing complicated long division sums."

My final acknowledgment is to James, who encouraged me to begin this adventure, kept me motivated, listened (and listened some more), and stayed by my side through the ups and downs of this endeavour called research.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

This study addressed a poorly understood variable of voice output communication aid (VOCA) use, namely mnemonic development. Forty children without disabilities, aged from 49 to 60 months, were required to use an IntroTalker (Prentke Romich Company) to participate in a one-on-one storybook reading task with the investigator. They were provided with sixteen messages to use during a scripted reading of The Three Bears. Children could use a trained verbal elaboration strategy or generate their own methods to retrieve messages.

Immediate and delayed responses of children under two training methods were compared, and the contribution of developmental factors, including metamemory, were evaluated. In the control method, Direct Instruction (DI), children learned to retrieve messages via an error-free method including simple repetition of a verbal elaboration mnemonic. In the experimental method, Active Problem Solving (APS), children were first led through a series of steps alerting them to the limitations of non-symbolic retrieval strategies and allowing them to make retrieval errors, thus discovered the relative value of various retrieval strategies. Next, they were taught to retrieve the remaining messages in the same way as the DI children.

Children with low metamemory skill were less accurate in their retrieval of messages, and produced more Self-corrected Responses when trained under the APS condition. Children receiving APS training showed an initial retrieval advantage on the first story-retelling immediately following training; however, on the second day retrieval by DI subjects matched APS. It was concluded that DI children experienced a de facto

"active problem-solving" condition on the first day, when they produced many errors, thereby enhancing the value of the verbal elaborations they had been trained to use.

Effects of perceptual, semantic and syntactic development, and of conflicts between the canonical and experimental Three Bears script were evident. Although the use of a normally developing population is controversial in the area of augmentative communication, the strategy was found to produce valuable insights into the errors made by children. Overall, the task was easy for most of the children, thereby supporting the use of VOCAs with young children.

INTRODUCTION

In 1980, DeLoache observed that a barrier to the study of the memory skills of younger preschool children was the fact that constructs such as metamemory and the mnemonic strategies had little relevance to young children. However, today, with the inclusion of computer-based speech prostheses (functionally similar to popular Touch 'n Tell toys) in early intervention programs for children with severe speech and physical impairments (SSPI), those constructs may be very relevant. If a child must remember which picture to press from an array on a keyboard to "speak" a message, then the act of remembering becomes an important issue to the child. Metamnemonic development is implicated when the act of remembering is the focus of the task. The metamnemonic development of preschool-aged children has been examined in terms of everyday tasks, with a focus away from use of symbolic mediators. However, using a computer for communication represents a very concrete, practical application of a paired-associates learning task. Metamemory is implicated, because children must use symbolic mediators to retrieve necessary messages. This study examined whether active problem solving (APS) enhanced the ability of normally developing preschool children's to retrieve messages from an IntroTalker, a computerized speech device. Immediate and delayed retrievals were considered, together with the contribution of various developmental factors in relation to training.

Metamemory for Mnemonic Strategies

The relevance of developmental memory to this type of computer-based communication has not been emphasized. The task has yet to be

characterized in terms of existing theories of developmental memory, taking into account parallel development of language. This chapter will establish the task and methods of training it within existing theories of developmental memory. For example, it has been a consistent finding that active problem solving enhances the procedural knowledge and the metamemory necessary for memory tasks (Fabricius & Cavalier, 1989; Istomina, 1977; Schleser, Cohen, Meyers, & Rodick, 1984). The acts of making decisions and creating strategies for remembering information assist in assimilating procedural and metamnemonic knowledge into an existing knowledge base. Assimilation enables new information to be accessed and used with greater automaticity than when information is passively learned. However, little is known about the effects of active problem solving on a young child's ability to produce and utilize the numerous strategies needed for computer-based speech devices in communicative contexts. Children must have well-developed metacognitive skills, including metamemory, to be aware of the need for specific strategies (i.e., verbal phrases linking the picture the stored material) to retrieve messages quickly and reliably.

The absence of studies may be explained by the recency of the introduction of computerized speech prostheses for adults and children with SSPI. The limited research has emphasized the relative complexity of various commercially available picture sets (Mirenda & Locke, 1989; Mizuko & Reichle, 1989; Musselwhite & Ruscello, 1984), vocabulary selection (Beukelman, Jones, & Rowan, 1989; Carlson, 1981), and selection techniques (Mizuko & Esser, 1991). However, Beukelman

and Mirenda (1992) identified learning issues associated with memory-based encoding techniques as one urgently requiring investigation, specifically the relative advantages and disadvantages of various encoding strategies for both literate and nonliterate augmentative and alternative communication (AAC) users. Although some studies have examined word-encoding and message-encoding, the subjects were literate adults with or without disabilities, not children (Angelo, 1984; Beukelman & Yorkston, 1984; Light, 1989; Light, Lindsay, Siegel, & Parnes, 1990).

The purpose of this study was to examine the ability of normally developing preschool children to use mnemonic strategies to remember adult- determined associations between pictures and the messages they encode. The study compared effects of active versus passive learning of verbally elaborated mnemonics (i.e., phrases linking each picture to its unique message) on the retrieval of messages stored under pictures on a voice output communication aid (VOCA). Children involved in the active problem-solving task were required to discover the need to use both the pictures and their accompanying verbal elaborations to facilitate message retrieval from the VOCA, in addition to learning the verbal elaborations themselves. Children in the more passive, direct instruction condition were required to learn the verbal elaborations linking pictures to messages through verbal rehearsal alone, without first becoming aware of their role in message retrieval. Their performance after a one-day delay was compared to determine strategy retention.

It was hypothesized that children in the active problem-solving condition would select more correct responses on a story retelling task than children engaged in the direct learning of the same material. This hypothesis suggests more is required of the children than the ability to represent a message with a picture; that is, the child must be aware of the need for a strategy for remembering this association and be able to understand its mechanism (i.e., metamemory). Results of this study provide (a) empirical data on alternative programs for training message retrieval from a VOCA requiring graded levels of association techniques, (b) the effects of a one-day delay on retrieval, and (c) insights into the developmental appropriateness of this type of mnemonic system for preschool-aged children. Alternative methods of training should be based on sound, theoretical models of those aspects of development inherent in the task. In this chapter, the task, which is unfamiliar to most people, will be described and characterized in terms of mnemonic and language development, thus establishing a purpose and rationale for the study.

Augmentative and Alternative Communication

Young children with severe speech and physical impairments (SSPI) often require early intervention to learn to communicate through AAC systems. Augmentative communication is generally used to refer to a whole system for augmenting and improving someone's communication, and it includes (a) devices and techniques, (b) representational sets and symbols, and (c) the communication skills needed by the user to exploit these components (ASHA, 1989; McCormick & Schiefelbusch, 1990). Early AAC intervention is now viewed as an

effective way of (a) bridging the gap between what the developing toddler can communicate independently at a given time, and what he/she needs to be able to communicate at that moment; and, (b) of preventing the emergence of secondary handicaps, such as academic failure, poor social skills, and psychological problems (Blackstone, 1990a).

Characteristics of Voice Output Communication Aids

The choice of components for an AAC system is an extremely complex, dynamic process governed by the changing characteristics of the user and the context (e.g., social, and situational) of device use (Beukelman & Mirenda, 1992; Burkhart, 1982). Until recently, toddlers with SSPI were limited to the use of nonelectronic communication boards or modified manual sign language as alternatives to speech. However, this situation is changing with the more widespread availability of affordable VOCAs, as well as computer-based games and toys designed specifically for small children (e.g., Prentke Romich Company; Don Johnston Developemental Equipment, Inc.). The advantage of VOCA use over these other augmentative techniques is its use of the auditory mode for transmitting messages. The voice output allows the child to get attention, to communicate over a distance (i.e., to "project"), and to communicate without the need for the active cooperation of the listener (i.e., the listeners need not cease their own activity in order to focus on what the child is indicating on a communication board). The VOCA thus provides the child with many of the communicative advantages inherent in speech.

However, the VOCA is unlike speech in several ways that make its use more complex, and its representation of a message more difficult.

This distinction is captured by Beukelman and Mirenda (1992) through the terms <u>intrinsic</u> and <u>extrinsic</u> message output. The concepts are difficult to define in simple terms, but are easily described.

Intrinsic message output refers to a situation in which the message and its medium are inseparable, as when someone speaks, gestures, points to a picture on a board, or points to a written word. There is an automatic quality to this output; an absence of intervening variables. For example, speech is a highly flexible and generative system of communication where any word within the child's repertoire can be produced at will to communicate a message.

By contrast, extrinsic message output requires some form of translation process, or some type of intervening variables between the speaker's mental formulation of an intended message and the resultant message form dictated by the repertoire available on the communication device. Memory becomes one such intervening variable for preliterate children using VOCAs. Because preliterate children cannot use the alphabet to generate novel ideas, they are limited to the preprogrammed options in the device, which may include single-word choices, word combinations, or whole messages. The child must therefore know the preprogrammed options, and select from the available words or phrases the item that is the best fit for the meaning of the intended message.

In addition, the VOCA user must translate between the auditorily learned representation of a word (i.e., speech) and the visual, pictured representation used by the VOCA. While the interrelationship between the auditory mechanism involved in speech perception and the

motor speech mechanism involved in speech production is well recognized in biological research, there is little indication that a similar biological link exists between the auditory mechanism and a nonspeech mode, such as pointing to pictures. The pointing-to-pictures output requires the formation of a relationship between pictures and the auditory message that is not encountered by the normally developing child learning to communicate through speech.

Speech is a rapid mode of communication; even kindergarten-aged children produce a mean of 2.33 syllables per second (SD of .70) when talking (Kowal, O'Connell & Sabin, 1975). The speed and accuracy of speech production cannot be duplicated in any other mode. An individual with no motoric impairments will have a slow rate of output when using a VOCA, while an individual with physical impairment may be limited to the production of only two-to-eight words per minute, compared to 180 per minute through normal means (Vanderheiden, 1984). The rate of message transmission via an AAC device by even the most sophisticated, experienced user is slow when compared to oral speech, placing the augmentative user at a distinct disadvantage in a society where rapid information transfer is prized (Buzolich & Wiemann, 1988; Glennon & Calculator, 1985; Light, Collier & Parnes, 1985 a,b,c; Parker, 1992). Parker, a college student who uses a VOCA, described time pressure during face-to-face conversation as "the biggest frustration that I have had to contend with every single day of my life"; and communication aids as "much slower than the human voice" (p.4).

The pressing need for rate enhancement during VOCA use creates many problems. Speech is infinitely generative, where rapid sequences of sounds can be combined, reordered, or modified to change the meaning of a root word, rearrange a sequence of words, or differentially inflect the same word to create different nuances of meaning. These properties contribute to the speed and efficiency of speech communication. These same properties detract from the speed of VOCA users by creating the need for more symbols that must be searched for on the overlay, activated, and converted to a synthesized voice response. To enhance communication rate, VOCAs are often programmed to produce longer messages under sequences of two-to-three pictures, or whole utterances under one picture. However, these time-saving strategies add complexity (i.e., the whole message must be remembered and associated with a picture or picture sequence that only indirectly suggests its meaning) that is not encountered by the unaided speaker. Tullos (1986) suggested that observational reports, alone, were available to support the claim that semantic compaction was the most efficient method of vocabulary retrieval from an augmentative communication device. He raised the question of whether its underlying theories were sound, particularly at the phrase and sentence level. More recently, the issue of trade-off between rate enhancement and developmental factors was raised as a caveat to interventionists (Blackstone, 1990b).

Memory Requirements for VOCA Use

Because oral communication is more effective than other means of expressing messages, children with SSPI will be more active and

independent as communicators if they use a technique such as a VOCA (Bruno, 1986). However, the complexity inherent in VOCA use means that the user faces increased demands on attention and memory; demands that may be beyond the capabilities of preschool-aged children without physical impairments (Cox, Ornstein, Naus, Maxfield, & Zimler, 1989; Guttentag, 1984). Furthermore, the preschool-aged child using a VOCA during stages of language acquisition has the task of learning to interpret picture-based representational systems in addition to the usual auditory word-based system of speech, and to use these pictures as mnemonic strategies for word and message retrieval. The representation of words using picture symbols is a complex symbolic ability requiring far more than a simple match of a picture symbol to a spoken word (Perlmutter, Schork, & Lewis, 1982). The comparisons of VOCA use to speech clearly indicate that AAC devices are not a simple substitution of one encoding system (picture-to-synthesized speech) for another (articulation of oral speech). Rather, the picture-encoding (representation) system required by a VOCA requires the child to bring under conscious control a series of deliberate actions, known as strategies, to assist memory (Pressley, Forrest-Pressley, Elliott- Faust, & Miller, 1985). The series of deliberate actions has two distinct, but related, phases, which involve the basic processes of memory, storage and retrieval.

Storage, sometimes called encoding, and retrieval, sometimes called decoding, are the two basic processes by which information is put into memory, or taken out of memory, respectively. These processes develop in sophistication and complexity. Under normal

circumstances, the terms encoding and retrieval are used to refer to the behaviors used in the process of memorizing and recalling one set of information. But within the context of VOCA use, these processes must also be involved in the simultaneous memorization and recall of the pictured representation and specific messages programmed in the VOCA. These basic processes of memory are believed to operate in two ways, intentionally and involuntarily. Both are apparent in the two phases of the VOCA task: (a) message encoding, consisting of initial memorization of material (i.e., available messages, picture codes, and associated verbal mnemonics); and (b) message retrieval.

Phase I: Message Encoding

. During the first phase of VOCA use, children are presented with VOCAs containing software with vocabulary and phrases encoded by pictures on the overlay and are required to engage in four distinct tasks. The first task consists of memorizing the various words and phrases available in the device. The use of a script constrains the range of available messages and so is believed to help the user memorize the material (Glennon, 1986). The knowledge that messages pertain to a given topic reduces the pool of potential messages. Memorization would be expected to proceed both automatically and effortfully: observation of pictures should, through recognition, evoke the relevant knowledge base automatically, so that what remains for the child is to remember which elements of the script are present in the device, and which are not.

The second task consists of becoming familiar with the properties of the pictures of the overlay. For example, this task may

involve the child examining individual pictures and noting differences between similar ones.

The third task involves learning the disambiguating mnemonics assigned to arbitrarily defined picture—message pairs. This relation may be suggested by an adult, or invented by the child. The availability of preprogrammed software packages makes the former situation a very common one. The child must recognize that the pictures are to be used as strategies to remember the location of various items. However, each picture can evoke multiple associations (i.e., a picture of a bear could represent "bear," "big," "animal," "furry," or "hibernating,") depending on a dynamic matrix of contextual cues. When all pictures pertain to a script, the absolute range of eligible associations may be reduced, but local ambiguities might still arise.

This potential ambiguity requires the user to engage in a fourth task consisting of the utilization of the single key concept underlying the unique relation between that picture and its preprogrammed word or message as a mnemonic device (Goossens' & Crain, 1987). The relation is necessary for future retrieval by the child of the message via the picture.

The use of the key concept as a mnemonic strategy is an example of a verbal elaboration strategy (Rohwer, 1973). For example, an arbitrary verbal elaboration mnemonic used to relate an overlay picture depicting a bed to a preprogrammed message, "I'm sleepy," might be "*I feel sleepy when I am in bed. So I will use the picture of the bed to remind me where I push to make the machine say, 'I'm*

sleepy.'" The picture of the bed could also arbitrarily encode the messages, "bed," or "Sweet dreams!" The memorization of the verbal elaboration encodes the specific, yet arbitrarily defined paired-associate information (i.e., the picture and its message) in such a way as to facilitate future efforts to retrieve the target message for the purpose of communication.

Theories differ as to how the information outlined above is initially stored in memory for future recall, and the differences have developmental implications. Theories differ according to whether storage proceeds intentionally or automatically.

Intentional storage. Intentional storage is the intentional, purposeful memorization of material (i.e., the messages, pictures, verbal elaboration mnemonics, and key concepts). That is, the rememberer is fully sensitive to the need to do something special about remembering material for the purpose of future recall; is able to identify how hard it will be to remember the material; and can choose, from an available pool, one strategy that will provide the most help. Thus, deliberate storage imposes a high demand on metamemory. In addition, it requires the rememberer to devote considerable resources to a task of questionable motivation (e.g., using the strategy of verbal rehearsal). Furthermore, deliberate memorization often requires the rememberer to recruit or imitate complex strategies. The more difficult the targeted memory task, the greater the need for deploying strategic behavior.

Incidental or automatic storage. Storage may proceed effortlessly, without the conscious control of the rememberer, as when

it occurs in the course of, or as the consequence of completing a task (Bjorklund, 1985). For example, because adults have a knowledge base rich in hierarchical associations, the act of reading a word list can result in an automatic encoding of items according to category (Bjorklund, 1985, 1987; Bjorklund & Harnishfeger, 1987). Children, whose knowledge bases are organized predominantly by episodic associations, may also automatically encode the same word list, but within different knowledge structures (Chi & Koesk, 1983; Nelson, 1986). Glennon (1986) has exploited the use of scripts to help children remember the content of the VOCA. That is, a child in the earliest stages of VOCA use may be more likely to retrieve messages accurately when the information on the overlay pertains to a familiar activity (e.g., snack).

Procedural knowledge, which includes information about how to do various cognitive and motoric tasks, can be gained through direct instruction, or can be learned automatically during interaction with people, problems, and materials. These automatically-learned insights include the particular values inherent in specific strategies (e.g., verbal elaboration vs. perceptual and spatial cues), their mechanisms, and their relationship to particular tasks (Fabricius & Cavalier, 1989). Finally, spatial information, too, is susceptible to automatic encoding (Parks & Mason, 1989).

Phase II: Message Retrieval

It is proposed here that the second phase of VOCA use, the retrieval of the intended message, occurs when children wish to convey a message in face-to-face communication. A task analysis of VOCA use

reveals several steps during the retrieval phase. At the simplest level, the child must be able to remember to use the VOCA if unaided techniques (i.e., speech or gesture) either fail or are likely to fail to meet the situational demands. Within an interaction, the child must be able to mentally generate messages; decide whether something is stored in the device that can be used to communicate this message; use the verbal elaboration strategy to locate and retrieve the desired message from the VOCA; know how to operate the VOCA; and know when to use it (Bray, 1990). In the previous example, failure to use the verbal elaboration strategy could result in the child pushing another picture, which, at that moment, suggests a sleep association. Conversely, the child could press the picture of the bed (encoding "I'm sleepy") in an attempt to communicate a different message (e.g., saying "Sweet dreams" to someone going to bed). These errors reflect the existence of other retrieval strategies available to the child.

Retrieval of messages from a VOCA can be accomplished through several strategies that vary in sophistication: (a) Children may ignore the symbolic mediator altogether and proceed to activate cells in trial-and-error fashion until the right message is spoken, a strategy consistent with Vygotsky's earliest stage of development (i.e., domination by perceptual responding); (b) They may exercise the simple strategy of using spatial orientation to direct their search. That is, they know that the desired message is in the bottom portion of the device, or in the bottom left corner; (c) They may activate the key bearing the picture which at that moment most readily forms some relation with the message they want to communicate, without being

conscious of its role as a mediator; and finally, (d) they may recognize that the situation calls for the recruitment of a retrieval strategy, specifically, the previously established relationship between a specific picture and a specific message. These behaviors represent a developmental progression with respect to symbol use and strategy use, and can be viewed as either intentional or automatic.

Intentional retrieval. Intentional retrieval is characterized by the same features as intentional storage. The rememberer (a) is fully sensitive to the need to do something special about retrieving information, (b) can assess the difficulty of the retrieval task, (c) can identify one or more candidate strategies, (d) can select the most appropriate one for the immediate task, and (e) can execute the retrieval task efficiently.

Children have several retrieval strategies available in the VOCA task, including conscious use of picture strategies at the perceptual level (recognition of something that is already present in perception or thought). However, it has been shown through the example above (sleep) that even deliberate use of a recognition strategy can fail to retrieve the desired message. Other intentional retrieval processes include the recall of something that is not present (often with the help of strategies); reconstruction of wholes from memory, given only the parts; and combinations of these three processes (Flavell, 1977).

The use of the verbal elaboration strategy requires considerable insight on the part of the child. Without specific cuing (including gestural and verbal cues), preschool children experience retrieval deficiencies, especially in the use of mnemonic mediators they created

(Goossens', Elder, & Bray, 1990; Pressley & MacFayden, 1983). Many theories explain retrieval deficits, including one suggesting that the difficulty derives from the lack of available retrieval cues with descriptive power for the child (Ackerman, 1985). In the VOCA task, children may see the pictures and be drawn to them without understanding their discriminative function with respect to specific messages. Alternatively, they may fail to see the relevance of the learned verbal elaboration mnemonics to the task, or believe that a simpler strategy is "better" in some respect.

Incidental or automatic retrieval. Effortless retrieval of messages occurs if the picture suggesting the targeted message happens to be correct, or if the need to use the verbal elaboration strategy was automatically cued by device use. Effortless retrieval occurs, for example, during a perceptual match: the child wants to request drink of orange juice, and the picture encoding the generic drink-request, "I want a drink," happens to depict a glass with on orange-colored filling.

Numerous experiences of failing to locate an exact picture match for the desired beverage could prompt the child at a later time to abandon the perceptual search, and attempt a different strategy; perhaps, use of a verbal mnemonic as a reminder. Note, the perceptual mismatch (i.e., "I can't see exactly what I want") should automatically cue strategy use (i.e., "The picture of orange juice makes me think of drinking. I push it to ask for any kind of drink.")

Metamemory and VOCA Use

The intentionality of the behavior required during both phases of the task is related to the concept of metamemory, a term coined by Flavell in 1971. Metamemory includes the ability to appraise (a) the difficulty of a task itself, (b) the suitability of known strategies to that task, and (c) one's ability to recover from errors. According to Flavell and Wellman (1977), people have metamemory when they recognize that some things are easier to remember than others, when they are aware when they are on the verge of recall, or when items are wholly irretrievable at that moment. Flavell and Wellman further describe metamemory as a form of social cognition, or awareness that emerges through interaction with others.

The social nature of metamemory development implies that children may be guided by parents and others to engage in the types of behaviors that result in the emergence of metamemory (Cavanaugh & Perlmutter, 1982). In the context of VOCA use, this social guidance may take many forms depending on the strategic demands of a particular phase of VOCA use.

Active Problem Solving and Memory in AAC

The critical distinction between intentional and incidental operation of basic processes is essential to understanding the mechanism of the problem-solving approach to learning. Children's knowledge bases are less stable than those of adults, and are therefore more susceptible to irrelevant contextual cues. In addition, children perform more poorly than adults on tasks requiring the distribution of attention and executive functioning across

multidimensional tasks (Guttentag, 1984). It is therefore more likely that they will produce important strategies in such tasks if their need is cued automatically.

To date, the research in AAC has addressed the importance of the child actively participating in choosing pictures to represent the messages stored in the VOCA (Bruno, 1987). It is well established that the child's knowledge base supporting the relationship between a given picture and an idea is structured differently from that of an adult (Bruno, 1988; Glennon, 1986). These studies have shown that when the child has an active role in selecting the picture to represent an object, the likelihood that the picture will be used to request or refer to the object is increased. Yet, despite the support for active participation by the child, practical matters continue to dominate the selection process, resulting in widespread use of starter-software packages in VOCAs. These packages were designed for subsequent customization to address child-specific preferences, but in practice, children are generally being required to master the pre-existing retrieval code without regard for their own associations.

Apart from research into active choice-making by children of symbol codes, however, there appears to have been little attention to the importance of active involvement in the development of strategic behavior in the service of memory in young children. It is important to stress the point that level of abstraction of the chosen pictures themselves becomes a factor only <u>after</u> the child has made the discovery that a strategy is needed for remembering the location of a stored word or message. Only then does the issue emerge of

determining a "best fit" between the symbol used to remind the child of the message in that location and the message itself. Thus, child participation in the picture selection process and the ability to make certain types of associations between target utterances and pictures in a selection array, might constitute only necessary, but not sufficient conditions of successful retrieval.

The technique of using invented cues or self-generated strategies, such as establishing a relationship between a particular picture and a message to be remembered, constitutes for Vygotsky a higher psychological function. Higher psychological functions are characterized by one important property: social mediation. In other words, the use of signs is learned through participation in social activities, rather than spontaneously emerging from individuals and their interactions with objects in the manner described by Piaget with respect to sensorimotor schema (Vygotsky, 1978).

What is of interest here is Vygotsky's characterization of how children are socially guided to move toward independent, self-generated strategy use. Social guidance consists of adults tailoring learning experiences that enable children to frame the problem, which, in this instance, is the need to use a sign to help locate the message; and to discover possible solutions.

According to Vygotsky (1978), children are more likely to develop higher level behaviors when older, more experienced persons design activities that are beyond the child's present level of ability, but within the limits of what the child can do when more experienced persons provided guidance to solve the problem; that is,

within the child's Zone of Proximal Development (ZPD). Guidance includes "scaffolding" and language modelling (Wood, Bruner, & Ross, 1976; Bruner, 1983). The key ideas related to VOCA use include active participation by the child, social modelling by adults of the to-be-learned mnemonic behaviors, and task presentation at a level that permits children to internalize roles and solve mnemonic problems independently (Paris, Newman & Jacobs, 1985).

Strategic Behavior and Social Participation

Paris, Newman, and Jacobs (1985) stress that imitation or simple transferral of step-by-step plans alone cannot account for the development of memory strategies: "children need to be motivated to remember, and they need to know how to adjust their behavior to new goals" (p.87). Building upon Vygotsky's (1978) theory, Paris et al. (1985) state three general principles about what they believe children learn about remembering from everyday experiences: agency, purpose, and instrumentality. Agency is what the child understands about the need to do something special about remembering (i.e., prospective planning, or storage for the future). At first, social agents, such as parents, prompt the child to remember, and perhaps even model strategies for him. Being an active agent implies that one is intentional, responsible, and critical about the remembering task (Paris et al., 1985).

Purpose refers to the child's recognition that the purpose behind the execution of certain behaviors is solely to aid memory. However, children have difficulty being purposeful about remembering because, although they can remember when remembering is part of the

task, they have trouble when it is a cognitive goal as an end within itself. Further, they may lack the necessary behavioral repertoire. Finally, children must learn <u>instrumentality</u>, or they may not treat the necessary behavior as instrumental to accomplishing the desirable goal. The responsibility that comes with agency consists of the ability to attribute a given outcome to one's own behavior (i.e., retrospective attribution). Parents play a role in focusing children on the relation between the activities they did before that enabled them to remember what they did later. The focus on this relation leads the child to learn about the goals or purposes of remembering.

Instrumentality may be seen as the link between agency and purpose. Children learn that certain behaviors help them remember, and that some behaviors are more useful than others in the achieving their mnemonic goal. Variables influencing the type of strategic behaviors children might use, include the meaningfulness of the task, and the degree to which the strategy is embedded in the task. When children are active agents in remembering, they become critical about their own behavior. They develop the special kind of knowledge described earlier as metamemory.

Vygotskian theory emphasizes the critical role of adult guidance in developing higher psychological functions, such as strategic memory, a skill of relevant to VOCA use. While changes in the knowledge base will allow children to use certain strategies automatically, without social guidance, these changes alone are likely to be insufficient to promote the type of picture mediated mnemonic strategy needed to make full use of a VOCA.

Active Problem Solving in Strategy Production

Successful message retrieval from a VOCA requires the execution of many complex steps. Although there are many apparent developmental dilemmas, many young children learn to use these devices effectively; others, however, are less successful, even when best practices are followed. A review of the work of master clinicians in AAC (e.g., Bruno, 1986; Burkhart, 1989; Musselwhite, 1985; Goossens' & Crane, 1988) suggests that best practices occur when the child has an active role in determining the messages and the pictures; and when instructional interactions take place in contexts that are meaningful to the child and in which there is a genuine need for retrieval of the specific messages in the devices. Another dimension needs to be added to the existing use of contextual facilitation in AAC: active problem solving of the need to use mnemonic strategies to facilitate location of desired messages.

There has been a movement away from models of intervention requiring the attainment of prerequisite skills prior to the introduction of aided techniques (Beukelman & Mirenda, 1992). The Participation Model is premised on the belief that everyone should have access to effective communication. VOCAs constitute an important part of an AAC system for many people, but there are developmental concerns regarding symbolic development and the need for strategic memory. The issue is not that we should dismiss the task on the grounds that it is beyond what the child can do at that moment. A more profitable approach follows Vygotsky, who stressed that children learn best when older, more experienced persons design activities that

are just a little beyond the child's present level of ability to perform independently, and provide special guidance that aids the child to solve the problem. In terms of VOCA use, the guidance includes heightening the child's sensitivity to the need to use the pictures as symbolic mediators. This study is structured in just such a way.

VOCA use imposes demands on both the storage and retrieval phases of memory. Despite the potential difficulty of the tasks, there is evidence from experimental data that their mastery may be helped when the child is provided with guided problem-solving experiences. It appears that problem solving helps children to recognize the need to inhibit impulsive, perceptual responding and use strategies learned through their interactions with adults. In the next section, experimental findings concerning developmental strategy use will be reviewed.

LITERATURE REVIEW

Active problem solving has been shown to enhance learning for children. To accommodate the need for active involvement, traditional methods are being supplemented or replaced with instructional enrichment. One application of instructional enrichment is to the learning of mnemonic strategies. Instructional enrichment modifies the way in which children are taught to use mnemonic strategies, by providing instruction not only in the procedural aspects of the strategy, but also in its rationale (Pressley, Forrest-Pressley, & Elliott-Faust, 1988). It has been a consistent finding that simple strategy instruction is insufficient to produce behavioral changes in memory tasks attempted by children of all ages (e.g., Bjorklund, 1985; Pressley, Borkowski, & Schneider, 1987; Schleser, Cohen, Meyers, & Rodick, 1984). When children fail to use pretrained, adult-determined strategies in appropriate tasks, they are said to exhibit "production deficiencies" (Flavell, 1970).

The production deficiency of interest in this study involves the use of multiple-meaning symbols (i.e., pictures) to encode and retrieve messages stored under individual keys of the IntroTalker (Prentke-Romich Company), a voice output communication aid (VOCA). Children sometimes fail to use verbal elaboration, a conventional mnemonic strategy, to assist the recall from memory of the picture/ picture sequences on the IntroTalker overlay corresponding to the stored message that the user wishes to speak. Instead, they use spatial or perceptual cues that can be misleading. This tendency suggests that instruction must address the representational and

procedural aspects of strategy use to ensure robust behavioral changes in four-year old children.

Aspects of Strategy Use Susceptible to Training

The most widely accepted definition of a strategy is provided by Pressley, Forrest-Pressley, Elliott-Faust, and Miller (1985) and is stated as follows:

> A strategy is composed of cognitive operations over and above the processes that are natural consequences of carrying out the task, ranging from one such operation to a sequence of independent operations. Strategies achieve cognitive purposes (e.g., comprehending, memorizing) and are potentially conscious and controllable activities (p. 4).

Strategies can become highly integrated into a task by a proficient user, so they are no longer used consciously. The relevant cues in the task will be sufficient to elicit the correct strategy. For example, use of an index to locate material in a book is a highly automatic behavior for people who use reference books routinely. Direct instruction in the mechanics of index use, and frustration from time wasted in random searches, combine to establish a causal and motivational link between searching and using the index.

Because the processes of storage and retrieval of messages from a VOCA are quite difficult when there are more than just a few items, people tend to use a variety of strategies to reduce effort. Children sometimes have difficulty spontaneously producing the strategies that can increase accuracy of VOCA use. In a study using normal children as subjects, Goossens', Elder, and Bray (1990) reported that spontaneous use of the picture encoding strategy was low, even for more able subjects. The mean proportion of unprompted, single picture responses in dramatic play settings after three

training sessions was around .30 and .50 for the lower and higher groups, respectively. The children required prompting, ranging from general verbal cues through an explicit fixed light cue on the target picture to produce responses, but no data on the degree of prompt that enhanced performance with greatest economy was reported. The authors noted that low response rate might be attributable to the dynamic (i.e., multidimensional) task, and the small amount of training. They have since extended training to seven sessions (Personal communication with N. Bray, 2-18-93).

Another interpretation could be that noninteractive instruction is not the best choice for this age group. Schleser, Cohen, Meyers, and Rodick (1984) investigated the effects of cognitive level and training procedure in the establishment and generalization of the use of self-instruction in problem-solving tasks (e.g., Matching Familiar Figures Test). They found that preoperational children in a faded rehearsal, directed discovery (similar to active problem solving), and no-training groups made more correct choices in tests than children in a didactic training group. Furthermore, the performance of the preoperational children in the didactic instructions group actually declined from pretraining to posttraining tests.

Flavell (1977) described a typical course of development of any given (voluntary) memory strategy in which he delineated three major periods. This developmental track holds for each new strategy to be mastered, and is not tied to specific ages. Indeed, the current view is that strategy knowledge is highly domain specific for young children (Borkowski & Turner, 1990). The developmental course can be

applied equally well to an adult or child learning to use a new mnemonic strategy. Moreover it pertains to both the storage and retrieval phases of remembering.

During the initial period of strategy learning, a given strategy is not available. The child cannot produce the necessary behavior in any way, nor be prompted to do so. During the second period, a production deficiency is noted; the child is capable of performing the necessary behavior under instruction, and execution of the strategy enhances retrieval. However, the child does not produce the behavior spontaneously during a test task. In the final stage of development of that particular strategy, mature strategy use is observed. When presented with a memory task, the child produces the necessary strategy without prompting, and execution of the strategy enhances retrieval.

It is generally believed that what is actually developing during the developmental phase is the child's knowledge base (Bjorklund, 1985). Knowledge base refers to a system of knowledge consisting of representations and processes (Kail & Bisanz, 1982). Schneider and Pressley (1989) claim that specific prior knowledge can affect memory directly. A good strategy user employs several kinds of knowledge consciously and unconsciously in strategy deployment. Effective strategy instruction should therefore address the various types of knowledge needed to promote spontaneous use of a target strategy.

There are several aspects of strategy use that are susceptible to training: (a) The mechanics of the strategy (i.e., the procedural knowledge), (b) the mechanism of the strategy (i.e., how it helps),

(c) the value of the strategy relative to other potentially helpful strategies, (d) the range of discriminative cues that could prompt the rememberer to use the strategy (e) environmental contingencies supporting or inhibiting strategy use, (f) user-specific variables (e.g., fatigue, willingness to carry out effortful tasks, etc.), and (g) the underlying representational system of the user. These aspects of strategy were exploited for the experimental training method.

<u>Strategy Mechanics</u>

Young children can be taught to use higher order strategies, such as (a) categorical grouping, as a way to learn lists of unrelated words, and (b) paired-associate learning (Pressley, Heisel, McCormick, & Nakamura, 1982). They appear to benefit from the training, but are unable to generalize it to other domains. Thus, training only the mechanics of a strategy is unlikely to promote its spontaneous use.

<u>Strategy Mechanisms</u>

Identification of the mechanism of a strategy, such as labelling the to-be-remembered, pictured items assisted four year olds in a structured memory task (Fabricius & Cavalier, 1989).

The ability to attribute a causal relationship to the use of a particular strategy and subsequent recall influences the child's ability to use it spontaneously. Providing experiences in which children can identify the causal links should enhance strategy use (Borkowski, Peck, Reid, & Kurtz, 1983).

<u>Comparative Strategy Knowledge</u>

McGilly and Siegler (1989) found that five year olds were able to detect contiguity relations in lists to be learned, and varied

their strategy use (i.e., the type of rehearsal used) accordingly. Children used repeated rehearsal on random lists, but not on contiguous ones. An important developmental finding was that the more children encoded about the material, the more they were able to vary strategy use accordingly.

Siegler and Shipley (1990) delineated three types of information influencing strategy use: effectiveness of each strategy (a) across all problems in the domain, (b) on problems with certain features, and (c) on particular problems. This knowledge is acquired through problem-solving experiences. Impulsive children, however, may not benefit so well from independent problem solving experiences. They may need the instruction of older, more experienced persons (Borkowski, Peck, Reid, & Kurtz, 1983).

Discriminative Cues

Children can benefit from environmental cues to strategy use (Dempster, 1985). Once they have learned through experience that one strategy is less effective than another in a given situation, the situation itself will cue the occasion for the more helpful strategy; or, a false-start with a poorer strategy will serve as a cue to do something different.

User-Specific Variables

A preschool-aged child using a VOCA usually uses picture-based symbols as the means to represent an idea or concept stored, or "hidden" in the device (for reviews, see Musselwhite & St. Louis [1988]; and Silverman [1989]). For a young child with limited-to-no functional speech because of a condition such as cerebral palsy,

picture symbols must augment or replace speech as the medium of the message, particularly until the child can read.

A picture-encoded expressive modality, however, influences the quality of possible messages (Glennon, 1989). Specifically, relevance and complexity of the available messages may be influenced indirectly by the constraints imposed by the user's vision, sensorimotor status, and development. These constraints influence number, appropriateness, flexibility (open-set or closed-set vocabulary), and configuration of items on a display. Unfortunately, these problems are not independent for young children. When children use VOCAs, they must be able to distinguish the dual role of pictures, a general subset of graphic symbols, as mediators of both meaning (specific pictures encode specific messages because of some relationship between the two) and memory (pictures are tools or markers that indicate the presence of messages under marked keys) in AAC devices.

The importance of this functional distinction to the construction of training activities should not be underestimated. Interactional styles between augmented speakers and their partners have been addressed from a discourse perspective (Higginbothom, Mathy-Laiko & Yoder, 1988; Higginbothom, 1989). It can also be seen that a communicative interaction between a VOCA user and a partner really contains an additional dyad: the child to his VOCA. That is, the child must be able to communicate with the VOCA, as much as to the listener, by knowing what it can say, where to find the messages (i.e., under markers), and how to find the messages efficiently (i.e., use a learned verbally encoded relationship established between a

given picture and its stored referent [Vygotsky, 1978]). The child must understand (a) the significance and utility of pictures as a strategy to locate messages that are communicated in synthesized or digitized speech when the appropriate picture is touched, and (b) how pictures represent these messages and thus serve as a communication system between speaker and listener.

Compounding the issue is the fact that it is not unusual for preschool children with severe speech and physical impairments (SSPI) to be considerably delayed in general language and cognitive abilities in comparison with peers without SSPI (Hardy, 1983). No normative data exist on the normally-developing child's ability to perform metacognitive tasks while in the process of communicating. Thus, the sophistication of these metacognitive activities should be investigated before we assume that they are appropriate for young, often multihandicapped, VOCA users.

The Underlying Representational System

The usefulness of available cues, especially in picture encoding, and the capacity and disposition of the child to use them are dependent on the child's level of representation. VOCA use is complex, making multiple demands on the child. The stability of children's representation and encoding, and their capacity to coordinate all aspects of VOCA use will now be addressed.

Capacity

Capacity, together with structure, and location of stored material constitute alternative ways to conceptualize the storage process. The notion of capacity is important to any account of

children's performances in tasks requiring strategic behavior. A popular view is that children are "universal novices," and as such, must expend a considerable proportion of their capacity for mental effort on otherwise routine aspects of tasks (Bjorklund & Harnishfeger, 1987; Brown & DeLoache, 1978).

A better understanding of the limiting role of a child's processing capacity for complex tasks has developed over the past 20 years since Flavell's (1971) description of production deficiencies. Wellman, Ritter and Flavell (1975) instituted a novel form of memory elicitation tasks ("hidden dog studies") for use with two and three year olds based on the belief that young children may exhibit higher levels of behavior only within well-understood tasks. Indeed, that was the finding. Since the first "hidden dog studies," there have been numerous variations of similar quasi-naturalistic tasks, ranging in complexity and age of subjects (DeLoache, 1985; Somerville & Haake, 1985; Wellman & Somerville, 1980). Quasi-naturalistic tasks have control elements built into their design, but otherwise are genuinely reflective of authentic, everyday mnemonic activities engaged in by young children. Activities include playground searches for lost items (Haake, Somerville, & Wellman, 1980; Somerville & Haake, 1985), and hiding games involving objects hidden in cupboards, boxes, and so forth, requiring logical search skills (Blair, Perlmutter, & Myers, 1978; Sophian, 1984; Wellman, Fabricius, & Sophian, 1985). It is reported consistently that, when the experimental tasks draw on familiar, well-understood knowledge, children are able to engage in sophisticated, mnemonic activity.

Location of information during the engagement of memory processes is another important consideration because the VOCA task appears to require the effortful, simultaneous coordination of several potentially complex behaviors. There is some question as to whether young children have the capacity to monitor multiple aspects of a task (Bjorklund, 1989). The amount of information anyone can monitor at one time depends on where in the memory process it is needed. The contents of memory is frequently subdivided into two components, short term memory (STM) and long term memory (LTM), the two differing in size, with LTM conceptualized as the larger (Baddeley, 1986). Variations of this model have emerged over time, including the modal model and the levels of processing model (Baddeley, 1886). Atkinson and Schiffrin (1968) extended Broadbent's (1958) two-tiered STM/LTM model to include an intermediary stage, the short-term store (STS). They also suggested that there are multiple stores corresponding with different sensory modalities, and that certain sensory stores were longer-lasting. The STS is thus regarded as a passive, holding station for information retrieved from either store. The length of time information resides in STS was said to determine learning, encoding and retrieval.

The STS is sometimes termed "working memory", although there are critical differences between the two (Baddeley, 1986). The STS is generally viewed as a passive repository of temporary information, while working memory is a multicomponent system consisting of a central processor and peripheral mechanisms which interact to process information (Schneider & Pressley, 1989). Certain mnemonic strategies

are closely associated with STM and LTM: rote verbal rehearsal (phonological encoding) and elaboration (semantic encoding), respectively. Working memory is limited in its absolute capacity, but can be enhanced through conscious strategies and unconscious means. "Chunking" information is a conscious process, used strategically. An example of chunking is the use of categorical labels. Unconscious means occur when certain aspects of a task are automated, including the use of a particular strategy. Through the task analysis of VOCA use, it was shown that children must divide attentional and processing resources among several tasks. It is, therefore, at the level of working memory that VOCA use imposes one set of difficult demands on the child.

Long term memory (LTM) may be considered as the general knowledge base of an individual. The contents of memory are usually divided into two types: semantic and episodic (Tulving, 1972). Episodic memory refers to memories for specific, personally experienced, past happenings. Semantic memory refers to all types of acquired knowledge, including language terms, their definitions, and their relations to one another (Bjorklund, 1989). The distinction is important for understanding developmental memory, especially the performance of preschool-aged children. There is considerable evidence that small children have very well-developed episodic memory that helps structure their experiences according to the event in which they participated, and that these event structures serve children's remembering in much the same way as taxonomic, semantic memory serves older children and adults (Nelson & Hudson, 1988).

The general conclusion from numerous studies of children's memory for items is that although children can recall items when presented with taxonomic cues (e.g., "tell me all the food that you saw"), they remember more items when the material stored as "slot-fillers" in "scripts" (Lucariello & Nelson, 1985; Bjorklund, 1985). Script is a term used to describe what children remember about routine events "organized in terms of temporal and causal relations between component acts" (e.g., going to the grocery store) (Nelson, 1983, p. 55). A slot is an optional part of a script (e.g., various grocery stores may be interchanged, or various food items purchased at a given grocery store without the basic script changing). A child is likely to recall more food items from lists structured to include items that would fit into recognizable slots (i.e., from the child's perspective) such as "all the food you eat at lunch time," rather than more general taxonomies, such as "food." The two lists might contain identical items, but retrieval cues draw on different organizational structures.

The inability of certain children to produce the cues necessary to retrieve stored information has been termed a production deficiency (Flavell, 1970); while the inability to use specific retrieval cues when they are provided by others is called a mediation deficiency (Reese, 1962). It would seem that constraints on processing space available in working memory might influence the probability that a child might exhibit production deficiencies. Conversely, mediational deficiencies seem more closely related to whether or not the

particular mediational cue actually addresses the knowledge base structure available to the child at that moment.

For example, a young VOCA user may be so engrossed in the conversational topic at hand, that she "forgets" to use the pictures on the VOCA to locate the message she wants to speak; instead, the child may activate keys on a trial-and-error basis until the desired message is spoken. The same child, on another occasion, might remember that the pictures help locate the correct key corresponding to the intended message. A mediational difficulty might consist of deciding which picture encodes the meaning the child wishes to convey. Mediational failure occurs if the picture that is selected does not encode the intended message. This state of affairs may derive from two sources: the pictures are not chosen on the basis of the child's knowledge base; or, the shifting nature (shallow) of perceptually-governed processing.

Depth of Processing and VOCA Use

Craik and Lockhart (1972) proposed multiple levels of processing, rather than just three. According to this model, the more perceptual the processing (i.e., the shallower), the more it is susceptible to being forgotten. Thus, the visual appearance of a word, the sound of the word, and the meaning of the word constitute a hierarchy of least to most memorable (Baddeley, 1986).

At the simplest level, if a child is using perceptual (i.e. shallow processing) relations to associate a symbol (e.g. a picture on a VOCA overlay, or a word in the message that the child has in his mind), with the message programmed in the VOCA, the stability of the

relation will only be as strong as the strength of the perception at that moment. Thus, if the message "I want a drink" is programmed under a picture of a glass of juice, and the child happens to want juice, his perceptual attraction to the picture will be sufficient to enable him to ask for the drink. On the surface (i.e., from the observer's perspective), the child will appear to be using the picture as a strategy for remembering where on the device to press to speak the message. By contrast, instead of using the picture to guide him, the child is actually being governed by it (Vygotsky, 1978).

This automatic perceptual match is qualitatively different from a situation in which a perceptual match is an inadequate retrieval cue, and the child must reflect on the fact that an arbitrarily defined property of the picture must be used to locate the message. Consideration of the other outcome, in which perception alone is insufficient, reveals the child's lack of strategic insight.

Thus, if the child happens to want chocolate milk, he may have difficulty using the juice picture to request it. This problem is also known as stimulus overselectivity, or the tendency to respond to a specific feature of a stimulus (e.g., color, location) instead of a general feature or cluster of features. Stimulus overselectivity is readily understood from a cognitive perspective as a problem characteristic of low-level perceptual responding. Children dominated by perceptual responding may be trained to recognize different properties of a stimulus, but will continue to be governed by the stimulus itself. As children move toward being active users of

symbols, they will become better able to decide which, if any of the available perceptual properties of a stimulus is relevant to the task.

If the memory task (i.e., finding where to push on a display to retrieve "orange juice") fortuitously addresses information that has a deeper, semantic level of processing (i.e., the relational link between drinking from a glass and the perceptual similarity of the picture to the word "orange,") it is possible that the child will perform a mnemonic task effortlessly and automatically, while giving the appearance of using a deliberate strategy. Note that it is still possible for the child to use the picture strategy at the deep semantic level, without doing so deliberately (i.e., without the need for metamemory). The more arbitrary the relation between the picture and the prestored message from the child's perspective, the less the child can rely on automatic processing to benefit from the pictures, and the more he must employ metamemory. Moreover, as the absolute number of to-be-remembered items grows, so does the demand on working memory capacity and the need for automatic retrieval.

Bruno (1988) compared serial responses to words and picture stimuli across three age-groups: four-, and six-year-old children, and adults. The results showed that first responses to both picture and word stimuli could be classified as naming responses. Naming is, thus, the most automatic response involving only perceptual demands, and is minimally demanding to working memory. Bruno therefore prevented the subjects from making naming responses through specific instruction. Subjects' non-naming responses were classified and ranked. Four year olds consistently produced as first responses to

the picture stimuli functional responses (69%), followed by episodic responses (22%), nominal responses (6%), and visual responses (3%), suggesting a hierarchy of processing demand. Functional responses have the form "noun-associated action" (e.g., book-read). Episodic responses are narrative descriptions of the form "Subject-Verb-Object" in which the response reflects a learned experience associated with the stimulus. The associated response could be a location (e.g., picture of a hammer = You put it in a tool box; picture of a book = You put it on the shelf), or a learned behavior (e.g., picture of a book = You put it away when you're done). A nominal response falls into the same grammatical class as the stimulus, and implies a specific subrelation to the stimulus (e.g., superordinate, coordinate, subordinate, part or location). A visual response describes a salient characteristic of a particular stimulus (e.g., daddy = big) or reflects a configural similarity (e.g., sun = round.) In response to word stimuli, rank-ordered non-naming responses were functional (70%), episodic (13%), nominal and auditory (8%), and visual (1%). An auditory response is generated on the basis of rhyming, or associated sound (e.g., hammer, ouch.)

Information-processing models provide an important link between the structure of memory and the processes that both contribute to and are influenced by the existing structure. Although the ability to retrieve information by way of a recognition strategy is present in young infants, the use of deliberate recall strategies appears to develop only later (Mandler & Stein, 1974; Ornstein, Naus, & Liberty, 1975). Information retrieval via recall necessitates the user having

a representation in either episodic or semantic memory; and the ability to use cues to evoke it in the absence of its referent in the immediate environment (Bjorklund, 1989; Dempster, 1985).

Developmental changes are most evident in the most effective cues for eliciting accurate recall in children, the ability to use learned strategies spontaneously in appropriate situations, and the ability to generate novel strategies via problem solving to enhance both storage and retrieval. Of particular interest is the concept of the memory capacity of children; that is, their capacity to use the basic processes of storage and retrieval.

Theorists favoring Piaget's developmental theory (e.g., Pascual-Leone, 1970; 1984) initially maintained that children's biological capacity to remember increased with age. However, this view has been rejected (Schneider & Pressley, 1989). Parsimonious accounts of memory development and performance in children highlight the roles of working memory and external factors, such as the time available for processing, and the total processing load (Dempster, 1985). Schneider & Pressley (1989) conclude that there is little evidence to suggest that the actual biological capacity of the child increases to account to apparent improved memory performance. Instead, what does appear to develop is speed and efficiency of information processing as a result of other changes in the child, including the structure of the knowledge base, metamemory, and use of strategies. Thus, Piaget's claim that memory is in some respect dependent on general cognitive development remains consistent with information processing models.

The concept of working memory as "space," of which a proportion is devoted to processing and the remainder is available for storage, serves to link the various lines of thought about developmental memory. If a child must divide attentional resources among several aspects of a task, as is the case with VOCA use, fewer resources will be available for voluntary tasks of retrieval that are apparently inherent in the task.

Developmentally young children tend to focus on one aspect of a task at a time. This unidimensional processing leaves fewer resources available for searching for a desired message, particularly if the situation is urgent or the physical/sensory demands of the task are high (Bruner, 1966). Bruno (1988) noted that it is very important for a child to have mastered the ability to locate messages in a VOCA automatically before using the device in the classroom, since timing and accuracy are so important in face-to-face communication. This need for automatic retrieval skills is dictated by both individual demands (i.e., constraints imposed by specific disabilities) and situational demands on the young user. However, techniques to address the training of the necessary strategies for memorization and retrieval of messages other than contextual use, free play, and rote rehearsal have not been addressed.

Knowledge Base

The pictures on an overlay serve as markers, signalling the presence of a message beneath marked keys. Moreover, each picture signals the existence of a specific message. The extent to which a child can use a given picture for locating a message rests on that

child's representational level in conjunction with structure of his knowledge base, and/or long term memory (LTM).

Pictures and spoken words are members of a broader set of signs. Peirce (1932) defined a sign as "something which stands to somebody for something in some respect or capacity" (p. 135). The field of semiotics defines signs according to their position on a scale of displacement from their respective referents. A symbol is considered the most abstract sign, bearing a relationship to its referent that is both arbitrary and conventional. For example, the word dog is a socially agreed upon symbol used in the English-speaking community to label a particular type of animal. An index is a sign that suggests its referent, for example a picture of a dog house suggests the dog because of the association. An icon is a sign that is inseparable from its referent. For example, a photograph of the dog resembles the actual dog.

A problem with these definitions is that the same sign may be used iconically, indexically, or symbolically by any given user depending on contextual and developmental factors (Lucas, 1980). For example, young children tend to use their earliest words and pictures in highly restrictive senses; their use of the word "chair," or a picture of a chair may be in reference to one particular chair, and not to the class of all chairs. Moreover, neither the word, nor the picture of the chair is in any way displaced in the child's initial understanding from the perceptual properties of that particular chair; the usage is highly contextualized. As the child's knowledge base grows and becomes conceptually (i.e., structurally) more like that of

an adult, he develops the ability to use the word more flexibly, in increasingly decontextualized ways, since he is no longer tied to a perceptual level of representation (Nelson, 1985). The process of developing rich semantic networks to support the child's growing vocabulary appears to be supported by the cooperation of more experienced language users who interpret and refine the words used by children (Ninio, 1983). Nelson and Lucariello (1985) suggest that children's lexical development includes the simultaneous development of three constituents of meaning: reference, denotation, and sense. These constituents of meaning have an important bearing on VOCA use.

The term reference refers to the relation between a word and what it signifies in the world; denotation relates a word to its possible referents (concepts); and sense relates words to other words (Lyons, 1977). Nelson (1985) differentiates between fine distinctions of meaning:

> It is important to note here that denotation in this discussion refers to the applicability of a term and not to its actual reference in an utterance, while sense refers to the relations of a word (lexeme) to other words in the vocabulary, and not to, say, a concept. (p. 14)

Nelson (1985), in addressing the development of first words, expanded on Lyons' definition of reference by suggesting that it should be considered as a highly contextualized, or deictic relation that may even be considered context-bound. Moreover, the ability to refer need not involve conceptual knowledge, but only the ability to form an association between a word and a particular object. When pictures are placed upon a communication board or a VOCA, they can be treated as substitutes for words. When children learn to mean through

the use of these pictures, interventionists must still deal with the tripartite classification between reference, denotation, and sense. Each picture can be used to refer to things in the world, denote some number of referents, and capture the sense of associated pictures.

<u>Whole Message Programming</u>

It is common for interventionists to program into a VOCA whole utterances, encoded under a single picture, or under a sequence of two or three pictures. This strategy has certain advantages for the child. It reduces the physical demands of selection; it reduces the overall number of items needed on a display; and it enables the child to make more precise reference in his communication. However, the cost of more specific reference is the decrease in denotational meaning permitted by the picture, and a reduction to just one of the senses in which a picture can be understood. A major cost to memory is that the child must remember exactly which aspect of meaning is encoded by each picture on the device (i.e., what is denoted by the stored utterance).

Bruno (1988) claims that because young children respond to picture stimuli in whole sentences, not single words, whole sentences should be stored, first. Bruno emphasized the importance of the associative value of pictures in facilitating memory:

> "Without any associative value, the process of message encoding becomes an arbitrary one. Recall of prestored information would be dependent upon the user's ability to intentionally memorize an arbitrary icon sequence and corresponding message." (p.19)

The present claim is that encoding and decoding remain arbitrary, even in the face of associative values. Indeed, when several items share

common associative value, arbitrariness is intrinsic to the problem, and unavoidable.

Further, the child must possess the cognitive ability to ascertain whether his current target may, in fact, have been programmed to denote something else. The aspect of meaning that is relevant to the encoding of a stored message is called a key concept (Goossens' & Crain, 1987). The key concept is derived from the message (M), inferred from a picture (P), and established by a relation (R). So, a verbal elaboration maps a particular denotational meaning onto a picture, which has a wide semantic field of senses, to enable the child to use the message for referential purposes. Consider, for example, a picture of a glass containing an orange drink. The programmed message might be, "I want orange juice." A situation might arise during preschool snack time where another child spills juice on the table. The VOCA user, in trying to participate in a discussion about the incident, might recognize the potential of the picture to refer to the spillage of juice. However, use the message stored under the picture of the juice (i.e., denoting a request) to capture the sense of the spill might mislead listeners and cause considerable confusion.

This message dilemma may contribute to frustration, or it could lead to early development of metacognitive skills for problem solving. There is also evidence from developmental studies of bilingualism that the emergence of a child's ability to "objectify words and speech" may be accelerated during the process of simultaneously learning two languages (Vihman & McLaughlin, 1982). There is evidence that the

acquisition of metamemory for a specific strategy can be facilitated (Lodico, Ghatala, Levin, Pressley, & Bell, 1983).

The notion that the same sign can be created and used differently by normally developing children at different developmental stages is only just being addressed in the AAC literature (Glennon, 1986; Musselwhite, 1992). Most of the attention has been paid to the representational properties of various picture sets and systems themselves in AAC research (e.g., Fuller & Lloyd, 1991), rather than the use of these signs by children at various developmental ages and within different contexts of use. The danger of focusing on symbol form is that interventionists lose sight of the developmental dynamism of picture use in children. Picture use is not a static phenomenon. Common misunderstandings between children and adults occur when the adult fails to recognize the level of symbolic displacement, or the sense of meaning, being used by a child, either via words or pictures, from one moment to the next.

Children who speak are required to manipulate only one dimension of mediation: the match between the message in their mind and the linguistic form (i.e., spoken words). Flexibility in word choice enables the child to select wording that will maximize the potential for correct listener interpretation. Even the youngest child is so good at this task that adults can typically interpret what a small child means by his words according to the context. This same flexibility is not available to a VOCA user: when a child activates a message in a VOCA that has been coded by a picture, there is a danger that the message spoken and the intended message may not be the same,

and the accuracy of listener interpretation is reduced, if not lost altogether. The flexibility is further decreased when whole utterances are encoded under a picture, resulting in increase in the cognitive demands on the child, especially the demand for memory as an intervening variable between message formulation and speech output.

The use of pictures to refer to speech requires the child to coordinate both symbolic and mnemonic mediation simultaneously. Task difficulty been largely underestimated. Baker (1985) argues that iconic representational systems obviate the need for recall memory by substituting recognition memory. The claim is that the user need only scan across the picture array, where the respective picture will serve to signal the message, as well as its location.

The problem with this assumption, with reference to four-year-old children, is that using such a strategy may not even occur to the child. While the child may be able to associate pictures with certain meanings in a reliable fashion (Bruno, 1988), deploying this knowledge might be difficult. However, under certain circumstances, the child might well appear to be using the strategy. This apparent paradox occurs because the use of mnemonic strategies develops along two separate dimensions best described in information-processing accounts of memory, and Vygotskian accounts of social learning. These two accounts of memory describe some strategies that proceed automatically without active control, and others that are actively controlled.

A practical way of overcoming the child's initial unfamiliarity with the use of strategies is to build the strategy use into the training of the whole task, so that it becomes as much a part of the

procedure as "speaking" the message. Strategy use becomes automatic, eliminating the need for active reflection on its use.

The Role of Symbolic Mediation as a Strategy

The task of retrieving prestored messages from a VOCA may be likened to a hide-and-seek game, in which the adult has hidden the messages in different "boxes" or cells, and the child must engage in some type of search behavior to find where the message is hidden. The child has three options: he can use ready-made relationships between the symbol and referent (perceptual relations that he observes from moment to moment); he can use semantic relations embedded within his knowledge base; or, the child can invent a relation between a picture marker, and the message it marks. This third strategy is an example of what Vygotsky calls symbolic mediation. Symbolically mediated search behavior is not well developed in young children, and undergoes refinement with increasing age (Wellman, 1985).

Vygotsky (1978) characterized the development of symbolic mediation of memory in terms of children learning to rely less on perceptual cues within the environment, and more on cues they invent for themselves. Moreover, children develop the ability to actively override the tendency to perceptually driven responding. Strategies may be different according to a child's developing knowledge base. At some point in this process, the child must be able to inhibit perceptually-governed responses, and use self-controlled responses. Part of development consists of the child becomes quite conscious of overriding an environmentally driven response (Wertsch, 1985). The

use of pictures to encode a predetermined, particular sense of meaning may require children to be able to override other possible meanings.

Two of the most common mnemonic strategies for memorizing stored messages are rehearsal and elaboration. Simple rehearsal entails simple, one-at-a-time repetition of material to be learned, and is one of the earlier strategies to develop (Cox, Ornstein, Naus, Maxfield, & Zimler, 1989). Cox et al. studied simple rehearsal among third grade children, and found that it was produced spontaneously, but was relatively inefficient when compared with cumulative rehearsal (i.e., the repetition of several items in each block); cumulative rehearsal could be trained with this age group. Pressing VOCA keys repeatedly has been identified in clinical settings as a common way for VOCA users to memorize the content and location of messages.

Elaboration, however, is not produced spontaneously, and may not emerge without instruction. It involves the formation of an association between pairs of information (e.g., words and pictures), that enables the rememberer to use the one to recall the other. Elaboration generates a common referential event in which either member of the paired associates may act as a retrieval cue to the other (Rohwer, 1973; Pressley, 1982).

A specialized application of elaboration is Minspeak (a commercial package), also known as semantic compaction, an encoding technique defined as a "semantic-feature-based-system ...(of encoding) ... the general ideas underlying human communication" (Baker, 1983, pp. 5 & 7). Baker (1986) identified the need for a limited number of graphic images that could be used arbitrarily, that is, similarly to

the alphabet, to provide VOCA users with easy access to the immense memory of words and phrases available in VOCAs. Semantic compaction is thus based on the polysemy (multiple meanings) of pictures, and the use of context as a means of disambiguating particular meanings.

Baker's use of context has been likened to a "filing system that permits a person to file sentences according to their connotations" (Creech, 1984). Context refers to the use of a picture symbol to denote a specific real-world context, or a representational context. For example, a picture of a truck connotes movement, and therefore could be used to denote the representational class of transportation. A picture of a lightning volt suggests speed. Together, the two pictures could encode the messages "Hurry up!" (i.e., lightning volt + truck), or "What a speed machine!" (truck + lightning volt).

Semantic compaction, implicitly, if not explicitly, requires the use of some type of verbal elaboration to encode the relation between a picture and its stored word, morpheme, or phrase. The pictures on the overlay can be used reliably as cues to messages once the user has encoded the one aspect, or key concept (Goossens' & Crain, 1987) of the picture that will establish its relation with a message. Unless the user has successfully encoded the relation, the picture will serve only as an unreliable guide.

Bruno (1988), in her Minspeak application program for young children, Interaction, Education, and Play (Prentke-Romich Company), distilled a key concept for each picture on the program overlay, and used it as the name of the picture (e.g., a complex picture, depicting a man extending a bowl in his hand has the name "want"). Children

using the program are required to memorize the names of the pictures to encode the relation used to relate picture to message.

Goossens', Elder, and Bray (1990) presented the relations to children in the form of longer phrases, such as, "The light bulb makes me think of 'lighting the candles.' When I want the machine to say 'Light the candles,' I push the light bulb." Again, children were taught to remember the relations through rehearsal alone.

The two strategies of rehearsal and elaboration are particularly effective in allowing the user to encode to-be-remembered material, and to retrieve it later. Unfortunately, spontaneous use of these particular strategies is not characteristic of four-year old children. Moreover, when strategic behavior has been taught in rote fashion to preoperational children, their performances on post-training tasks has been observed to decline (Schleser, Cohen, Meyers, & Rodick, 1984).

An alternative to didactic training entailing simple rehearsal of the verbally-elaborated mnemonics would be a package that embedded the rote rehearsal within a game-like problem-solving task in which the child must discover the need for remembering just one of the many possible relations suggested by each picture. A task established as a variation of familiar hide-and-seek games could provide the child with the opportunity to discover that pictures alone may be unreliable guides, since one picture may suggest one idea at one moment, and another at the next. This problem-solving approach will be used as part of the experimental method in this study.

Active problem solving provides a causal link between locating a message and the need to use the relation encoded in the verbal

elaboration. The causal link establishes in the user's mind why picture A should be chosen over picture B, to encode message C. Recall that the semantic compaction system treats pictures as arbitrary symbols (Baker, 1983). Thus, a picture of a glass containing an orange substance could be assigned to an extensive domain of message referents: "I want a drink, please;" "I'm thirsty;" "orange;" "She spilled the juice," and so forth. A picture of a six-pack of soda might be assigned to a domain of messages intersecting the domain of the first example. The verbal elaboration containing the critical relation assigned to the picture-message pair serves as a discriminative cue to the specific picture needed.

Nonspatial Mnemonic Strategies

Children may use perceptual strategies to retrieve messages, that is, they may activate pictures that physically suggest the idea they have in mind. This behavior is qualitatively different from a child who is trying to use the elaboration strategy, but fails to find the mediation of the pictures helpful. A child using pictures at a perceptual level may by unaware of strategy use. A potential problem facing interventionists is that many children functioning at the presymbolic stage are impulsive responders, drawn to whatever catches their eye at that moment; they rely on existing, perceptual links between a picture and a word to effect retrieval (Yussevich, in Vygotsky, 1978). Borkowski, Peck, Reid, & Kurtz (1983) examined the long term effects of impulsive responding on strategy use, and conjectured that impulsive responders were at risk for failing to learn the mechanism and value of strategies. Lack of understanding of

the mechanism of strategies appears to promote a pattern of impulsive responding in problem-solving situations, so that these children fail to benefit from strategies, or learn their value. The importance of this finding to AAC training should not be overlooked. Haphazard presentation of picture-encoding systems to children could prevent them from short-term success with their VOCAs, and also impair their ability to learn the underlying mechanism of the strategy necessary for progress along a continuum of more abstract representation.

Spatial Mnemonic Strategies For VOCA Use

The use of pictures as spatial markers and as symbolic mediators is causally linked. When the number of pictures on an overlay exceeds some critical number, the user has decreased ability to deploy the automatic use of spatial location as a cue. Studies of spatial encoding used by small children suggest that the encoding of the spatial location of pictures in visual arrays is automatic (Mandler, 1977; Park & James, 1983; von Wright, Gebhard & Kartlunen, 1975).

Park and James (1983) found that the proportion of correct responses by first grade children to questions about the position of a stimulus item from a field of two when they were instructed to look at the item, or remember its color was .63 and .65, respectively, compared to .71 and .70, respectively, when they were told to remember the position, and both position and color.

Von Wright et al. (1975) found that five-year olds were able to recall about 50% of locations of pictured items from a field of four in a series of ten fields, when location was the only feature asked to be recalled. Instructions (i.e., directing children to attend to

other features) had no effect on recall of spatial location, adding further support to the claim that memory for spatial location is somewhat automatic. Pertinent to the VOCA task was the finding that the children experienced significant interference in recalling the names of the pictures when asked to recall both the names and the locations. Although the children were able to encode spatial location automatically, conscious efforts at recall were still close to chance.

An additional complication for the use of a spatial strategy alone in the VOCA task is that four-year olds lack understanding of projective and Euclidean spatial relations (i.e., perspective and metric distance). Thus, the information that a message could be accessed with "the key near the top" of the VOCA would probably be insufficient for accurate retrieval, due to the child's lack of metric and orientational information, (Acredolo, Pick, & Olsen, 1975).

Information about young children's ability to encode the spatial location of unrelated pictures in an array, either intentionally or incidentally, suggests that some encoding is achieved automatically; intentional encoding enhances accurate retrieval; but that overall accuracy is low, and negatively influenced by additional task demands. Use of spatial retrieval strategies alone is unlikely to be adequate for retrieval in view of task complexity and need for accuracy.

Determinants of Strategy Use

People discriminate among available strategies on the basis of how well a given strategy will meet a need (Lodico, Ghatala, Levin, Pressley, & Bell, 1983). Needs vary, but they can be summarized as the need to reduce "effort," obtain rewards, and avoid penalties. All

of these needs may derive from one, or more physical, social, or cognitive sources (Paris, 1988). The user's perspective is most important in such considerations, especially with reference to small children. In the VOCA task, it has been shown that there is a need for considerable cognitive effort on the part of the child. The degree to which a child may choose to deploy an adult-targeted strategy, such as rehearsal or elaboration, hinges on how the child evaluates possible outcomes based on past experience. If the strategy has proven to be very effortful in the past, it will be less likely to be deployed by the child in the future (Cox, Ornstein, Naus, Maxfield, & Zimler, 1989; Ornstein, Medlin, Stone, & Naus, 1985).

Some children may find a trial-and-error approach to locating a message intrinsically rewarding, since the behavior involves playing with the device, and listening to the output from each keystroke (Todaro, 1990). Children with physical impairments may derive added pleasure from the same behavior, if it is one of the few they can control. Direct reinforcement and collateral reinforcement (e.g., if random activation of messages stimulates greater attention from other people) are very powerful. This hidden reward system could sabotage the child's motivation to go to the trouble of using pictures and verbal elaborations to locate messages. In other words, production deficiencies may derive from choice, rather than accident.

Other children might prize maintenance of an ongoing social interaction, or wish to minimize physical exertion if complex selection techniques are required for device access. These children might value strategies that minimize activations of unintended

messages, which could result in communication breakdown on the one hand, or the need for more exertion, on the other.

Thus, there are many subtle influences on children's choices of strategic behavior, apart from knowledge about the strategy. Because it is difficult control for these hidden reinforcers, learning experiences should focus on (a) making the value of using the target strategy to accomplish a particular goal more salient by providing positive reinforcement for its use, and (b) preventing reinforcement for non-target responses. Experience is thus encoded incidentally.

Incidental, or involuntary storage, stands in direct contrast to controlled, or deliberate storage methods that have just been described. This dichotomy was first addressed by Soviet researchers, particularly in the 1930s (Meacham, 1977). Incidental, or <u>involuntary</u> memory (storage) occurs when the individual is attempting to understand material, or to accomplish some other goal, and may be seen as a byproduct of the primary task. The Soviet investigators saw the development of the basic processes of storage and retrieval as an increasing reliance by the child on volitional activities for memory tasks. Volitional activities include the use of mediational strategies in general, and symbolic mediational cues in particular (Leontyev, 1977, cited by Schneider & Pressley, 1989).

In a problem-solving approach to the learning of verbally elaborated mnemonics, children are involuntarily learning the values accruing from all the various strategies they apply to a problem. Without engagement in problem solving, children merely mimic the behavior of others, thereby failing to derive an understanding of the

value and significance of their own behavior, much less its value relative to the other spontaneously available strategic behaviors. For example, passive repetition of verbal elaborations linking pictures to stored messages does not provide the occasion for the incidental learning of the rationale and merit of the elaboration. Furthermore, if, at the time of storage, the existence of "hidden" messages and picture cues leads the child to the use of the target strategy as a successful solution to the retrieval problem during practice, it seems likely that the same aspects of the task also will serve as discriminative cues to the target strategy at a later time (Fabricius & Cavalier, 1989). Such a cuing system is likely to simplify the task, thereby reducing cognitive effort by freeing up more "capacity" (Cox et al., 1989; Lodico, et al., 1983).

Goals of Present Study

The issues raised in the preceding review suggest that VOCA use is complex, requiring the co-ordination of several attention-demanding tasks, including use of symbolic mediators. It is proposed here that four-year-old children, because of their limited metacognition and symbolic representation, will experience mediational and production deficiencies when using the VOCA in a controlled task. At present, there is no information to guide the interventionist in establishing effective training of multimeaning-picture representation systems currently used with VOCAs, nor are there reliable guidelines for determining candidacy for particular systems of representation.

This study is motivated by the need to address system failure at a time when advocates are demanding, as a right, access to specific

systems that require use of multimeaning pictures. The need for early intervention with voice output systems appears a promising way of preventing secondary disabilities (e.g., social and academic problems). However, the limited survey data available, and the numerous complaints which reach the author, a practicing SLP in a university clinic, point to the fact that system implementation is very difficult, resulting in children and caregivers, alike, rejecting the systems. There is an urgent need to address the memory demands of the task, because memory is clearly fundamental to VOCA use, and highly susceptible to the developmental limitations of four-year olds, a population targeted in early intervention.

VOCA use is a practical extension of the hide-and-seek studies that have been effective tools for studying children's memory development. Metamemory appears to be critical to VOCA use, particularly when abstract representation is used. This study is therefore motivated by the practical issue of intervention, and the empirical issue of how children come to master the use of mnemonic strategies. Of the numerous possible questions concerning the memory demands of VOCAs, three have been chosen for this study.

The first question addresses the use of problem solving as a training strategy. Given that task effortfulness is known to compromise the performance of children on memory tasks, it seems logical to ascertain whether known measures to reduce effortfulness (i.e., letting children discover need for strategy) enhance strategy use over an existing method.

A second problem noted in the literature is the tendency of young children to use a strategy immediately following training, but not after a delay, at which time they revert to pretraining behaviors. This regression is taken to mean that the children failed to appreciate the value or purpose of the strategy, in that the situation did not cue them to use it, or they either rejected or forgot it.

Finally, the developmental appropriateness of the task may be addressed through an analysis of subgroups of children participating in the study identified by age, and performance on pretests of memory, general intelligence, and symbol manipulation.

The questions this study asks are:

1. Does a training package that includes a problem-solving component (i.e., the discovery of the need to use the adult-determined symbolically-mediated mnemonic strategy [i.e., pictures with corresponding verbal elaborations and rehearsal]) improve performance on a story-retelling task, compared with a similar training package that excludes the problem-solving component?

2. Is retention of the trained strategy consistent for both groups when a delay period is imposed between trials?

3. Can performance under a given training condition be predicted from age, or performance on tests of general verbal intelligence, memory, and picture symbol manipulation?

METHOD

The purpose of this study was to determine if active problem solving (APS) enhances the ability of normally developing preschool children to retrieve messages from an IntroTalker during a story-retelling task. Of particular interest was message retrieval requiring more complex retrieval strategies, such as the production and use of a verbal elaboration strategy (i.e., a phrase linking a picture to its unique message). The APS method of training was compared with a passive (error-free) learning method in which subjects received direct instruction (DI) to rehearse the verbally elaborated mnemonic orally. Strategy production was assessed in the context of an interactive story retelling task. Retention of learning was measured by having subjects repeat the task on the following day. Children's placement on a battery of pretests was used to identify subgroups within the sample (a) to ensure balanced groups, and (b) to measure the overall contribution of preexisting skills to, and interaction with, training methods.

Subjects

The subjects of this study were forty preschool-aged children without SSPI who completed a test battery and a two-day training program. Subjects ranged in age from 4;1 and 5;0 years. Thirty-eight subjects were Caucasian, one was Asian-American, and one African-American. Forty-four subjects initially qualified for the study by performing within the average range on a screening profile. This original population was administered an additional battery of tests related to memory and picture association abilities. These results

were used to assign subjects to the experimental and control groups, balanced for performance along these multiple measures of memory and picture association. Three subjects were discontinued prior to, and a fourth after completion of the study.

Subject Selection

Subjects were recruited from seven local daycare centers whose directors agreed to participate in the project. All seven centers were associated with large, main-stream churches in the capital city region. The socioeconomic group represented could best be described as middle-class, based on the fee structure at these centers.

A description of the proposed study and consent forms were disseminated to the parents of four-year old children identified by the director. Subjects whose parents returned signed consent forms were screened for normal development in hearing and general verbal abilities. To qualify for the study, subjects met two criteria:

1. Normal hearing as measured by a pure-tone air conduction screening of octave frequencies 1000-4000 Hz; and

2. Performance of not more than 1 SD below the mean on the Peabody Picture Vocabulary Test-Revised (PPVT-R) (Dunn & Dunn, 1981).

Group Assignment

Subjects who met the screening criteria were administered an additional test battery prior to assignment to the experimental and control groups. The battery consisted of a test of picture symbol manipulation termed the Semantic Compaction Competency Profile (SCCP) (Elder, Goossens', & Bray, 1990), three subtests from the Metamemory Test (Belmont & Borkowski, 1988; Kurtz, Reid, Borkowski, & Cavanaugh,

1982), and a simple test of short term memory using data from the Memory Estimate Test, a subtest of the Metamemory Test. A description of all tests is provided below.

Initial assignment to either the experimental (APS) or control (DI) condition was based on the PPVT-R. The subjects were rank-ordered according to Standard scores on the PPVT-R, with odd-numbered subjects placed in the experimental and even-numbered subjects in the control groups. These groups were further divided into subgroups based on performance on the SCCP. This division resulted in subjects subclassified according to the test protocol as either "high" or "low" in picture-symbol manipulation abilities for the experimental and control groups, based on performance on Subtest II (Appendix A).

The groups were subdivided a third time based on performance of a composite of the memory subtests. Composite scores, together with a group mean, were calculated from the STM and metamemory subtests, to create a memory factor with two levels (high and low). Subjects generally were calssified as strategy users or nonusers, hence the dichotomous variable. Following this assignment, subjects in both the experimental and control conditions were subclassified as (a) High SCCP-High Metamemory, (b) Low SCCP-High Metamemory, (c) Low SCCP-High Metamemory, or (d) Low SCCP-Low Metamemory.

The groups at the initiation of the study were equal in size, with twenty-two members in each group, and balanced in distribution across the SCCP-Metamemory subclassifications. However, four of the original subjects were lost to attrition; including one parental request for withdrawal, one chronological age that exceeded the limit

by the time she could be seen, one child unable to perform the task, and one nonattendance resulting in loss of one set of data. The final groups included nineteen subjects in the experimental group and twenty-one in the control group. Table 3.01 presents the distribution profile of subjects who completed the study, categorized the SCCP-Metamemory subclassifications (later identified as "Memsym 1-4").

Table 3.01

Distribution of Subjects in Experimental and Control Groups Subclassified as High of Low in Picture Symbol Manipulation (SCCP) and Metamemory Abilities

	SCCP/STM-Metamemory Classification			
	Low/Low	Low/High	High/Low	High/High
Experimental	8*	3	4*	4*
Control	5*	4	7	5
Combined	13	7	11	9

* denotes one subject lost due to attrition.

Materials

The materials in this study included test instruments, equipment and materials associated with a voice output communication aid (VOCA), recording equipment, a motivational tape, and a storybook and script used to elicit responses.

Test Instruments

The test instruments used for subject selection and group assignment included standardized measures and informal instruments described in research reports. Because the subtests of the Metamemory

Test were modified from the originals, and are not readily available or well known, they are described in some detail.

The PPVT-R (Dunn & Dunn, 1981) is a screening measure of verbal intelligence and was used to screen for normal abilities. This test requires that the meaning of single vocabulary words be associated with line drawings selected from a choice of four, a task similar to that required on a VOCA.

Hearing screening was used to establish normal hearing thresholds. The digitized speech used on the VOCA is difficult to understand, compared to normally produced speech, and even a mild hearing loss could further reduce the perception of intelligibility of digitized speech. Children's hearing was screened using a Maico MA 40 portable audiometer calibrated in dB HL (ANSI, 1989). Screenings were conducted on site under the quietest conditions available, with distractions minimized.

The Semantic Compaction Competency Profile (SCCP) is an instrument specifically designed to assess a child's ability to use pictures at increasing levels, or "patterns" of encoding (Elder, 1986; Elder, Goossens' & Bray, 1990). It was used to ensure that training groups were balanced in terms of symbol manipulation skill. The test yields a profile of performance according to a hierarchical ordering of patterns. Pattern 0 indicates an inconsistent ability to use pictures to represent single verbal messages. Pattern 1 indicates that a specific picture can be associated with a single verbal message. Pattern 2 indicates that a single picture can be associated with multiple meanings or verbal messages (i.e., a picture of an apple

can be used to represent "round," "small," "red," "eat," "juicy," or "fruit." Patterns 3 and 4 indicate that a sequence of two and three pictures, respectively, can be used to represent a single complex message (i.e., truck + apple = "Let's go [trucks go] eat [you eat apples]"). Pattern 5 indicates the ability to use "themes" (Baker, 1988) to encode and retrieve messages stored under 2-3 symbol sequences. These patterns reflect very different skill levels for picture-message association tasks. Elder et al. (1990) classified children exhibiting Patterns 0-2 as having "Low" ability, while those exhibiting Patterns 3-5 were classified as having "High" ability. This classification was based on a sample that included older children. Because four children in all (including two lost to attrition) in the present sample attained pattern 3, performance passing performance on Pattern 2 was used to determine a more descriptive measure of symbol manipulation than the original. A full description of the SCCP is presented in Appendix A. The Icon Association Flexibility subtest serves as the ceiling for Pattern 2. The passing criterion is correct use of 6 out of a possible 12 semantic association techniques. The latter correspond to the techniques required for the experimental task. The validity of the SCCP as a predictive tool for the use of the semantic compaction encoding strategy is still under investigation (Elder et al. 1990).

Metamemory Test. This test includes three subtests adapted from similar procedures described in the literature (Kurtz, Reid, Borkowski, & Cavanaugh, 1982), together with the STM test mentioned above. It was used to ensure that subjects were balanced on these

skills between the two conditions. A composite score was obtained on each test. Subjects scoring at or below the mean (11.46) were classified as having "Low Metamemory," and the remainder were classified as having "High Metamemory." Appendix B contains a complete description of the metamemory test.

The first subtest is a "Story List" (SL) (Belmont & Borkowski, 1988). This subtest assesses knowledge about the efficacy of elaboration. Subjects are shown eight pictures (man, bed, tie, shoes, table, dog, cat, car) and asked if the items would be easier to remember after hearing them named or hearing them in a story that included the eight words (maximum = 8 points).

The second subtest, "Preparation Object" (POT), measures children's planful behavior for preparing for future retrieval (Kurtz et al., 1982). In the original task, designed for elementary school-aged children, subjects were asked to assess the situation of a child in a story. The situation involved a child who wanted to skate after school on the next day. Children were asked what they might do tonight, if they were that child, in order to remember to take the skates to school the next day. The original test, devised for children in elementary school, was modified slightly for the younger population in this study. All the daycare centers held a water-play activity during the week known as "Splash Day". To participate, children were expected to have brought swimsuits and a towel. The original, hypothetical skate scenario was presented to each child, but a modified scenario was then presented. The children were asked to suggest how they could remember materials they would need for Splash

Day. Eight response classes are scored, and an extra point is awarded for a second instance from a class, and another if three different response classes are included (maximum = 8 points).

The third subtest, the "Memory Estimation" test (MET) (Belmont & Borkowski, 1988), measures the ability to judge memory capacity. Subjects must first predict how many of the 16 unrelated pictures of common items they could freely recall if given one minute to study them. After the initial prediction (P_1), they were given one minute to memorize a second set of 16 pictures, and one minute to recall them aloud to the examiner. Finally, a third set of 16 pictures was presented, and the children made their second prediction (P_2) about how many they could recall if given one minute of study time. The first prediction was scored as $4(1-[P_1 - A]/A)$, where A was the actual number recalled from the second list. The second prediction is scored $5(1-[P_2 - A]/A)$. Negative scores are regarded as zeroes. The second formula weights a hypothetical increase in awareness of memory capacities produced by the practice trial. The two scores are summed to obtain an overall ME score (maximum = 9 points).

Short Term Memory Test. The number of pictures actually recalled by children in the MET (above) was used as a measure of STM. Sixteen pictures were used to correspond to the sixteen pictures on the IntroTalker overlay (8 points).

Equipment and Customized Materials

This study required use of non-standard equipment and customized materials to accompany it. Materials are listed and described below.

Voice output communication aid. An IntroTalker (Prentke-Romich Company) VOCA was used to elicit subject responses this study. This VOCA allows verbal messages to be programmed and retrieved using pictures or symbols arranged on an overlay. The IntroTalker was set up in 32-location overlay format, which allows for 32 different, single-hit messages to be elicited by touching the corresponding picture for that cell. A rigid keyguard separates individual cells. Each cell measures 1 3/8" x 1 3/8", a size that is easily activated independently of surrounding cells by preschool-aged children. The keyguard provides a 2/8" frame around the non-edge borders, and a 1/2" frame around the edge borders. Two standard vinyl overlays, one blank, and one with pictures were used. An IntroTalker is functionally similar to commercially-available toys with membrane keyboards and synthesized speech that "talk" when the child presses a place on the keyboard. An external speaker (Realistic Minimus Speaker) was attached to the IntroTalker to enhance the clarity of the speech. A switch, interrupting the speech output to the external speaker, was used by the investigator to disenable the speech output at critical junctures. The switch remained hidden from the child under a towel on which the examiner rested her hands.

Switch. A custom-made finger switch (Radio Shack SPDT MOM Push Switch) was used by the investigator to control the location of messages that could be activated during training.

Stop watch. A Timex triathlon watch with stop watch function was used to time the memory tests.

Recording equipment. A TCS-43C Sony cassette recorder with a (Radio Shack) microphone was used to record the verbal story retellings on Day 2. A Panasonic AG-170 VHS video camera was used to record the picture selections made by the children during the story retellings. The camera was mounted behind and to the left of the child to capture the child's pointing responses.

Motivational tape. A four-minute videotape depicting four-year children with cerebral palsy (CP) using adaptive equipment (by means of electromechanical switches activated with hands or elbows), and an IntroTalker (by means of single finger access) was shown to participating subjects. This videotape showed the investigator interacting with two children (a male with CP and his able-bodied twin) using an IntroTalker in the context of a storytelling task. The tape was played from 1/2" VCRs available on site and was shown on a 20" color television screen mounted at the subject's eye level.

Illustrated book. The illustrations from the storybook The Three Bears (Golden Press, 1983) were used to elicit both the verbal and the VOCA assisted story retellings. The classic fairy tale was selected because most children know the story and can verbally retell a large number of events with minimal prompts. The familiarity of the story serves to reduce the working memory requirements for story recall so that greater attention can be directed to locating associated VOCA messages. Moreover, the pictures in this version clearly depict each of the important events presented in the story reading script. A script, rather than the words printed in the book, was used for all book reading events.

Story script. A script designating the exact wording that the investigator used to read The Three Bears story ensured that all subjects had the same opportunities to hear and to participate equally in the retelling task. The detailed script included the places in the story where the adult paused to allow the child to complete the sentence or idea using the VOCA (see Appendix C.) The script paused at 76 separate places and required 14 different messages for an accurate retelling, each represented by a specified picture.

Picture layout on the VOCA overlay. The standard 32-location vinyl overlay, together with the corresponding keyguard, was placed on the panel of the IntroTalker. The term cell refers to a visual location on the overlay identified by an alphanumeric coordinate (e.g., A1 on Figure 3.01 is the uppermost cell in the left corner). When messages are stored at a given location, the computer encodes the alphanumeric coordinate.

	1	2	3	4	5	6	7	8
A		BA		SI		EA		TU
B	WR		FA		BI		LI	
C		BR		LO		HO		OU
D	HE		NO		GO		MO	

Figure 3.01. Alphanumeric cell identification, and location of pictures, specified by their identification codes, on the 32-location IntroTalker overlay

---

A checkerboard design was selected for picture arrangement because it reduces visual confusion for novice VOCA users. The

checkerboard array presents certain problems for experimental design. The cells used in columns 1 and 8 (i.e., A8, B1, C8, and D1) have special spatial salience, not only because they are on the edge, but also because there are only two cells used per column, in contrast to four cells per row. One solution would be to leave all edge cells blank. Then, however, the cells used in columns 2 and 7 would assume undesired, privileged, spatial salience. It was therefore determined to place filler items at these locations. Thus, the visual configuration includes all 16 target locations, but the interfering variable of spatial privilege is minimized.

The term item will be used henceforth to refer to an associated pair consisting of a picture and a message, together with the derived verbal elaboration mnemonic. Each item has a unique identification code (Table 3.02). Because stimulus material was assigned to association categories according to the investigator's criteria, an analysis of the resultant ranking of items was planned. Within- and between-category item analyses were also performed as part of a reliability check on experimental results.

Items were assigned to the cells by a two-step procedure. First, the four filler items were randomly assigned to the four edge cells. Next, the twelve target items were randomly assigned to the remaining cells according to the checkerboard array, without regard to order of appearance in the script, or category of message represented. The cells of the overlay were designated as first, second, third, etc., to receive the items as they were drawn in the randomization procedure. Thus, the first target item to be drawn was assigned to

A2, the second to A4, the third to A6, and so forth. The outcome of the randomization procedure is presented in Figures 3.01 and 3.02.

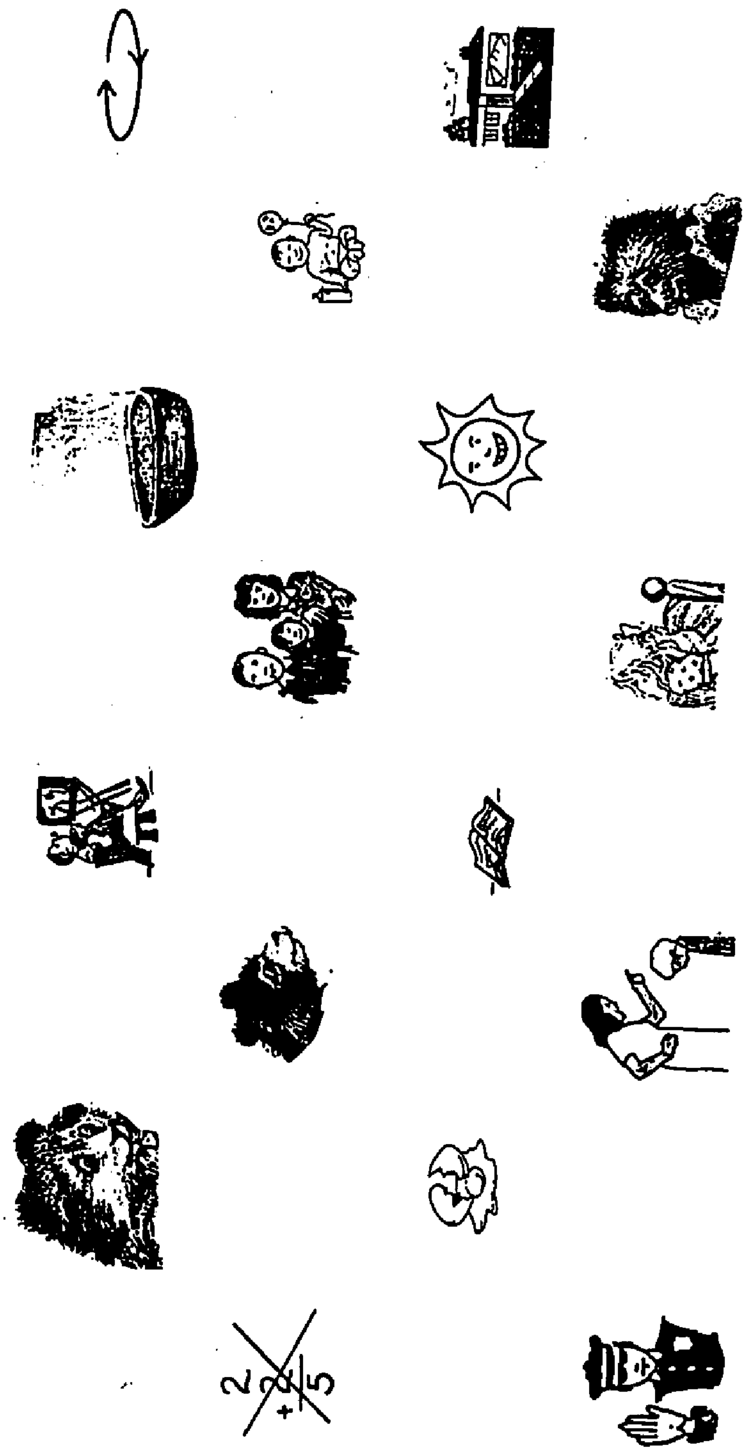
IntroTalker messages. Five types of messages available for use by the subjects to participate in the VOCA-assisted story retelling task were programmed into the IntroTalker. They were (a) names (e.g., Father Bear), (b) descriptive characteristics (e.g., hot), (c) repeating lines of text (e.g., "Someone's been eating my porridge"), (d) prompted fillers (e.g., "Turn the page, please"), and (e) unprompted fillers (e.g., "I pushed the wrong one"). The list of messages, categorized by type of response, is provided on Table 3.2. Categories 4 and 5 comprise the fillers for the spatially privileged cells. Because use of all 16 target locations on the overlay was necessary to reduce the influence of spatial salience on the non-privileged cells, four filler items were developed. Constraints on the selection of items for fillers included the need for items that reflected those typically used by children using VOCAs, and the practical problem of finding additional messages that could be repeated five times. Three commonly-used behavioral regulators (i.e., Items 13, 15, & 16) (DeBaun, 1991), and a tangential concept from the story (Item 14) were selected as the fillers.

There are many factors extraneous to the experimental training conditions that could influence use of these fillers (e.g., spatial privilege, importance to maintaining the interaction) and non-use (lack of importance in the story, low probability that speech-intact children would use the device for an interpersonal task that is extrinsic to story retelling), hence their planned exclusion from

Table 3.02

Item Number, Identification Code, and IntroTalker Message Characterized by Association Category Used for Retrieval

Item Number	Identification Code	IntroTalker Message
	Naming Items	
1	MO	mother bear
2	FA	father bear
3	BA	baby bear
4	GO	Goldilocks
	Descriptive items	
5	LI	little
6	BI	big
7	HO	hot
8	BR	broken
	Repeated line items	
9	NO	No, no, don't do that!
10	EA	Someone's been eating my porridge.
11	SI	Someone's been sitting on my chair.
12	LO	Look!
	Prompted filler items	
13	TU	Turn the page, please.
14	OU	Outside
	Unprompted filler items	
15	HE	I need some help please.
16	WR	I pushed the wrong one.



<u>Figure 3.02</u>. Picture overlay used on the IntroTalker by subjects to retrieve messages for story retelling activities.

data analysis. Their inclusion on the overlay is justified on the grounds of providing options for the privileged cells.

Stimulus pictures. Eleven realistically colored 1" x 1" drawings selected from Minsymbols (Prentke-Romich Company) and Pick 'n Stick (Imaginart) pictures, and one picture from a published overlay (Glennon, 1986) were selected to represent eleven messages programmed in the VOCA. In addition, five pictures were cut to the 1" x 1" size from a copy of the Golden Press (1983) version of The Three Bears (i.e., the four characters and the father bear's porridge bowl) and used to encode the remaining five messages. Each picture alternated with one blank cell (i.e., only white vinyl was visible), so that sixteen pictures, in all, were displayed (Figure 3.02).

Pictures for the display were selected to represent the scripted messages using a concept-listing approach, where a key concept is abstracted from the message. For example, the key concept in the message, "Someone's been eating my porridge" is "eat," and so a picture, such as a bowl, is selected to represent the key concept and, by association, the message from which it was derived (Goossens' & Crain, 1987). Note that a key concept (i.e., a unique denotation from many possible senses of meaning of the picture) must also be identifiable from the chosen picture. Once affixed to the cell of the overlay containing the programmed message, the picture becomes a symbol for that message. The categories of actual key concepts, in contrast to the set of possible key concepts suggested by the pictures, together with the corresponding verbal elaboration mnemonics provided for training, are presented on Table 3.03.

Table 3.03

Verbal Elaboration Mnemonics Pairing Pictures and Messages via a Key Concept (Sense of Meaning) Suggested by Pictures, by Association Type

Identification code	Key concept	Verbal elaboration mnemonic
		Naming associations
MO	mother	... mother bear.
FA	father	... father bear.
BA	child	... baby bear.
GO	girl	... Goldilocks.
		Episodic associations
NO	no	... a mother, and mothers shake their fingers and say "No, no, don't do that!"
EA	eat	... a bowl, and you eat from a bowl.
SI	sit	... a chair, and you sit in a chair.
LO	look	... a book, and you look at a book
		Visual associations
LI	little	... a baby, and babies are little.
BI	big	... a father, and fathers are big.
HO	hot	... the sun, and the sun is very hot.
BR	broken	... an egg that is broken.
		Prompted fillers (various associations)
TU	turn	... arrows turning around and they make me think of turning pages.
OU	outside	... trees and flowers, and trees and flowers are outside.

(table con'd.)

Identification code	Key concept	Verbal elaboration mnemonic
		Unprompted fillers
HE	help	... a policeman, and a policeman helps you.
WR	wrong	... an X, and those numbers have an "X" on them because they are wrong.

Note. Each verbal mnemonic begins with the carrier phrase, "That's a picture of..."

Three types of abstraction were used in deriving the key concepts for non-filler items, following Bruno's work on the picture-association skills of four-year old children (Bruno, 1988). The types are naming-, episodic-, and visual-associations. These three types ofassociation were chosen to serve as reliability checks on the results, because the need to use the verbal elaboration strategy is dependent on the level of abstraction of the picture-message association.

Naming refers to a response involving perceptual demands, and is used most often by this age group unless specifically prevented (e.g., the child is told not to say the name of the picture.) It is thus highly automatic, making minimal demands on working memory. The verbal elaboration mnemonic used to train the picture-message association consists of simply naming the key concept pictured. The inclusion of associations based on simple naming assured that (a) the VOCA task itself could be completed by all subjects, allowing some degree of success with the story-retelling task, and encouraging the abler subjects to attempt more difficult mnemonic behaviors; and (b)

limiting floor effects on results. Floor effects in the experimental task could occur when the overall task is too difficult for subjects, resulting in uninterpretable, poorer-than-chance performance on the task as a whole. Success on items requiring naming associations and failure on items requiring more abstract picture associations can thus separate problems with strategy use from a more general inability to use the VOCA.

An episodic response is a narrative description (i.e., Subject-Verb-Object) in which the response reflects a personal experience associated with the stimulus (e.g., a book = You look at pictures in books; eat = You eat from a bowl.) Episodic responses lie between naming and visual responses in terms of association difficulty, based on their spontaneous production in confrontational picture association tasks (Bruno, 1988). Spontaneous retrieval of messages encoded under episodically associated pictures might suggest the use of the verbal elaboration strategy. However, because this type of association easier than visual association, it may represent an easier entry level for children being trained to use a strategy as sophisticated as verbal elaboration.

A visual response describes a salient characteristic of a particular stimulus (e.g., daddy = big) or reflects a configural similarity (e.g., sun = a round shape). Visual responses were included because they are not the first associations (i.e., the most automatic) that children make to picture stimuli in confrontational picture association tasks. Correct, spontaneous retrieval of messages encoded with visual association properties would suggest the use of a

more complex mnemonic strategy than labeling the immediate perception, such as the verbal elaboration strategy, which designates the salient features used to guide attention. The inclusion of visual responses was further justified by the need to avoid ceiling effects that occur when stimulus material is too easy, rendering use of the strategy and the training redundant to successful VOCA use.

Filler items may be classified as Episodic (Items 14 & 15) and Conventional (Items 13 & 16). Conventional associations are based on social uses of symbols (e.g., the letter "X" superimposed on material indicates that the material is wrong). Note that the filler items did not enter into data collection.

All target pictures entered into some type of semantic ambiguity with at least one other picture. These ambiguities arise when more than one picture could potentially represent a concept. For example, the picture of the father bear, the human father, and the bowl of steaming porridge (Father bear's bowl) all could suggest the concept of "big," but only the cell designated by the human father was programmed with that message. Children were required to use a more complex retrieval strategy, such as the previously learned verbal elaboration mnemonic linking a specific picture to a specific message to resolve ambiguities, except in the case of the naming responses, which are primary associations for this age group (e.g., "Father bear").

Use of a purely perceptual strategy, or primary association (i.e., father bear picture), would assure correct retrieval of one message ("father bear") without the use of the elaboration strategy;

but this perceptual strategy would not work reliably for retrieval of visually or episodically encoded responses (e.g., "big", encoded by a picture of a human father). Only one picture, the broken egg, could logically denote "broken," however it could enter into a relationship with the picture which suggests "eat" (i.e., the bowl). The four filler pictures were not planned to be ambiguous, but given that any picture can potentially evoke multiple associations, ambiguities cannot be ruled out and would be desirable in so far as they would create additional need to use higher level strategies.

The possibility that spatial strategies could be used was addressed via the filler items in the most salient regions, the corners. However, the matrix was small and absolute control over use of spatial strategies, alone or in combination with other cues, could not be assured. Trial-and-error responding was limited to three attempts with voice-output cancelled.

Verbal elaboration mnemonics. Sixteen phrases containing the key concepts associating each message with its picture symbol were developed. These phrases were presented to subjects during training to help them encode the key concepts needed for the retrieval task. Table 3.4 provides each key concept and the corresponding verbal elaboration associating the key concept to be extracted from the picture with the corresponding message programmed under the picture.

Prompt hierarchy. A predetermined set of graded prompts for the story retelling activities was developed following an adaption of a procedure proposed by Goossens', Elder, and Bray (1990) (Table 3.04). Responses during the story retelling task were assigned a score based

Table 3.04

Revised Prompt Hierarchy Used During Story Retelling Tasks, Together With Examples of Verbal and Nonverbal Cues Available to the Children

Code used on script	Description
	Spontaneously Correct Responses
1	Investigator pauses at appropriate juncture in scripted story (Appendix A), providing rising intonation on last word, and a gaze-shift to the child. Example 1: Contextual cue provided by the picture. Goldilocks is seated at a table and is eating out of baby bear's bowl. This picture, together with the auditory script cue (see below) should cue the child to match it to the similar picture on the overlay. Example 2: Contextual cue provided simultaneously by the script. "It smelled so good that someone decided to taste it. I wonder who it was?" The question is readily answered by a perceptual match between the subject (i.e., salient figure in picture) and the one on the overlay.
	Prompted Responses
2	Investigator says, "Your turn!" If the child responds verbally, a verbal cue ("Make the machine say it") is given, accompanied by a gestural sweep across the display without fixating on a particular picture. Cue is repeated.
	Self-corrected Responses
3	Investigator verbally highlights key concepts in the

(table con'd.)

message without specifying picture choice. Example: "It wasn't a *little* chair!"

Uncorrected Responses

4 Investigator verbally prompts the child ("Here's the right one"), pointing to the target until the selection is made.

---

on the level of prompt required for elicitation. In the adapted version a score of 1 was awarded to a spontaneous, correct response; a score of 2 reflected a response in which the child was prompted indirectly with respect to message content, but not necessarily withrespect to device use; a score of 3 reflected a self-correction consisting of the choice of the correct picture after one or two errors canceled for voice output; and a score of 4 reflected inability to locate the correct key within three attempts, or admission of "I don't know" through verbal or nonverbal means (Table 3.04).

Procedure

Each subject participated in three experimental sessions conducted on three consecutive days. The first session was designed to familiarize the child with the nature and purpose of the IntroTalker, and to receive the first exposure to the Golden Book (1983) version of The Three Bears story. This session was identical in format for both groups of subjects. The second session was designed to provide training in the use of a verbal elaboration strategy in conjunction with the pictures on the IntroTalker display, to practice retrieving the sixteen messages, and to learn to use the IntroTalker to participate in the scripted retelling of the story.

The third session required each subject to verbally recall the story, recall the messages in the IntroTalker, and use the IntroTalker once again to participate in the scripted story retelling. The format of this session was identical for both groups of subjects.

Responses produced by the subjects to the scripted version of the story using the IntroTalker were coded for level of prompt. Results were analyzed using a mixed design split plot repeated measures analysis of variance for main and interaction effects. Main effects related to training condition (DI versus APS), development (pretest status according to memory and symbol manipulation), and time between first and second attempts at the scripted retelling (immediate versus one day delay after training), and task difficulty (category). Interaction effects were related to the effects of training, delay, and task difficulty on subjects of different developmental levels.

Separate analyses of Correct Responses (i.e., Prompts 1 & 2, pooled) alone to the twelve messages grouped by category and ranked within category were completed to ascertain the reliability and internal consistence of the a priori categories. Trend analysis was used to determine whether the children's retrieval pattern, overall, followed the prediction that retrieval of Naming items would exceed retrieval of Episodic items; and that the latter would exceed retrieval of Visual items. A repeated measures multiple analysis of variance, with three levels of category (Naming, Visual, Episodic), and two levels of time (Time 1, Time 2) was subsequently completed to determine the magnitude of differences.

First Session Activities: Both Conditions

During the first session subjects participated in four activities, including listening to a reading of the scripted version of The Three Bears story, participating in a second reading in which subjects are asked to provide segments of the story, viewing a videotape depicting a same-age peer using a VOCA, and freely interacting with an IntroTalker. The purpose of this session was to provide an initial exposure to the modified Golden Book version of the story, and to familiarize the subjects with the nature and purpose of the IntroTalker.

Activity 1

The first reading of the story took place at the subjects' day care center in a small room or a relatively quiet section of a larger room. The reading was conducted as a group event, with all the subjects from that site (4-7 children) simultaneously listening to the story. Due to absences, make-up sessions were arranged as needed, until all children experienced one group session. The scripted story (Appendix A) was read using a storybook reading register, with the corresponding illustrations from the Golden Book (1983) version of the story shown at each page interval. This reading was conducted with no elicitation of comments or parts of the story from the subjects, thus providing a largely uninterrupted presentation of the script. However, children's initiations were acknowledged and briefly elaborated through answers to questions, reactions to comments, or clarification of misperceptions. This activity familiarized subjects with the scripted version of The Three Bears Story.

<u>Activity 2</u>

Immediately following the first reading, a second reading was conducted, with subject participation elicited. Participation was obtained through the use of the cloze technique, gestural cues, and direct questioning. The cloze technique refers to a procedure in which the adult begins a sentence, but then pauses and waits, allowing the child to participate by completing the sentence. In the context of the story, the reader might begin by reading, "And the mama bear said ______." The reader uses rising intonation on the word, "said," shifts gaze from the book to the children, and pauses and waits for responses from the children. For Session 1 only, gestural cues were used either when cloze technique alone failed to elicit a response, or when the reader called for participation via specific labelling of a picture. For example, the reader might stop before the word "chair" in the utterance, "Who's been sitting on my ____," and point to the picture of the chair on that page. Use of this type of gestural cue in VOCA assisted story retellings could cue the child to use a perceptual matching strategy (i.e., picture in book with a picture on the overlay). A cue of this type could artificially produce both correct and incorrect responses. Although picture-context cues were sometimes available during the story retelling, they were not always appropriate. Indirect verbal cues included questions that gave no clue to the key concept such as, "What did the baby bear say?" Examples of specific cues are presented on Table 3.04.

This second reading was conducted for the purposes of maintaining the subjects' attention to the story, providing experience

with responding to the cloze technique without the additional requirement of VOCA response, and increasing the familiarity of the story so that greater memory and processing could be devoted to retrieving the messages from the VOCA during subsequent sessions. Familiarity with these cuing techniques was intended to assist the child to participate more successfully in the tasks presented in sessions 2 and 3, where subjects were required to remember and respond to the story with the added requirement of VOCA use.

<u>Activity 3</u>

Following the elicited book reading, the subjects were shown the videotape depicting age-equivalent peers' interaction through the use of VOCAs. The investigator explained that the children on the tape, including a boy identified as "John," could not make their mouths work right, and so they use special machines like the IntroTalker to speak. Specific instances of the use of the device to communicate a message were pointed out, and the subjects were encouraged to identify additional examples. Questions generated by the subjects were simply and briefly answered. The subjects were informed that they would be making a videotape to show the children in the tape how to use the IntroTalker during storytime, and that their co-operation was very important. Activity 3 was designed to establish the general purpose of an IntroTalker, and the rationale for requiring them its use.

<u>Activity 4</u>

Following the videotape exposure to the IntroTalker, the subjects were shown how to use the device. Each child was given several opportunities to activate the device by pushing blank cells

(i.e., without a picture overlay) that had been programmed with messages, such as "Hi!" or "Buzz off!" Two IntroTalkers were placed on a table, and subjects were given ten minutes to explore them to become familiar with the relationship between a pressed cell and a corresponding message, as well as the sound of digitized speech. The digitized speech was programmed with the investigator's voice. This activity familiarized subjects with the IntroTalker.

Second Session Activities: Both Conditions

During the second session, subjects participated in either the Direct Instruction (DI) condition or the Active Problem Solving (APS) condition. In each condition, subjects were trained to use a verbal elaboration strategy (i.e., the use of a learned verbal mnemonic, such as, "You eat from a bowl") to assist in the use of the pictures on the IntroTalker as retrieval cues for messages; and were introduced to the sixteen programmed messages used in the story book reading task, together with their picture associates. The manner in which the children were trained to use the verbal elaboration strategy differed between the two groups: with subjects in the DI condition receiving explicit training in the association between a picture and its corresponding message, and those in the APS condition receiving guidance to enable discovery of the need for use of both a picture and the verbal elaboration strategy to retrieve the message. Verbal rehearsal was used by both groups to facilitate storage of the verbal elaboration encoding the salient relation between each of the paired associates (i.e., picture—message).

Second Session Activities: Direct Instruction Condition

The Direct Instruction (DI) Condition consisted of two activities, including a training activity used to teach the relationship between a picture and its corresponding message, and a story retelling activity in which the subject used the messages stored in the IntroTalker to tell parts of the scripted story. The retelling from the second activity was used to derive the dependent measures for the Immediate Retelling independent variable. The subjects' third repetitions of the verbal elaboration mnemonics served as a control for the effects of short term memory on strategy use (Borkowski, et al., 1983).

Activity 1

The training of the relationship between a picture and its corresponding message encoded by the verbal elaboration mnemonic took place in a quiet room in the subject's day care center. Prior to beginning the actual training, the subject was given the following preparatory set to establish a reason for the activity:

"I want you to help me tell The Three Bears story with this talking machine. We're going to make sure it's ready for John, the boy you saw on TV last time, so that he can join in the story time at his school. It will help John if he sees other kids using the machine to talk. You are going to have to learn to find the right part of the story when it's your turn to talk. You are going to use these pictures because they help you find the message. I'm going to make a tape of how we do it."

Following the preparatory set, training to use the pictures and verbal elaboration strategy to retrieve messages in the IntroTalker was conducted using a procedure adapted from one used by Goossens' et al., 1990. Each subject received individual training consisting of a five-step process conducted in a predetermined sequence for each of the sixteen messages programmed in the IntroTalker. The sequence was established through a random selection of items, without regard to order of appearance in the story, or location on the overlay.

Step 1. For each of the sixteen messages, the subject was explicitly cued to attend to a picture on the overlay. Beginning with the first picture, the investigator touched the relevant picture. The investigator cued the child to activate the message by saying, "See that picture? Push down on it. Make the machine talk." The investigator paused while the subject pressed the cell and listened to the message. The subject was prevented from receiving feedback from any other cells activated through the investigator's covert use of the interruption switch.

Step 2. After the message was completed, subjects were asked to repeat the message with the prompt, "What did it say?" If the child was unable to repeat the message, the investigator reactivated it, instructing the child to listen carefully and repeat the message. If the message still could not be recalled, the investigator instructed the child to listen carefully. She then verbally provided the message, and again asked the child to repeat it. The purpose of Step 2 was to ensure that the child knew exactly what the message was (i.e., can discriminate the digitized speech and recall the message),

and also to provide a short distraction. Children had difficulty understanding some of the messages: they consistently repeated "Sahzzabuh" for "Father Bear," on the first attempt, but had no difficulty with the live presentation of the message, or subsequent IntroTalker presentations.

Step 3. To enhance the long term recall of the message, the investigator made a statement (i.e., a verbally elaborated mnemonic) to reinforce remembering how the picture related to the stored message. For example, the verbally elaborated mnemonic for the message 'little' is "Look! That is a picture of a baby, and babies are little. When I want the machine to say 'little,' I touch the picture of the baby, because babies are little." Subjects were asked to try hard to remember the mnemonic clue (i.e., the underlined words) and then repeat it after the investigator (Schneider & Pressley, 1989). The complete list of verbally elaborated mnemonics is presented in Table 3.03.

Step 4. The child was asked to say the message using the IntroTalker. For example, the investigator said, "Now you make the machine say 'little.' If the child did not press the correct cell, the investigator cued the correct response by touching the picture. Incorrect keystrokes were interrupted by the investigator to prevent incidental learning.

Step 5. The child was indirectly prompted to verbally recall the mnemonic used to associate the picture with its corresponding message, with the question, "How did you know to push the picture of the baby to make it say little?"

Step 6. The investigator instructed subjects to "try hard" to remember the experimental mnemonic while it was repeated, and to repeat it after her.

Step 7. The entire sequence was repeated for each of the sixteen messages on the IntroTalker, according to the randomized order determined prior to training so that the child had three repetitions.

Activity 2

Immediately following the training for the sixteen messages, the first story retelling used in the data analysis was elicited. The investigator presented the book of The Three Bears (Golden Press, 1983) and reminded the child that the book had been read to the group previously. Prior to beginning the actual retelling, the subject was given the following preparatory set to establish a reason for the activity:

> "Remember that I need you to help me tell The Three Bears story with this talking machine. We need to make sure it's ready for John, the boy you saw on TV last time, so that he can join in the story time at his school. Now that you know how to find the messages on the machine, I want you to use it to help me tell the story. I'm going to make a tape of how we do it. Remember, if you push in the wrong place, the machine won't talk."

Following the preparatory set, the investigator turned to the first page of the book, mounted it in a clear plexiglass book holder in the child's view, and began to read the corresponding, customized story. Page 1 introduced the story, and required only two responses by the child: a naming response and an opportunity for the child to tell the investigator to turn the page. On the second page, the investigator used the cloze technique at the nine designated places in the script to indicate to the subject that the IntroTalker should be

used to tell that part of the story. For example, the investigator read, "Well, Mother bear knew that her family LOVED porridge, and so she cooked lots. Her cooking pot was VERY ____," and paused for the child to provide the word "big" using the IntroTalker. This level of prompting is called a Contextual Cue (coded "1" on the script), and is characterized by an expectant pause, rising intonation on the last word, and gaze shift toward the child.

If the subject did not provide the word or phrase, increasingly more explicit prompts were used to elicit the response in accordance with the hierarchy adapted from Goossens' et al. (1990) and described in Tables 3.04. The prompts ranged from an indirect general verbal cue, such as "Your turn," or "Make the machine say it," through the direct cue of touching the target picture until the child made the correct selection. The interruption switch was used to prevent the child from receiving auditory feedback from incorrect picture selections. Responses were scored on-line. Verbal responses were acknowledged, but subjects were redirected to use the IntroTalker by the prompt, "Okay, but we need to use the machine and show John what to do. So make the machine say it." This procedure was followed for all twelve pages of the script, providing 76 instances where the subject was required to use the fourteen messages to participate in the story retelling event. The two unprompted fillers could be used at the discretion of the child throughout the storybook reading.

Second Session Activities: Active Problem Solving Condition

The Active Problem Solving (APS) Condition also consisted of two activities, including a training activity used to teach the

relationship between a picture and its corresponding message, and a story retelling activity in which the subject uses the messages stored in the IntroTalker to participate in the scripted story retelling event. The retelling from the second activity was used to derive the dependent measures for the Immediate Retelling independent variable.

Activity 1

Training of the verbal elaboration mnemonics took place in a quiet room in the subject's day care center. Prior to beginning the actual training, the subject was given the same preparatory set as in the DI condition to establish a reason for the activity:

> "I want you to help me tell The Three Bears story with this talking machine. We're going to make sure it's ready for John, the boy you saw on TV last time, so that he can join in the story time at his school. It will help John if he sees other kids using the machine to talk. You are going to have to learn to find the right part of the story when it's your turn to talk. I'm going to make a tape of how we do it."

Following the preparatory set, training in the use of the verbal elaboration strategy as a means of disambiguating confusing pictures during the retrieval of stored messages from the IntroTalker was conducted in two phases. During the first phase, (Steps 1-10), each subject was presented with an IntroTalker covered with the blank, vinyl overlay and the 32-location keyguard. Each subject was guided through an experimental problem-solving procedure involving the same first four messages of the sequence used in the DI Condition. After the introduction of the first four messages, the complete vinyl overlay with pictures affixed as for the DI Condition was placed over the blank overlay and secured under the keyguard with display clips. Subjects were then given the opportunity to guess at the identity of

the messages that might be "hidden" under indicated pictures. The second phase of training proceeded according to the procedure used with subjects in the DI Condition. However, to control for exposure to the first four items in Phase 1, these items were reviewed once, only. The remaining twelve items were reviewed twice.

Step 1. The first message was targeted, as in the DI Condition, but without the benefit of the picture overlay, or verbal elaboration mnemonic. The investigator indicated first cell (see DI Condition), and cued the subject to activate the message by saying, "See that place? Push down on it. Make the machine talk." Any untargeted activations were cancelled by the investigator via the switch.

Step 2. After the message was spoken, subjects were asked to repeat the message with the prompt, "What did that say?" If a subject was unable to repeat the message, the investigator moved the IntroTalker so that the overlay was out of the child's view, and activated the message, instructing the subject to listen carefully and repeat the message. If the message still could not be recalled, the investigator instructed the subject to listen carefully, provided the message verbally, and directed the child to repeat it. Step 2 ensured that the child understood the digitized speech and could recall the message; and also provided a short distraction.

Step 3. The subject was then prompted to locate the message from the blank overlay with the prompt, "Now, see if you can find the message by yourself. Try hard to find it. I'll give you three tries. If you push in the wrong place, the machine won't talk." Incorrect

responses were canceled by the investigator via the switch, and accompanied by a comment, such as, "I guess it's not in there."

If the child located the message within the three trials, the investigator acknowledged the response, elicited an explanation of the child's strategy with the prompt, "How did you know where to find it?", and proceeded directly to step 6. If, however, the child did not retrieve the message after the three attempts, the investigator proceeded to step 4.

Step 4. The subject was asked to repeat the target message with the prompt, "Which message are you trying to find?" After the subject's response, a follow-up question was asked through the prompt, "Why can't you find it?" The child's response was acknowledged via a restatement.

Step 5. The investigator elicited an explanation of the child's strategy with the prompt, "Tell me how you're trying to find the message."

Step 6. Indicating the location of the message, the investigator cued the child to activate the cell for the second time with the prompt, "Now you make it talk."

Step 7. The successful activation was acknowledged and the child was prompted to proceed to the second message with the prompt, "You found it! Let's do the next one."

The procedure outlined in steps 1 through 7 was followed for the second message, except that step 5 followed 6 and 7. The reversal served to reduce the frustration level for the young subjects to promote responses to the question about their current strategy use.

Step 8. The investigator prompted subjects to think of a better way to locate the messages with the prompt, "What is something else you could do to remember where the messages are hiding?"

Step 9. For the third message, the investigator followed procedures parallel to steps 1 through 7 as used for the second message, except that subjects were prompted to use the self-generated strategy from Step 8 using a prompt containing a restatement of what they had suggested (i.e.,"I want you to try hard to find the message, but this time, I want you to `_______________'.)

Step 10. The procedure for the fourth message was identical to that of the third (see step 9).

Step 11. The procedure for the fifth message was identical to that of the third and fourth, except that the investigator suggested the use of pictures as markers by explaining, "Some people use pictures to help them find the messages, particularly when there are lots of messages hiding in the machine." The subjects were asked to provide an explanation of the use of pictures with the prompt, "Why do you think some people use pictures to help them find the messages that are hiding?

Step 12. The investigator produced the picture overlay, telling the subjects, "Here are the pictures that help me find the hidden messages." When the overlay was secured to the IntroTalker, the subjects were prompted to guess at the messages located under sequenced pictures 1-4, respectively, with the prompt, "Tell me which message you think is under this one, but don't make it talk." The investigator pointed to each picture to indicate it. Then, for each

cell, the subjects were asked, "What makes you think it's <u>there</u>?" Next, the subjects were directed to activate messages 1-4, respectively, with the prompt, "Now you push the picture and find out if you were right."

<u>Step 13</u>. The investigator explained the use of the experimental verbal elaboration mnemonics related to the first four messages, and, following steps 1 through 6 of the DI Condition, introduced subjects to the remaining twelve items. Each of the twelve items was exposed to the child three times, as in the DI Condition. That is, because the APS subjects were exposed to the first four messages three times via a different training strategy, the simple rehearsal used in DI was applied only to the remaining twelve items.

<u>Activity 2</u>

Immediately following the training for the sixteen messages, the first story retelling for the data analysis was elicited. The procedure was identical to Activity 2 in the DI Condition.

<u>Third Session Activities</u>

After a delay of one day, children were seen for the third session. During this session, each child was seen individually, as before, and was informed that the video camera had chewed up the tape and that it would be necessary to tell the story over. The procedure was identical for the subjects from both the DI and the APS Conditions.

<u>Step 1</u>. Each child was asked to retell the story verbally, without any aids (i.e., neither the book or the IntroTalker was available to the child) into a microphone held by the child or the

investigator. The story was audiotaped. The subjects were directed to retell the story with the prompt, "First I want you to tell me the story, all by yourself."

Step 2. After the child had finished, an additional prompt was given, "Is there anything else?"

Step 3. Next, the child was asked to recall the parts of the script he/she had learned, with the prompt, "Tell me the parts of the story that are in the machine." If this prompt proved unsuccessful in eliciting the correct responses, the follow-up was, "What did the machine say last time?"

Step 4. Each child was prompted to explain the function of the pictures with the prompt, "What are the pictures for?"

Step 5. Each child was given the IntroTalker, complete with the overlay, and the examiner and child retold the story, as described in Session 2, Activity 2. The story was interrupted, as necessary, to prompt the child.

Design and Data Analysis

Three sets of data were required to answer the experimental questions: descriptive data about the subjects' performance on pretests, the scores based on the coded responses produced during the retrieval tasks, and the verbal and IntroTalker substitutions made by children during the retrieval tasks that were coded on-line.

Transcription

A transcription of the subjects' verbal/IntroTalker responses to non-filler items (i.e., Items 1-12) during the two story-retelling sessions, together with a code for the prompt they required for each

programmed message, was completed. The transcript used the actual story script from which the investigator read, with spaces provided for notation of what the child activated or said, and what type of prompt was used. The script is included in Appendix C.

Scoring

Terminology used in this section was presented on Table 3.04. An overall measure of retrieval is a derived score called a Correct Response. It is defined as one that was indirectly cued (i.e., Prompts 1 and 2). In terms of general analysis of retrieval, the remaining responses were ignored as incorrect. Correct Responses to the twelve target items were recoded from responses originally entered into a dBASE III file according to the scaled prompt hierarchy (Table 3.04). Indirectly cued responses were assigned a score of 1, whereas remaining scores were given a value of 0. A mean Correct score for each subject was calculated by dividing the total number of Correct responses by the total number of presentations of that particular item. Responses to the four filler items were not analyzed. The purpose of the Correct score was to examine the children's immediate retrieval responses.

The original scores of 1, 2, 3, and 4 were retained and used to differentiate certain characteristics. The general verbal/gestural cue (2) served as a significant transitional prompt assisting only those children exhibiting classic, strategy production deficiencies. The indirect verbal cue (3) differentiated impulsive from reflective responders; and children who attempted some type of strategy (e.g., "Try again") and succeeded in the retrieval, from those children who

either abandoned the task, or for whom no attempted retrieval strategy proved successful (score of 4).

Reliability

Ten percent of the videotaped story retellings were transcribed and scored on clean scripts by a second person. Only responses to target items 1-12 were scored. Reliability was calculated by dividing the total number of agreements by the total number of opportunities for agreement (i.e., 58 presentations on two occasions). Interrater reliability was calculated to be 95%. Ten percent of the SCCPs, PPVT-Rs, and Metamemory tests were rescored by a second person. Reliability was calculated as above and found to be 99%.

Data Analysis

A preliminary data analysis served as a reliability check for the main findings. Category and item analyses was completed to obtain a baseline measure of the children's pooled performance on the different types of associations used in the stimulus material. It was expected that experimentwise performance on stimulus items requiring naming associations should approach 100% based upon Bruno's study (1988). The finding of the same rank ordering of associations as Bruno's would suggest that the main findings occurred as the result of experimental treatment, and not as an artifact of the procedure. Three 4 (item) by 2 (time) repeated measures MANOVAs were completed on items to account for large differences between items within the same category. A 3 (category) by 2 (time) repeated measures multiple analysis of variance of the three categories yielded information about the magnitude difficulty of the stimulus material.

A mixed effects Split-Plot design was used to analyze retrieval of messages during the story-retelling tasks (Edwards, 1968). The first and second questions were answered from the results of a 2 (condition) by 2 (time) by 3 (category repeated measures MANOVA. For the third question, two additional independent variables were added to the design: 2 (memory) x 2 (symbol). These MANOVAs tested for main effects for each training condition (DI vs. APS), memory developmental level (low vs. high), symbol manipulation development (low vs. high) category (Naming vs. Episodic vs. Visual), and for story retelling occasion (immediate vs. delayed), and interactions of the factors. The results yielded information about the effects of treatment according to condition, developmental level, category, and occasion. Simple effects, and orthogonal contrasts or post-hoc multiple comparisons, were used where warranted.

Next, multiple regression analyses using standardized scores for age and scores on the PPVT-R, SCCP, and memory battery were completed on Correct Responses to determine the joint contribution of all developmental measures known on the subject pool. Because the dependent variables came from two separate groups of children (i.e., APS/DI-trained), a separate regression analysis was conducted for each condition. Only predictors contributing significantly to the regression were considered for use in a covariate analysis: PPVT-R, memory score, and SCCP met this criterion. PPVT-R score, a continuous variable, was then used as a covariate with condition, memory and SCCP to measure the influence of memory and symbol development independent of its contribution.

RESULTS

The purpose of this study was to determine if active problem solving (APS) enhanced the ability of normally developing preschool-aged children to retrieve messages from an IntroTalker, particularly when use of a higher level strategy, such as verbal elaboration, is needed for retrieval. In addition, strategy retention was measured by comparing retrieval by APS with retrieval by Direct Instruction (DI) immediately following instruction and after a one-day delay period. Finally, the influence of the developmental factors memory, general verbal intelligence, picture symbol manipulation on message retrieval was examined in relation to the two training conditions.

The comparisons between the APS and DI conditions were dependent on two assumptions. The first assumption was that the groups did not differ in terms of age and the developmental factors noted above. These factors influence use of verbal mediation in problem-solving situations. If no differences between the groups could be shown on these abilities prior to training, then differences in experimental message retrieval could be attributed more reliably to training rather than developmental discrepancies between the groups.

The second assumption was that the task was sufficiently difficult to require use of increasingly complex retrieval strategies, including the verbal elaboration mnemonic strategy (VEMS) to retrieve messages from the IntroTalker. To verify the need for more complex strategies, it was necessary to demonstrate significant differences between a priori categories of stimul: specifically, that messages where there was a direct relationship between picture and message (i.e.,

Goldilocks' picture elicited the message "Goldilocks") were retrieved with greater accuracy than were messages where there was a more indirect relationship (i.e., a picture of the sun elicited the message, "hot"). Only then would it be possible to evaluate the claim that more than a simple, recognition strategy was required to retrieve items encoded indirectly.

This chapter will first address the two assumptions regarding absence of differences between the two groups and task complexity. The effects of training on message retrieval under the APS and DI conditions will then be explored. Both immediate and delayed performance will be analyzed to determine if one training method has inherent advantages over the other for this age group, and the overall effects of task repetition will be addressed. Finally the developmental appropriateness of the task and training for preschool-aged children will be examined.

Preliminary Analysis: Group Composition (Assumption 1)

Developmental skills needed to exploit the VEMS explicitly trained in this study, together with the tools of measurement, include the ability (a) to recognize both concrete and abstract words and pictures (Peabody Picture Vocabulary Test-Revised [PPVT-R]), (b) to recognize that words and pictures may have more than one sense of meaning (Semantic Compaction Competency Profile [SCCP]), and (c) to remember a unique sense of meaning common to both the picture and word(s) used to associate the two for future retrieval (Metamemory/STM Battery). These skills are developmental in nature, and preschool-aged children of the same chronological age may differ widely in their performance

on these measures. To assure that (a) differences in message retrieval were related to the training received, and not to developmental differences between the groups, and (b) within-group developmental differences did not differ between the groups, the APS and DI groups were compared using age; and general verbal ability, picture-symbol manipulation, and memory skill as measured by the PPVT-R, SCCP, and Metamemory/STM battery, respectively. The four subtests contributing to the latter test were reported previously.

A multiple analysis of variance (MANOVA) using the four developmental variables as the dependent variables, and the two levels of condition as the between subjects factor was completed on the mean memory scores (Table 4.01). The main effect for condition was not

Table 4.01

Means and Standard Deviations of Subject Selection and Group Assignment Variables for Subjects in Experimental (APS) and Control (DI) Conditions

	APS group (n = 19)		DI group (n = 21)	
Variable	Mean	SD	Mean	SD
Age	54.63	3.09	54.71	3.32
PPVT-R	102.74	13.10	102.81	10.01
SCCP	7.05	2.25	7.86	1.74
Metamemory/STM	11.83	6.25	11.13	6.07

significant (F (7,32) = .67, p = .844), and so it may therefore be concluded that the groups were not different according to the pretest measures.

The joint distribution of the pretested skills was also addressed via a comparison of mean memory scores obtained by the four subgroups (memory/symbol) identified within each training group (Table 4.02). A

Table 4.02

Mean Memory Scores and Cell Counts for the Four Combinations of the Memory and Symbol Variables According to Condition and Whole Group

Condition				Whole Group	
APS		DI			
Mean	No.	Mean	No.	Mean	No.
Low Symbol/Low Memory					
8.00	8	5.43	5	7.01	13
High Symbol/Low Memory					
7.32	4	7.46	7	7.41	11
Low Symbol/ High Memory					
19.16	3	16.81	4	17.82	7
High Symbol/High Memory					
18.48	4	17.43	5	17.90	9
Total					
11.83	19	11.13	21	11.46	40

2 (condition) by 2 (memory) by 2 (symbol) analysis of variance was completed on the composite memory score revealing no significant differences between the training conditions, F (1,32) = 2.03, p = .164 (Table 4.03). Thus, the first assumption of this study was supported.

Preliminary Analysis: Task Difficulty (Assumption 2)

Message retrieval from a VOCA can be achieved using a variety of strategies. The verbally elaborated mnemonic strategy (VEMS), or the

Table 4.03

Mean Percentage Correct Scores for Association Categories for the First and Second Days, Together With Scores Pooled Across Both Days

Category	Day 1		Day 2		Pooled	
	Mean	SD	Mean	SD	Mean	SD
Naming	.887	.105	.944	.061	.916	.066
Episodic	.820	.130	.933	.073	.876	.090
Visual	.727	.180	.863	.177	.795	.152

use of a verbal reminder such as "The sun is hot, so the picture of the sun makes me think of the message 'hot'" is one strategy. But other strategies, such as automatic or deliberate memorization of the spatial location of the messages, or perceptual matching of some cue from the picture with a corresponding cue in the message, are alternatives that could produce correct responses. Identifying discriminating items retrieved with less accuracy than other items would support the required use of a more complex retrieval strategy, such as (but not restricted to) the VEMS, for those items. The discriminating items should conform to predictions based on the abstractness of relationship between picture and message, both for categories of items and for the items within the categories. The predictions should hold for both the immediate and the delayed story-retelling tasks.

Analysis of Categories of Stimulus Items

The a priori-defined relationships between the VOCA pictures and their respective messages ranged from concrete (i.e., the category of

Naming items) through abstract items (i.e., the category of Visual items). The continuum of difficulty leads to the prediction that all subjects' mean Correct Responses would be highest on the Naming items, intermediate on the Episodic items, and lowest on the Visual items, but no prediction for significance of magnitude is made (Table 4.03). From Table 4.03 it can be seen that a ceiling effect was evident for Naming items on day 1, and for Episodic items by day 2. By the second day, the mean for Visual items remained marginally below ceiling. It is noteworthy that the Visual standard deviation was still very high, reflecting a wide range of performance. Results containing interactions pertaining to contrasts between Naming and Episodic categories must be interpreted cautiously because of the ceiling. Ceiling effects may result in statistical interactions that do not reflect genuine differences in the data (Bock 1975). Furthermore, the absolute range of the change between days 1 and 2 (i.e., a maximum of 13.6% observed on Visual items) further limits the reliability of interpretations of effects.

A 2 (time) by 3 (category) repeated measures MANOVA with post hoc tests for simple effects and individual orthogonal contrasts between pairs of categories was completed on Correct Responses (i.e., Prompts 1 & 2). This analysis was completed to ascertain whether category means differed significantly from one another, and if so, which pairs differed. The MANOVA (Table 4.04) yielded significant main effects for time and category at the $\underline{p} < .05$ confidence level. Simple effects for category at Times 1 and 2 were significant.

Table 4.04

Repeated Measures MANOVA Completed on the Entire Subject Pool Comparing Correct Category Responses Averaged Over Both Sessions

Source	SS	df	MS	F	Sig.F
Between					
Within	1.48	39	.04		
Constant	178.46	1	178.46	4698.16	.0005
Within: Time					
Within	.47	39	.01		
Time	.62	1	.62	52.03	.0005
Within: Category					
Within	1.29	78	.02		
Category	.61	2	.30	18.33	.0005
Within: Time by Category					
Within	.71	78	.01		
Time by Category	.07	2	.03	3.70	.0290

Note. Analysis completed on data pool across training conditions. Hence, it differs from a later analysis where condition, symbol, and memory variables are introduced.

For Time 1, Wilks' Λ (2,38) = .59436, p = .0005, and .80151, p = .015, respectively. Difference contrasts (i.e., 1 vs. 2, and 1 and 2 vs. 3) at time 1 were both significant. For the first contrast (Naming vs. Episodic), F (1,39) = 7.28, p = .010; for the second contrast (Naming and Episodic vs. Visual), F (1,39) = 22.60, p = .0005. For Time 2, only the second contrast was significant, F (1,39) = 9.12, p = .004. Simple effects of the contrasts were also obtained. Times 1 and 2

differed in terms of the first contrast, F (1,39) = 7.34, p = .01. Thus, on the first day, both contrasts of mean Correct Responses for the three categories differed significantly. However, on the second day Naming and Episodic appeared to reach a ceiling (Table 4.03). Also, although mean retrieval of the Visual category improved, it remained significantly lower than both of the other categories, suggesting that ceiling level was not attained by the second day.

In summary, retrieval according to association category followed the predicted direction, and the relative difficulty of the Visual category was reflected in significantly less accurate retrieval than the other two categories on both days. In addition, a ceiling effect was detected on Naming items; the Naiming items were planned to be easy to retrieve. For Episodic items, retrieval was more accurate than had been predicted, and resulted in a ceiling effect by the second day. Assumption 2 was met; however, conclusions drawn from the results must be tempered by the the overall accuracy of retrieval and small range of improvement.

Within-Category Analysis of Items

Use of semantic association category is an intuitively logical means of assigning an estimate of retrieval difficulty to a stimulus item. However, the wide differences within the categories detected in this study question this fundamental assumption. An unexpected finding was the lack of homogeneity within each group. From Table 4.05, the large ranges of item values within each category are evident. Note that there is so much overlapping of items that the integrity of the categories as valid units is questioned. In fact, 10

Table 4.05

Comparison of Mean Percentage Correct Responses and Standard Deviations for Naming, Episodic, and Visual Items and Categories on Days 1 and 2, and the Averaged Performance for Both Days

Item	Day 1		Day 2		Days 1 & 2	
	Mean	SD	Mean	SD	Mean	SD
Naming Category						
Item 1: GO	.955	.085	1.000	.000	.977	.042
Item 2: MO	.925	.117	.945	.128	.935	.103
Item 3: BA	.825	.193	.930	.116	.877	.112
Item 4: FA	.845	.233	.900	.157	.872	.150
	.887	.105	.944	.063	.916	.066
Episodic Category						
Item 1: NO	.971	.074	.996	.026	.983	.039
Item 2: LO	.820	.207	.955	.085	.874	.128
Item 3: EA	.800	.217	.900	.187	.850	.168
Item 4: SI	.687	.298	.881	.179	.784	.190
	.820	.130	.933	.073	.876	.090
Visual Category						
Item 1: BR	.825	.261	.968	.172	.892	.183
Item 2: HO	.715	.235	.845	.233	.780	.199
Item 3: LI	.719	.273	.831	.262	.775	.220
Item 4: BI	.650	.264	.817	.238	.733	.181
	.727	.180	.863	.177	.795	.152

out of 12 items (i.e., all but Goldilocks and No) had standard deviations ranging from approximately 12% to 30%. Because the stimulus items themselves behaved less reliably than expected, an item analysis is included to document performance variability. Each category was analysed separately using repeated measures MANOVA with four levels of item averaged across both sessions (Tables 4.06 - 4.08). The contrasts demonstrate that items differed significantly from one another.

Table 4.06

<u>Repeated Measures MANOVA Completed on the Entire Subject Pool Comparing Correct Responses Averaged Over Both Sessions Measured at Item Level Within the Naming Category</u>

Source	SS	df	MS	F	Sig.F
<u>Between Subjects Effects</u>					
Within	1.35	39	.03		
Constant	268.28	1	268.28	7768.24	.0005
<u>Within: Item Within</u>*					
Within	2.35	117	.02		
Item	.60	3	.20	9.96	.0005
<u>Univariate F-Tests with (1,39) D.F..</u>					
Contrast item 1 vs 2				42.66	.0005
Contrast item 2 vs 3				6.56	.0140
Contrast item 3 vs 4				.05	.8300

*Maunchly sphericity test, W = .52, Chi Square (5 d.f.) = 24.59, p = .0005. Wilks' Lambda (3,37) = .45496, p = .0005.

Table 4.07

Repeated Measures MANOVA Completed on the Entire Subject Pool Comparing Correct Responses Averaged Over Both Sessions Measured at Item Level Within the Episodic Category

Source	SS	df	MS	F	Sig.F
Between Subjects Effects					
Within	2.55	39	.07		
Constant	245.73	1	245.73	3760.81	.0005
Within: Item Within*					
Within	3.75	117	.03		
Item	1.66	3	.55	17.25	.0005
Univariate F-Tests with (1,39) D.F..					
Contrast items 1 and 2 vs 3 and 4				22.62	.0005
Contrast item 1 vs 2				37.92	.0005
Contrast item 3 vs 4				1.49	.2300

* Maunchly sphericity test, W = .68, Chi Square (5 d.f.) = 14.27, p = .014. Wilks' Lambda (3,37) = .42353, p = .0005.

It is therefore concluded that the use of semantic association, alone, as a guide to difficulty of a mnemonic process requires further investigation. It appears to be more reliable as a means of determining abstract items than concrete ones, given that items defined as "Visual" were retrieved more similarly to one another, than were items otherwise classified. Thus, criteria for defining properties of concrete, easily retrievable items are poorly understood. For example, the significant differences among the three

bear pictures must be addressed. The implications of this finding to this study are important and will be addressed in the next chapter.

Table 4.08

Repeated Measures MANOVA Completed on the Entire Subject Pool Comparing Correct Responses Averaged Over Both Sessions Measured at Item Level Within the Visual Category

Source	SS	df	MS	F	Sig.F
Between Subjects Effects					
Within	7.18	39	.18		
Constant	202.25	1	202.25	1098.16	.0005
Between Subjects Effects					
Within	1.35	39	.03		
Constant	268.28	1	268.28	7768.24	.0005
Within: Item *					
Within	4.85	117	.04		
Item	1.10	3	.37	8.87	.0005
Univariate F-Tests with (1,39) D.F..					
Contrast item 1 vs 2				23.14	.0005
Contrast item 2 vs 3				.88	.3540
Contrast item 3 vs 4				1.71	.1990

* Maunchly sphericity test, W = .97, Chi Square (5 d.f.) = 1.32, p = .932. Wilks' Lambda (3,37) = .58046, p = .0005.

Summary. The value of Correct Responses pooled over both days for categories supports the assumption that classes of stimuli planned to be difficult to retrieve were retrieved with less accuracy than those

planned to be retrieved easily, thus satisfying Assumption 2. However, the individual stimuli within the a priori categories were not of equal difficulty. This finding suggests that additional factors, beyond association category, must be sought through further research to account for retrieval differences.

Comparison of APS and DI Methods of Training on Retrieval

Mean percentage category scores for a combination of Prompts 1 and 2, and each individual prompt level were calculated for the experimental and control groups (Tables 4.09 & 4.10). These scores served as dependent measures for five repeated measures MANOVA to test the hypothesis that APS training resulted in better retrieval, particularly of difficult items, and greater ability to recover from initial miscues (Self-corrected vs. Wrong) than DI training. The repeated measures MANOVA used for the five analyses had (a) one between-subjects factors: condition with two levels; and (b) two within-subject factors: time, with two levels; and category, with three levels. Separate analyses for the prompt levels (i.e., the different types of responses made by children) were completed to avoid the problem of linear dependence. Each analysis considered a different dimension of retrieval.

Summary. There were no main effects of condition for any response class, and no training condition by category interactions. Thus, the experimental method of training did not improve retrieval of the twelve items overall, nor did it significantly facilitate retrieval of the items thought to require greater effort.

Table 4.09

Means and Standard Deviations for Categories at Each Level of the Prompt Hierarchy on the First Day According to Condition

Prompt	APS group (n = 19) Mean	SD	DI group (n = 21) Mean	SD	Pooled (n = 40) Mean	SD
			Naming			
Prompt 1	.603	.271	.581	.254	.591	.259
Prompt 2	.318	.249	.276	.241	.296	.243
Prompt 3	.071	.071	.131	.110	.103	.097
Prompt 4	.008	.019	.012	.027	.010	.023
Correct	.921	.077	.857	.120	.887	.105
			Episodic			
Prompt 1	.571	.282	.559	.274	.564	.275
Prompt 2	.255	.235	.256	.208	.255	.219
Prompt 3	.111	.108	.099	.071	.105	.090
Prompt 4	.059	.085	.087	.081	.074	.083
Correct	.825	.151	.814	.110	.820	.130
			Visual			
Prompt 1	.475	.320	.415	.290	.443	.302
Prompt 2	.262	.221	.304	.226	.284	.222
Prompt 3	.184	.167	.171	.108	.177	.137
Prompt 4	.080	.111	.110	.088	.096	.100
Correct	.736	.223	.719	.136	.727	.180

Table 4.10

Means and Standard Deviations for Categories at Each Level of the Prompt Hierarchy on the Second Day According to Condition

Prompt	APS group (n = 19) Mean	SD	DI group (n = 21) Mean	SD	Pooled (n = 40) Mean	SD
Naming						
Prompt 1	.750	.242	.750	.261	.750	.249
Prompt 2	.187	.205	.200	.225	.194	.213
Prompt 3	.063	.066	.040	.052	.051	.059
Prompt 4	.000	.000	.010	.026	.005	.019
Correct	.937	.066	.950	.061	.944	.063
Episodic						
Prompt 1	.764	.255	.750	.284	.757	.267
Prompt 2	.167	.232	.185	.259	.176	.243
Prompt 3	.043	.056	.047	.064	.045	.060
Prompt 4	.026	.034	.018	.036	.022	.035
Correct	.931	.061	.935	.084	.933	.073
Visual						
Prompt 1	.684	.320	.696	.297	.691	.304
Prompt 2	.151	.184	.192	.249	.172	.219
Prompt 3	.132	.179	.083	.101	.106	.144
Prompt 4	.033	.053	.029	.039	.031	.046
Correct	.835	.223	.888	.121	.863	.177

Effects of a One-Day Delay on Retrieval

The means for the two training conditions on both story retellings, summed over categories, are summarized on Table 4.11. In this section, the findings pertaining to the main and interaction effects of time and condition obtained from the foregoing series of repeated measures MANOVAs will be addressed. These findings will be discussed separately for each prompt condition to ascertain any differential effects of delay and training condition on accuracy of retrieval, and strategy coordination (i.e., VEMS and use of IntroTalker to respond). Recall that subjects could respond in four different ways, and that the first two prompt conditions are combined to obtain a measure of retreival accuracy.

Analysis of Correct Responses (Prompt 1 + Prompt 2)

There was a significant effect, F (1,32) = 58.05, p = .0005 for the within-subjects factor time, demonstrating that subjects improved overall on the second attempt at the task (Table 4.12). The number of Correct Responses (i.e., sum of Spontaneously Correct and Prompted Responses) averaged across the three categories, increased from M of 81.14% on the first day to 91.33% on the second day (Table 4.11). There was a significant interaction between time and condition, F (1,32) = 4.11, p = .05. The gain in DI score of 12.75 percentage points was significantly more than the 7.33 percentage point APS gain. This indicates that the initially better (but not significantly so) performance of the APS group immediately after training was not maintained after a one-day delay. No conclusion may be drawn from this interaction because of the ceiling effect on performance.

Table 4.11

Mean Percentage of Scores Averaged Over Categories at Each Prompt Level According to Condition, Whole Group, and Day of Story Retelling

	APS group (n = 19)		DI group (n = 21)		Pooled (n = 40)	
Prompt	Mean	SD	Mean	SD	Mean	SD
			Day 1			
Prompt 1	.5493	.28	.5183	.25	.5333	.26
Prompt 2	.2783	.20	.2786	.20	.2784	.20
Correct (1 & 2)	.8276	.11	.7968	.09	.8114	.10
Prompt 3	.1219	.08	.1337	.06	.1281	.07
Prompt 4	.0490	.05	.0695	.05	.0998	.05
			Day 2			
Prompt 1	.7321	.25	.7326	.25	.7324	.25
Prompt 2	.1683	.20	.1922	.22	.1808	.21
Correct (1 & 2)	.9009	.10	.9243	.06	.9132	.08
Prompt 3	.0795	.09	.0567	.04	.0675	.07
Prompt 4	.0197	.02	.0189	.02	.0193	.02

Analysis of Spontaneously Correct Responses (Prompt 1)

Correct Responses may be broken down further into the original form of Spontaneously Correct and Prompted Responses. Recall that use of the IntroTalker is, itself, a strategy requiring conscious monitoring on the part of the user. It is therefore important to

Table 4.12

Averaged Univariate Tests of Significance for 2 (Condition) x 2 (Time) x 3 (Category) Repeated Measures MANOVA of Correct Scores

Source	SS	DF	MS	F	Sig. F
Between Subjects Effects					
Within cells	1.13.	32	.04		
Constant	178.46	1	178.46	4580.14	.0005
Condition (cond)	.00	1	.00	.02	.8870
Within Subject Effect: Time					
Within cells	.42	38	.01		
Time	.62	1	.62	55.97	.0005
Cond by time	.04	1	.04	3.96	.0540
Within Subject Effect: Category					
Within cells	1.27	76	.02		
Category (cat)	.61	2	.30	18.13	.0005
Cond by cat	.02	2	.01	.56	.5750
Within Subject Effect: Time by Category					
Within cells	.70	76	.01		
Time by cat	.07	2	.03	3.66	.030
Cond by time by cat	.01	2	.01	.62	.543

account for children's change in need for prompting to produce the target response. If children's absolute capacity to coordinate strategies is limited, then one would expect that as they learned more about the strategies required for the task, they would improve across tasks corresponding to those strategies.

Indeed, within the overall category of Correct Responses, the proportion accounted for by Spontaneous Responses increased as the need for prompting either to use the device or to take a turn decreased. Thus, children became more accurate coordinating the retrieval and augmented speech tasks. When Spontaneously Correct Responses are considered in relation to all responses made (i.e., not simply as a proportion of Correct Responses), they accounted for 53.33% of all responses on the first day, increasing to 73.24% on the second day, $\underline{F}$ (1,38) = 35.62, $\underline{p}$ = .0005). This improvement will now be shown to come partly from better coordination of the two tasks, and partly from better retrieval.

Analysis of Prompted Responses (Prompt 2)

In parallel to the increase in Spontaneously Correct Responses was a decrease in Prompted Responses, accounting for 27.84% of all responses on the first day, but only 18.08% on the second day, $\underline{F}$ (1,38) = 8.69, $\underline{p}$ = .005. Thus, task repetition decreased the need for prompting to use the IntroTalker and better understanding of the cloze prompting procedure. However, the observed change of approximately 10 percentage points within the Prompted response class is less than the 20 percentage point gain noted for Spontaneously Correct Responses; the improvement in the latter must therefore have come from changes resulting from increased accuracy of retrieval-strategy use, rather than task awareness.

Analysis of Corrected Responses (Prompt 3)

There was a significant decrease in self-corrections. Self-corrections, accounting for 12.81% of all responses on the first day,

decreased to 6.75% on the second day, F (1,38) = 29.10, p = .0005). The fact that children were able to learn successfully from their miscues on the first day suggests that the task was developmentally appropriate, overall.

Analysis of Uncorrected Responses (Prompt 4)

Uncorrected Responses decreased significantly, F (1,38) = 30.32, p = .0005, from 9.98% on the first day to 1.93% on the second day.

Summary. Overall, task repetition significantly enhanced retrieval of messages from the IntroTalker, decreased the need for prompting, and reduced the number of Self-corrections and Uncorrected errors made by the children. The only significant interaction between time and training was noted on Correct Responses, where the gain in DI exceeded that of APS. However, the difference was minimal, and can be explained satisfactorily by the ceiling effect noted above. Therefore, the observed changes in ability to respond correctly or spontaneously, the need for prompting, and commission of Corrected and Uncorrected Responses were consistent between the training conditions. Because between-group differences were apparent in Correct Responses, it appears that APS may potentially promote greater initial accuracy. However, any marginal advantage disappears after just one practice session and a one-day delay.

The joint contribution of task repetition and delay to the relative improvement across categories was described in the preliminary analysis where it was shown that a ceiling effect was noted on Naming retrieval, whereas significant improvement for both Episodic and Visual items was noted.

The Influence of Developmental Factors on Retrieval

The third major question considered whether developmental factors, including the memory and symbol factors, general verbal intelligence, and age, influenced general performance on the experimental task.

Symbol Manipulation and Memory

Recall that the SCCP and the metamemory /STM battery scores had been partitioned into two levels according to test procedure (SCCP) and strategy-users/nonusers (memory battery). To answer the third question concerning effects of training at the levels of symbol and memory ability, the foregoing MANOVAs were rerun with two additional independent variables, each with two levels, symbol and memory. These variables represent high and low levels of SCCP and STM/Metamemory, respectively. Their contribution to retrieval will be assessed first, in view of their hypothesized relationship to the retrieval task. Because memory and symbol development are directly related to general verbal intelligence and age, it could be argued that differences detected among the four combinations (i.e., low symbol/ low memory, etc.) reflected general developmental factors associated with age and verbal intelligence. An analysis of covariance using PPVT-R score was completed to establish the reliability of the findings concerning the contributions of memory and symbol ability to retrieval.

Correct Responses (Prompt 1)

No significant between-subjects main or interaction effects involving memory or symbol were obtained in the MANOVA (Table 4.13). Thus, correct retrieval according training condition did not differ among the four groups represented by the levels of memory and symbol,

Table 4.13

Averaged Univariate Tests of Significance for 2 (Condition) x 2 (Symbol) x 2 (Memory) x 2 (Time) x 3 (Category) Repeated Measures MANOVA of Correct Scores

Source	SS	DF	MS	F	Sig. F
Between Subjects Effects					
Within cells	1.13.	32	.04		
Constant	178.46	1	178.46	5056.31	.0005
Condition (cond)	.00	1	.00	.02	.8820
Symbol (sym)	.00	1	.00	.02	.8980
Memory (mem)	.10	1	.10	2.79	.1050
Condition by Symbol	.07	1	.07	2.05	.1620
Condition by Memory	.09	1	.09	2.44	.1280
Symbol by Memory	.03	1	.03	.96	.3340
Cond by Sym by Mem	.06	1	.06	1.69	.2030
Within Subject Effect: Time					
Within cells	.34	32	.01		
Time	.62	1	.62	58.05	.0005
Cond by time	.04	1	.04	4.11	.0510
Symbol by time	.01	1	.01	1.22	.2780
Memory by time	.03	1	.03	2.89	.0990
Cond by sym by time	.01	1	.01	.90	.3510
Cond by mem by time	.02	1	.02	2.17	.1500
Symbol by memory by time	.00	1	.00	.00	.9670
Cond by sym by mem by time	.00	1	.00	.23	.6330

(table con'd.)

Source	SS	DF	MS	F	Sig. F
Within Subject Effect: Category					
Within cells	.97	64	.02		
Category (cat)	.61	2	.30	20.07	.0005
Cond by cat	.02	2*	.01	.62	.5430
Symbol by cat	.02	2	.01	.71	.496
Memory by cat	.12	2	.06	3.85	.026
Cond by sym by cat	.03	2	.01	.89	.417
Cond by mem by cat	.04	2	.02	1.26	.291
Sym by mem by cat	.05	2	.02	1.51	.230
Cond by sym by mem by cat	.06	2	.03	1.86	.164
Within Subject Effect: Time by Category					
Within cells	.68	64	.01		
Time by cat	.07	2	.03	3.16	.049
Cond by time by cat	.01	2	.01	.53	.590
Sym by time by cat	.00	2	.00	.14	.867
Mem by time by cat	.00	2	.00	.05	.954
Cond by sym by time by cat	.00	2	.00	.14	.870
Cond by mem by time by cat	.00	2	.00	.11	.897
Sym by mem by time by cat	.01	2	.00	.25	.783
Cond by sym by mem by time by cat	.00	2	.00	.17	.847

* Multivariate analysis was not significant, Wilks' Lambda (2,31) = .86, *p* =.091.

The subgroups did not differen interms of change in accuracy or ability to retrieve difficult stimuli.

Spontaneously Correct Responses

Coordinating retrieval with device use is measured by Spontaneously Correct Retrieval. Results pertaining retrieval according to levels of symbol and memory development from the previously described MANOVAs included a significant three-way interaction, condition by memory by time, F (1,32) = 5.49, p = .025, and a four-way interaction, condition by symbol by time by category, Wilks' Lambda (2,31) = .73261, p = .008.

Condition by memory by time. Simple effects for each level of time revealed no significant differences between the levels of memory or the levels of condition. The Duncan Multiple Range test completed on cell means (Table 4.14) revealed a significant difference at .05 level only in mean difference scores (Day 2 - Day 1) for the two

Table 4.14

Mean Spontaneously Correct Responses According to Condition, Memory, and Time

APS				DI			
Memory							
Low		High		Low		High	
Mean	SD	Mean	SD	Mean	SD	Mean	SD
Day 1							
.5047	.27	.6256	.31	.4341	.22	.6304	.24
Day 2							
.6590	.29	.8587	.11	.7434	.26	.7171	.25

levels of memory within the DI condition (i.e., .3095 < .0867, computed from Table 4.14). Subjects in the high memory APS group retrieved 86% of responses spontaneously, suggesting that there was room for DI subjects to improve further. The negative influence of the ceiling effect on the reliability of this interaction is therefore reduced. A conservative interpretation is that children with low memory ability within the DI condition benefitted more from task repetition after the time delay than high memory DI children because a combination of reduced novelty of the task, and the problem-solving situation they experienced when they made errors on the first day. It is possible that error-making induces discrimination training leading to greater ability to remember to do something special about remembering.

Condition by symbol by time by category. Orthogonal contrasts of adjacent category means revealed that only the contrast between Naming and Episodic was significant, F (1,32) = 11.37, p = .002. This interaction was observed on the first contrast (i.e., Naming - Episodic). Simple effects of this contrast were tested, and the change in the relationship between retrieval of Naming and Episodic items over time differed between the two levels of symbol within the DI condition, but not the APS condition, Wilks' Lambda (4,64) = .72, p = .037. The between levels contrast was found to be significant, F (2,32) = 4.53, P = .019. Because these two categories attained ceiling level, the interpretation of the interaction depends on how close to ceiling the means were (Table 4.15). Given that the high symbol group in DI attained 82% level on Episodic items on day 2, the

Table 4.15

Mean Spontaneously Correct Responses (Prompt 1) and Standard Deviation According to Levels of Condition, Symbol, Time, and Category

Category	APS		DI	
	Mean	SD	Mean	SD
	Day 1			
	Low Symbol			
Naming	.6364	.26	.4833	.25
Episodic	.5818	.26	.5694	.28
Visual	.4549	.30	.3773	.28
	High Symbol			
Naming	.5563	.29	.6542	.24
Episodic	.5552	.33	.5507	.28
Visual	.5016	.36	.4434	.30
	Day 2			
	Low Symbol			
Naming	.7545	.23	.7000	.26
Episodic	.7795	.21	.6491	.34
Visual	.7542	.26	.5866	.32
	High Symbol			
Naming	.7438	.28	.7875	.27
Episodic	.7417	.32	.8260	.22
Visual	.5880	.39	.7785	.26

effects of the ceiling are reduced, suggesting that children with high symbol ability within the DI condition perhaps associated use of the device for speaking repeating lines, and so used it relatively more

spontaneously for this aspect of story telling, than for providing information (i.e., Naming responses).

Prompted Responses (Prompt 2)

A four-way interaction, condition by symbol by time by category was found within Prompted Responses, Wilks' Lambda (2,31) = .69083, p = .003. The first orthogonal contrast (i.e., Naming - Episodic) for the omnibus MANOVA was significant, F (1,32) = 14.10, P = .001. The change in time in the relationship between the need for prompting to use the device for Naming in contrast to Episodic categories differed significantly between the levels of symbol within the control condition (Table 4.16). Simple effects were not significant at the .05 level, and given the overall performance, no meaningful conclusion may be drawn from this effect. Visual inspection of the means obtained for the levels of symbol within both conditions suggests that there was little real difference in the need for prompting between groups, given the high standard deviations (Table 4.17).

Table 4.16

Prompted Responses: Difference Scores ([Naming 1 - Episodic 1] - [Naming 2 - Episodic 2] for Symbol Levels Within APS and DI Training Conditions

	APS		DI	
Symbol	Mean	SD	Mean	SD
1	-.0152	.41	-.1319*	.13
2	-.0833	.06	.0892*	.18

* denotes means significantly different at p = .05, Duncan Range Test.

Table 4.17

Mean Prompted Responses (Prompt 2) and Standard Deviation According to Levels of Condition, Symbol, Time, and Category

Category	APS Mean	APS SD	DI Mean	DI SD
		Day 1		
		Low Symbol		
Naming	.2909	.23	.3278	.25
Episodic	.2458	.25	.2356	.21
Visual	.3102	.22	.3130	.24
		High Symbol		
Naming	.3563	.29	.2375	.23
Episodic	.2672	.23	.2705	.22
Visual	.1948	.22	.2972	.22
		Day 2		
		Low Symbol		
Naming	.1864	.18	.2444	.23
Episodic	.1564	.20	.2843	.33
Visual	.1208	.14	.3074	.30
		High Symbol		
Naming	.1564	.20	.1667	.23
Episodic	.1818	.28	.1104	.17
Visual	.1922	.24	.1049	.18

Corrected Responses (Prompt 3)

A marginally significant two-way interaction between condition and memory was noted, $F\ (1,\ 32) = 3.88$, $p = .057$. Simple effects were not

significant for either the levels of memory within condition, or the levels of condition within memory. Post-hoc multiple comparisons were completed on the relevant means using the Duncan method, which maintains the .05 error level for all pairwise comparisons of means. The harmonic mean was used to accommodate unequal cell sizes. No pair of means differed significantly (4.18). A floor effect negates any meaningful interpretation of the interaction.

Table 4.18

Mean Percentage of Corrected Responses (Prompt 3) Over Both Days for the Levels of Memory Within APS and DI Condition

APS				DI			
Metmem 1		Metmem 2		Metmem 1		Metmem 2	
n = 12		n = 7		n = 12		n = 9	
Mean	SD	Mean	SD	Mean	SD	Mean	SD
.12	.09	.06	.04	.09	.04	.10	.04

Uncorrected Responses

The final repeated measures MANOVA was completed on Uncorrected Responses and a significant interaction effect was noted only for memory by time F (1,32) = 6.81, p = .014. Inspection of the means for Uncorrected Responses suggests that the interaction is an artifact of the floor effect (Table 4.19). The simple effect of memory on the first day only was significant, F (1,32) = 4.18, p = .049. This finding could be interpreted to mean that memory ability was implicated in the production of outright errors immediately after

training. However, because the mean proportion of errors was so low, the claim marginal.

Table 4.19

Mean Percentage of Uncorrected Responses (Prompt 4) According to Each Day for the Levels of Memory

Day 1				Day 2			
Metmem 1 n = 12		Metmem 2 n = 7		Metmem 1 n = 12		Metmem 2 n = 9	
Mean	SD	Mean	SD	Mean	SD	Mean	SD
.07	.05	.04	.05	.02	.02	.02	.03

Summary of the developmental factors. The inclusion of the developmental variable did not result in significant first or lower-order effects for Correct Responses. However, when (a) spontaneity of response, or (b) the need for prompting is considered, either to take a turn or to use the IntroTalker, small differences on the easier stimuli (i.e., Naming & Episodic) over time were noted.

General Developmental Factors

The memory and symbol variables were introduced because of their hypothesized relation to the task. PPVT-R score was used initially to screen out children who peformed below one standard deviation below the mean, however, children performing above one standard deviation above the mean were retained for the study. Thus, there were a few children with higher than average scores. The PPVT-R task is similar to the retrieval task because in both tasks, children are required to interpret pictures. Representation and memory are intimately bound up with other types of development, such as that addressed by the PPVT-R.

Combined Effects of Age and PPVT

Before final conclusions were drawn about the roles of symbol and memory ability in retrieval, a correlational analysis was conducted using raw scores for the known developmental characteristics of the subjects. The means and correlations for the forty-subject pool are presented on Tables 4.20 and 4.21, respectively.

Table 4.20

Means of Developmental Factors for the Forty-Subject Pool

Variable	No.	Mean	Std. Dev.
PPVT-R	40	102.7750	11.4276
SCCP	40	7.4750	2.0126
MEMORY	40	11.4608	6.0896
AGE	40	54.6750	3.1735

Within the whole group and within APS, the only significant correlation observed between any pair of variables was between PPVT-R and SCCP, where $p = .014$, and $p = .032$ (two-tailed), respectively. The ability to interpret a variety of meanings from pictures is common to both tasks, and so the correlation may be meaningfully interpreted. Within the DI condition, no pair of scores correlated significantly.

In considering the effects of general verbal intelligence (PPVT-R score) and age on retrieval, a multiple regression analysis was also performed. This analysis was used to determine the importance of PPVT-R and age development in relation to the symbol/memory variables that were the focus of this investigation.

Table 4.21

Correlation Values for Age, and Scores on the PPVT-R, SCCP, and Memory Battery for all Forty Subjects

		PPVT	SCCP	MEMORY	AGE
PPVT	All	1.000	.3849*	.0437	.2023
	APS	1.000	.4929*	.1575	.3784
	DI	1.000	.2395	-.0929	.0148
SCCP	All		1.000	.2296	.2978
	APS		1.000	.4120	.2984
	DI		1.000	.0524	.3129
MEMORY	All			1.000	-.0945
	APS			1.000	-.0123
	DI			1.000	-.1647
AGE	All/APS/DI				1.0000

* 2-tailed Significance < .05

Multiple regression analysis. Next, multiple regression analysis was completed on Correct Responses averaged across time and condition. The predictor variables were the standardized scores for age and scores for the PPVT-R, SCCP, and memory battery, and these were entered using the backward method. The investigator acknowledges that a compromise is made between statistical and clinical reality when raw scores are converted to standardized scores. However, given the differences in the scales, it was felt that standardized scores permitted a more valid comparison for the purposes of the regression analysis.

With completion of the final step, only two factors remained in the equation: PPVT-R and memory score, R Square = .25989 (Adjusted R Square = .21989)(Table 4.22). Clearly, age and symbol manipulation

Table 4.22

ANOVA and Variable Summary of Multiple Regression Analysis of Correct Responses Averaged Across Days and Conditions

Source	DF	SS	MS	F	Sig. of F.
Regression	2	.06417	.03208	6.49635	.0038
Residual	37	.18273	.00494		

Variables in the equation

Variable	B	SE B	Beta	T	Sig. of T
Zmemory	.01951	.01126	.24520	1.732	.0916
ZPPVT	.034731	.01126	.43636	3.082	.0039

Variables not in the equation

Variable	Beta In	Partial	Min Tolerance	T	Sig. of T
Zage	.05715	.06469	.94838	.389	.6996
ZSCCP	-.18815	-.19640	.80648	-1.202	.2327

ability (SCCP) did not contribute significantly to the regression in relation to memory score and general verbal intelligence. Even the memory variable made a small, comparatively non-significant contribution. However, because the dependent variable was based on two different sets of subjects, a separate regression analysis was performed on each set (Tables 4.23 and 4.24). It was found that success, as measured by the Correct Responses, was differentially

Table 4.23

ANOVA and Variable Summary of Multiple Regression Analysis of Correct Responses Averaged Across Days for the APS Condition

Source	DF	SS	MS	F	Sig. of F.
Regression	3	.08556	.02852	4.75818	.0159
Residual	15	.08991	.00599		

Variables in the equation

Variable	B	SE B	Beta	T	Sig. of T
Zmemory	.05637	.01954	.58619	2.885	.0113
ZPPVT	.04766	.01832	.55340	2.601	.0201
ZSCCP	-.04613	.02039	-.52182	-2.263	.0389

Variables not in the equation

Variable	Beta In	Partial	Min Tolerance	T	Sig. of T
Zage	-.06960	-.08819	.62050	-.331	.7454

influenced by different configurations of developmental skills. For the APS condition, only age made a nonsignificant contribution to accuracy of response. Memory, symbol and PPVT-R scores appeared to be important predictors of accuracy. By contrast, within the DI condition, PPVT-R score alone predicted accurate retrieval of messages. Based on the regression analyses, age was therefore excluded from further consideration.

Analysis of covariance. The final analysis used PPVT-R as a covariate in the MANOVA analysis. All PPVT-R scores of no less than one SD below the mean, but a few were above one SD above the mean.

Table 4.24

ANOVA and Variable Summary of Multiple Regression Analysis of Correct Responses Averaged Across Both Days for DI Condition

Source	DF	SS	MS	F	Sig. of F.
Regression	1	.02315	.02315	9.13721	.0070
Residual	19	.04814	.00253		

Variables in the equation

Variable	B	SE B	Beta	T	Sig. of T
ZPPVT	.03885	.01285	.56986	3.023	.0070

Variables not in the equation

Variable	Beta In	Partial	Min Tolerance	T	Sig. of T
Zage	.30377	.36962	.99978	1.688	.1087
ZSCCP	.11673	.13792	.94264	.591	.5620
Zmemory	.03615	.43806	.99136	.186	.8545

to account for the higher scorers. However, each of the crossed symbol by memory cells were not balanced for PPVT-R score. Use of PPVT-R score as a covariate has the advantage of determining the independent contribution of symbol manipulation ability and memory. When PPVT-R was used as a covariate, several significant main and interaction effects attained significance. Responses at each level of prompt, including the composite variable Correct Response, averaged over both days were used as the dependent variables. Repeated measures MANOVAs, as before, were used for analysis.

Correct Responses. The adjusted means following removal of the covariate are presented on Table 4.25. Without the influence of

Table 4.25

Observed and Adjusted Means for Symbol, Memory, and Symbol by Memory Levels Within the APS and DI Conditions After the Removal of the Effects of PPVT-R Score, Averaged Across Time

Condition	Low Symbol/ Low memory		Low Symbol/ High Memory		High Symbol/ Low Memory		High Symbol/ High Memory	
	M	M'	M	M'	M	M'	M	M'
APS	.870	.872	.902	.971	.768	.710	.921	.858
DI	.839	.851	.856	.872	.869	.860	.875	.873

general verbal intelligence, there was a significant main effect for symbol, F (1,31) = 4.96, p = .033; for memory, F (1,31) = 10.89, p = .002; interaction effect for symbol by condition, F (1,31) = 7.00, p = .013, memory by condition, F (1,31) = 5.98, p = .020, symbol by memory, F (1,31) = 6.22, p = .018, and condition by symbol by memory, F (1,31) = 7.24, p = .011 (Table 4.26).

Symbol effect. Correct retrieval was marginally higher in the low symbol group, however the real significance of the difference is negligible (i.e, approximately 85% is scarcely less than 87%).

Memory effect. Better retrieval by children with high memory ability across the training conditions was clearer, because the actual means reflect almost a 10% difference. However, the standard deviations in the scores have already been shown to be quite large, and so this result must be interpreted with caution.

Table 4.26

MANOVA of Correct Responses, Summed Over Both Days, with PPVT-R as a Covariate.

Source of Variation	SS	DF	MS	F	Sig of F
Design 1					
Within cells	.09	31	.00		
Regression	.10	1	.10	31.59	.0005
Constant	.05	1	.05	17.42	.0005
Symbol	.01	1	.01	4.96	.0330
Memory	.03	1	.03	10.89	.0020
Condition (Cond)	.00	1	.00	.02	.8620
Symbol by condition	.02	1	.02	7.00	.0130
Memory by condition	.02	1	.02	5.98	.0200
Symbol by memory	.02	1	.02	6.22	.0180
Cond by symbol by memory	.02	1	.02	7.24	.0110
Design 2					
Symbol within APS	.05	1	.05	16.17	.0005
Memory within APS	.04	1	.04	13.77	.0010
Symbol within DI	.00	1	.00	.05	.8240
Memory within DI	.00	1	.00	.45	.5070

Symbol by condition interaction. Simple effects of the levels of symbol were obtained for each condition. For APS, F (1,31) = 16.17, p = .0005; for DI the effect was not significant F (1,31) = 0.05, p = .824. The absolute difference within the APS group was still only

approximately 4%. However, within the APS condition, the mean for the low symbol group (90.6%) actually exceeded the mean for the high symbol group (81.5%).

Memory by condition interaction. Simple effects of the levels of memory were obtained for condition. For APS, F (1,31) = 13.17, p = .001; for DI the effect was not significant F (1,31) = .45, p = .507. Again, the real difference (7%) between the levels was still small. Within the APS condition, the high memory group exceeded the low memory group (91.3% > 80.8%).

Symbol by memory interaction. Although it statistically possible to obtain multiple comparisons of the four possible combinations of independent variables, its meaningfulness is limited in view of the small differences observed. Visual inspection is therefore a preferable means of determining whether differences might exist. Visual inspection of adjusted means suggests that (a) the high symbol/low memory group's scores were lower than both high memory groups, and no different from the low/low group; and (b) the low/low group's scores were lower than both high memory groups (calculate from Table 4.25). Within the DI condition no subgroups differed significantly.

Condition by symbol by memory interaction. Although multiple comparisons are statistically possible, their meaningfulness is questionable. Limited conclusions may be suggested from the interaction. One was the finding that children with low memory and high picture-symbol manipulation ability within the APS condition had the lowest Correct Response score of all other groups. Within the low

memory group, the low symbol group actually exceeded the high symbol group (87.2% > 71.5%). There was no difference in means between the low and high symbol groups within the high memory group (91.1% and 91.5%, respectively). Within the low symbol group, the means for the low and high memory groups did not differ (92% = 91.1%). However, within the high symbol group, the high memory group exceeded the low memory Group (91.5% > 71.5%).

Next, the low memory groups within DI retrieved items with equivalent accuracy to their high-memory/like condition peers, but with less accuracy than the lowest group in APS, as well as the high memory groups. Apparently children with both low memory and low picture ability perform better with APS than DI training. Children with high memory skill perform similarly, regardless of training.

This configuration suggests that some aspects of APS training confused children who were capable of extracting information from pictures, but who lacked the metacognition or metalanguage to put the information to use in the required manner. It may be concluded that children with low symbol ability performed significantly more poorly than all other subgroups when trained within the APS condition.

No additional analyses were completed on the remaining response classes, in view of the very small absolute numbers of responses falling within them.

<u>Summary</u>. The overall contribution of symbol and memory development to correct retrieval was apparent only in the APS condition, and mainly after the effects of PPVT-R score had been removed. The power of the findings remains low, given the number of

variables, the variability of performance exhibited by the children, and the ceiling effect on retrieval. The APS training condition promises to be enhance the performance of children with relative strengths in both symbol manipulation and memory domains. Children with a combination of high picture ability, but low memory may experience some confusion, however, this conclusion requires further study. Overall, it is noteworthy that the results suggest some relationship between memory ability and changed performance over time (Table 4.14), and between symbol ability when interactions involve the effects of category (i.e., representation ability) (4.15 & 4.16). In view of the ceiling effect on overall performance, it may be that the roles of memory and symbolic development are potentially important. However, there a better balance between test items and control items would need to be achieved to measure the effects of these types of development. It seems logical that metamemory ability would related to harder aspects of task use, and that symbolic development would also influence the ability to retrieve more abstract items.

Qualitative Analysis of Miscues

Miscue analysis provides qualitative information about the errors reflected in Self-Corrected and Uncorrected Responses summarized above. Not all miscues were annotated on-line; only on-line errors were used in this analysis. All annotations from scripts were transcribed and two totals were used: total errors (TE) and total coded errors (CE). The CE score was divided into subtotals for each type of error made by subjects on the Naming, Episodic, and Visual categories of items. Errors were then classified according to classes

of substitutions evident in the data, some of which had been anticipated (e.g., use of the Father Bear picture to retrieve "big"), while others had not (e.g., use of speaker to encode message). Because the errors consist of substitutions of one picture for another, reference to the overlay itself (Figure 3.02) is helpful in establishing the relationship between target and error. For example, when subjects miscued on the message "hot" (encoded by the picture of the sun), they often selected the picture of the porridge bowl (encoding the message "Someone's been eating...[EA]).

Because not all miscues were transcribed on-line, a task beyond the scope of this study, the information presented here can provide no more than clues as to how children were garden-pathed. However, certain error patterns exhibited strong regularity regardless of the training group, thus suggesting reliability.

Naming Items. From Table 4.27 it appears that equivalent numbers of errors were noted on-line for both training conditions. The Father Bear and Baby Bear items clearly elicited more retrieval errors on the first day for the DI group than for the APS group.

A profile of miscues is found on Table 4.28. From the data collected, DI subjects exchanged the FA and BA pictures more than the APS group. DI subjects were also more likely to substitute the picture of the baby (encoding "little") for BA, and the picture encoding "big" for FA. Overall the errors reflect the strength of specific spatial cues, particularly size. Although these items are all names, and some are direct elicitations, subjects produced miscues. There is a complementary distribution of errors for the bear

items and all of the Visual items. DI subjects committed all errors substituting dialogue for the targeted speaker (i.e., substitutions 7,9,10,11).

Table 4.27

Total Errors (TE) and Coded Errors (CE) Made on Naming Items According to Condition, Time, and Item

	Direct Instruction				Active Problem Solving			
Item	Day 1		Day 2		Day 1		Day 2	
	CE	TE	CE	TE	CE	TE	CE	TE
MO	3	7	0	1	1	11	2	6
FB	16	22	4	10	6	7	4	5
BB	24	31	6	7	8	12	4	6
GO	1	3	0	0	1	2	0	0
Total	44	62	10	18	16	32	10	17

Classes of episodic errors. All episodic responses may be classified as dialogue. Two responses were canonical repeating lines of the story (i.e., "eat" and "sit" phrases), whereas the other two were noncanonical repeating lines woven into the script to encourage participation by the children and to allow for the inclusion of pictures used widely on devices to encode important messages (i.e., a book for "look"; Self-talk picture for "No"). Two additional phrases available for use were the remaining unprompted fillers (i.e., "I pushed the wrong one" (WR) and "I need some help, please" (HE). All target messages are spoken by characters in the story.

The proportion of coded errors to total errors was calculated for the Episodic category (Table 4.29) and found to be equivalent for the

Table 4.28

Number of Substitution Errors for Items Produced According to Day and Condition

	DI		APS	
	Day		Day	
	1	2	1	2
1. Substitution of FA for BA	5	1	1	0
2. Substitution of BA for FA	5	2	2	1
3. Substitution of MO for BA or FA	3	0	2	2
4. Substitution of BA or FA for MO	1	0	1*	2*
5. Substitution of BI for FA	6	1	3	1
6. Substitution of LI for BA	15	5	4	1
7. Substitution of EA for FA	0	1	0	0
8. Substitution of LI for MO	1	0	0	0
9. Substitution of SI for GO	1	0	0	0
10. Substitution of LO for BA	2	0	0	0
11. Substitution of SI for FA	2	0	0	0
12. Substitution of BR for BA	0	0	1	0
13. Miscellaneous	3	0	2	3
14. Substitution not noted	18	8	16	10

*Both substitutions were in the context of "..middle-sized ___ that belonged to...".

APS and DI groups, therefore comparisons of errors are likely to be informative. Errors fell into recognizable classes that may be ccharacterized as novel deviations from the canonical script. The

Table 4.29

Total Errors (TE) and Coded Errors (CE) Made on Episodic Items According to Condition, Time, and Item

Item	Direct Instruction				Active Problem Solving			
	Day 1		Day 2		Day 1		Day 2	
	CE	TE	CE	TE	CE	TE	CE	TE
EA	24	31	7	11	16	19	8	9
SI	21	29	3	5	25	31	7	10
LO	9	19	5	7	10	24	3	5
NO	1	3	0	0	1	3	0	0
Total	55	82	15	23	52	77	18	24

experimental script included several deviations from a canonical Three Bears script, including the following: (a) the intrusion of tangential details provided by filler items (Table 3.03); (b) the addition of a novel episode (Appendix C, storybook page 2); and (c) the addition of a new repeating line ("Look")(LO)(Table 4.30).

In the experimental script, the first four presentations of LO preceded either of the canonical lines, "Someone's been sitting/sleeping..." (Appendix C). Children produced 47% of responses as miscues on the first opportunity to retrieve it, reflecting chance performance. Accurate retrieval of LO increased to an average of approximately 90% for the remaining four trials. The difference in correct retrieval of the first and fifth presentations of "Look" was

measured using a Sign Test and found to be statistically significant (p = .0005), with subjects decreasing errors from 24 to 2 on the first

Table 4.30

Substitution Errors for Episodic Items According to Condition and Day

	Condition			
	DI		APS	
	Day		Day	
	1	2	1	2
1) attempt to elicit speaker	30	7	27	6
2) exchange of repeating line	4	1	0	2
3) use of alternative dialogue	0	2	6	3
4) predictions, salient concept	0	3	11	1
5) miscellaneous	6	10	17	2
Total	40	23	50	14

day, and from 5 to 0 on the second day. An explanation of the improvement within and between each day is found in the miscue analysis where the only substitution made by subjects was of the repeating line, "Someone's been sitting in my chair!" This phrase was contextually correct, because it was the next line to be elicited.

Visual Category. All visual items are attributes: big, little, hot, and broken. The complete profile of errors according to coding status is presented in Table 4.31. The number of items coded on-line was approximately equivalent for the APS and DI groups, and the item "big" clearly gave subjects the most difficulty.

Distinct classes of Visual errors could be identified from the miscues (Table 4.32). The most common miscue was to substitute the

Table 4.31

Total Errors (TE) and Coded Errors (CE) on Visual Items According to Condition, Day, and Item

Item	DI				APS			
	Day 1		Day 2		Day 1		Day 2	
	CE	TE	CE	TE	CE	TE	CE	TE
HO	10	29	9	15	17	34	11	15
BI	27	46	16	23	28	46	19	22
LI	19	27	9	11	13	17	12	16
BR	4	11	0	1	2	7	4	4
Total	60	113	34	50	60	104	46	57

Table 4.32

Identifiable Classes of Substitutions For Visual Items According to Day and Condition

Classes of Substitution	DI		APS	
	Day 1	Day 2	Day 1	Day 2
1. Correctly related character used to encode the size	24	14	20	9
2. Incorrectly related character used to encode size	3	2	4	2
3. Visual perceptual error (use of porridge bowl to encode 'hot')	9	8	23	9
4. Use of associated concept	2	2	1	1

correctly related character when that character's size was the target. Thus, children selected the picture of Baby Bear to retrieve themessage "little," and Father Bear to retrieve "big." There were a few instances where subjects selected an erroneously related character to retrieve a size-concept. Thus, they chose the father bear's picture to retrieve "little," because Father Bear's picture was "little" in relation to Baby Bear's picture. The picture of the porridge bowl was selected to retrieve the message "big," presumably because that particular picture was physically big, in relation to the other pictures, and because it was clearly associated with the concept "big" (i.e., it was the big bowl belonging to the Father Bear.) The item "broken" was strongly associated with Baby Bear and with the message "Someone's been sitting on my chair." Where children miscued on "broken" they substituted Baby Bear (whose chair was broken), or the associated repeating line (i.e., 'someone's been sitting').

Summary. The miscue analysis pinpoints regularities in children's errors. It is clear from the foregoing analyses that children's confusion arose from a variety of sources. In the next chapter, the results will be considered from a theoretical perspective, and a suggested explanation of the relative value of each training method for children at different stages of development will be offered.

DISCUSSION

Children who require speech augmentation via voice output communication aids (VOCAs), such as the IntroTalker (PRC), also require training in their use. Comprehensive training programs have not yet been developed, and so training proceeds on an ad hoc basis. The review of literature presented earlier supports the claim that task demands remain poorly understood, particularly with reference to children, who are still in the process of developing adult language and cognition. This study addressed a previously unidentified variable of device use, namely mnemonic development, by asking three questions: (a) Does a training method based on active problem solving enhance retrieval of messages stored in an IntroTalker and encoded by pictures, particularly when the use of a higher level strategy, such as verbal elaboration is necessary; (b) Is retention of the strategy consistent for when a delay period is imposed between trials; and (c) Can performance under a given training condition be predicted from age, or performance on tests of general verbal intelligence, memory, and picture symbol manipulation?

Comparison of Training Methods

First, it was hypothesized that the APS subjects would retrieve more Correct (i.e., indirectly prompted) responses than their DI peers, and that the difference would be greatest on the items least susceptible to retrieval via nonsymbolic strategies (i.e., Visual items). The superior performance was predicted because APS-trained children had been trained to selectively attend to a variety of cues signalling the need to use a retrieval strategy. Their training

biased them against spatial and visual-perceptive strategies in favor of the verbally elaborated mnemonic strategy (VEMS).

Use of the VEMS entails beginning the retrieval process by scanning the target message for the key concept relating it to the VEMS, and then using the VEMS to resolve any confusion over competing picture cues. The pictures on the overlay were chosen to create situations in which two or more pictures could potentially be associated with the same message. For example, the pictures of Father Bear, Baby Bear, and the steaming bowl of porridge could just as easily encode "big," "little," and "hot," respectively, as could the correct pictures (i.e., the family portrait, the baby, and the sun, respectively). Without use of the VEMS, therefore, children could miscue. The qualitative analysis of miscues demonstrated that children's errors followed the predicted patterns very consistently for children within both training groups.

However, in terms of overall ability to retrieve information correctly, the children did not differ according to the training they received. Furthermore, no significant differences between the two groups of subjects were detected at any other level of response when training method was the only between-subjects factor. Because the overall retrieval rate was high, even for the Visual items, it must be concluded that the experimental task was easily within the capacity of the children. Children learned the VEMS and were able to apply it effectively during the two story retellings sufficiently often to retrieve messages accurately.

The Effects of a One-Day Delay on Task Performance

The significant findings involving the variable, time, may be discussed in terms of the general improvement exhibited by all subjects; the interaction of time with training; and the interaction of time with the variables symbol and memory, reflecting picture symbol ability, and STM/metamemory, respectively. The general effects of time and its interaction of training will be addressed in this section.

General Effects of a One-Day Delay

The strongest result of the study was that all subjects made dramatic improvement on the second day. The improvement was reflected in increased retrieval (i.e., Correct Responses) and decreased production of Uncorrected Responses.

A second measure of improvement was the significant increase in Spontaneously Correct Responses and the parallel decrease in Prompted Responses, suggesting improvement in ability to monitor all dimensions of the task. However, because the increase in Spontaneously Correct Responses exceeded the reduction in Prompted Responses, part of the improvement is attributable to changes in accuracy of retrieval.

A third measure of improvement was the fact that retrieval of even the Visual items improved significantly. The preliminary analysis of categorical data revealed a ceiling effect for Naming and Episodic items after the repetition of the story retelling task. After the second attempt, children found Episodic items equivalent to Naming items in terms of ease of retrieval. By contrast, despite equivalent improvement on Episodic and Visual items, children

continued to retrieve Visual items with significantly less accuracy that the others.

A fourth measure was a decrease in the time taken to complete the task. It took most children at least thirty-five minutes to complete the task on the first day, but only about twenty-five on the second day. This finding will be discussed with reference to the role of effortfulness of a task in strategy production.

The Contribution of Reduced Effortfulness

One explanation for overall improvement is the reduction in the novelty of the task, and this is what would be predicted by an information-processing model. It predicts that once the novelty of a task is reduced, children, even more than adults, are free to allocate more attention to specific features, particularly the more demanding ones (Miller, Woody-Ramsay, & Aloise, 1991). On the first day, the load on working memory was high because the experimental task was nested within several ongoing tasks, each demanding attention. The task required subjects to attend to the orally-delivered story, to the storybook, to the task of using the IntroTalker as a replacement for speech, and to the social situation created by the examiner-subject dyad. The complexity of this task imposes a very high demand for attention on the children, but it is precisely within such contexts that IntroTalkers must by used.

Reduction of Prompted Responses. Support for the explanation of reduced novelty is the reduction in responses categorized as Prompted Responses. These responses changed between days one and two because children decreased the need to be told either to take a turn, or to

use the IntroTalker to respond. Prompted Responses are unaffected by changes in accuracy. On the first day, 28.33% of their responses fell into this category, compared to 10.26% on the second day. Prompted Responses simultaneously reflect ability to recall the message and picture correctly, but difficulty with two other factors: (a) interpreting the nonverbal Prompt 1 (i.e., a cloze procedure characterized by a pause, rising intonation, and an expectant facial expression by the investigator), and (b) coordinating the retrieval strategy with the unusual strategy of communication.

Regarding use of Prompt 1, there were relatively few problems associated with interpreting the cloze method of prompting, compared with remembering to use the device. The tendency of children was to take a turn at the appropriate juncture, but to do so verbally without using the device.

When children provided the correct verbal response, they appeared puzzled when the investigator did not continue with the story, and some second-guessed their responses. The pause apparently suggested to them that it was the content, rather than the modality of the message that was wrong. This behavior reflects their lack of ability to attend to a novel task with multiple components, specifically telling the story via the IntroTalker.

On the second day, children continued to offer spontaneous verbal responses, but with a difference: often they signalled their recognition that they had forgotten to use the IntroTalker, sometimes spontaneously, but usually after merely a gestural prompt to use the device. For example, they giggled and made faces, or directed a

finger to the target key, pressing it with great exaggeration. Some even commented on having forgotten to use the device. Verbal responding in conjunction with increased spontaneous device use reflects rapid, but incomplete, assimilation of the new skill into an existing repertoire. Thus, the demand for attention to the new task had been reduced, but not eliminated. Although children decreased reliance on prompting to use the device, most were unable to suppress simultaneous oral verbal responding, although they had been encouraged to do so. Even after most children had grown accustomed to the unusual modality, they generally failed to inhibit simultaneous oral verbalization. This is a good sign, because it is highly desirable that children who need voice output devices continue to verbalize.

On the first day, most children were completely oblivious to the additional requirement of refraining from speaking. However, on the second day, many children made valiant attempts to hold their lips shut tight, often signalling their attempts through a "SHHHH!" gesture. Their behavior suggested that attention to a nonobligatory instruction (i.e., to remain silent) was only possible after they had reduced the amount of attention needed to complete the retrieval task itself. The incidental instruction to use the machine to talk was given to reduce the artificiality of the task for verbal children who had no need to use the IntroTalker, and thereby to reduce the violation of the discourse maxim of sincerity (Grice, 1983) committed when the investigator failed to continue after a verbal response.

Contributions of scripting. The improvement in retrieval evident on the second day must also be attributed to greater

familiarity with the script. Because the complexity of face-to-face communication involving the use of a VOCA cannot be reduced, other aspects of the task must be simplified if young children are to be expected to attend to its more challenging aspects, such as use of mnemonic strategies. Examining the issue of strategy use required that children be provided with opportunities to produce a standard set of responses, but within a familiar context, and free from a test-like atmosphere. The use of a relatively well-known script was planned to reduce both the effortfulness of remembering what to say, and the undesired influence of recall memory that could interfere with the reliability of conclusions about the influence of representation level and strategy use on retrieval.

Reliance on children remembering an entirely novel script carries the risk that their retrieval errors may be attributable to factors unrelated to the use of picture mnemonic strategies. The experimental script was generally canonical, with a few minor deviations. Miscues could still occur because children select the correct picture corresponding to the message they believed to belong at that juncture in the story. Of interest to the experimental hypotheses, however, are miscues arising when the correct message is identified, but the wrong picture is used to retrieve it.

Two classes of retrieval error included of (a) replacement of noncanonical lines with canonical counterparts; and (b) exchanges of repeating lines (e.g., "Someone's been..."). Children's use of their knowledge of the canonical script is evident from their replacement of noncanonical with canonical lines. One important conclusion is that

the change in performance between the first and second days is partially attributable to greater familiarity with the idiosyncrasies of the experimental script, rather than better strategy use. A second conclusion is that the experimental script, where it was consistent with the canonical script, succeeded in promoting easy recall of what to say.

The clearest examples of errors attributable to interference by the canonical script, rather than miscoding, are found within the Episodic category, where children substituted a logical alternative line from the canonical script for the actual line required by the experimental script (e.g., "Someone's been sitting..." for "Look!"); and where they perseverated or anticipated similar lines. The consistency of the substitutions suggests the interference of the canonical Three Bears script, rather than a problem with its representation on the overlay.

Where the experimental script deviated from the canonical script, correct retrieval demanded the preliminary step of closely attending to the new script to know what to say, prior to locating the appropriate key on the IntroTalker to communicate the message. In other words, children's expectancy of what was usually said by the father bear at that juncture in the story ("Someone's been sitting in my chair!" and not "Look!") impaired their attention to the storybook pictures, and the accompanying verbal and gestural cues provided by the investigator via the script. Another interpretation of the increased accuracy observed between the first and remaining presentations of "Look!" is that the act of making an error drew the

children's attention to the need to listen carefully to the script. The role of problem solving will be addressed later.

Exchanges of repeating lines. Two other substitution classes suggested the influence of a previously-learned script on retrieval: perseveratory and anticipatory exchanges of the canonical repeating lines. Perseveratory errors were most evident on the first day, and consisted of children retrieving the message, "Someone's been sitting on my chair" (SI) when the correct response was "Someone's been eating my porridge" (EA). On the second day, in addition to perseverating on SI, they anticipated EA when SI was the target.

Costs and benefits of scripts. The foregoing error patterns provide further evidence that children attended to just one cue, that is, the syntactic slot for "what a bear says," rather than dual semantic and syntactic cues provided by the script and episode in the story, respectively. There is a serious implication for language development in preschoolers with SSPI. It is possible that over-reliance on scripting could inhibit language development by incidentally training children to be "prompt-dependent" on a restricted set of cues ("slots") to take a turn in an interaction; and then, having recognized the cue, to activate whatever message is most strongly associated with that cue, regardless of the presence of additional discriminating cues. On the other hand, scripting appears beneficial if the main goal is to encourage young children to participate in a complex task, particularly when skills must be established.

Interaction Between Time-Delay and Training

The two significant time-by-condition interactions occurred in the Correct and Uncorrected Response classes. However, these statistical interactions were uninterpretable in view of the ceiling and floor effects observed in the data. Examples of errors made on Naming items will therefore serve as the basis of the between-groups comparison because it is on these items that the largest between-group differences (i.e., 9:2 ratio) were observed, particularly on the qualitative miscue analysis. In view of the near perfect retrieval of the Goldilocks item, it will be excluded from the present discussion.

On the first day, while the task was novel, APS scores were equivalent across all three bear items, whereas the DI subjects retrieved Mother Bear (MO) with significantly greater accuracy than either Father Bear (FA) or Baby Bear (BA). However, by the second day, APS subjects' Correct Responses remained unchanged from the first day, whereas the DI group caught up to APS for FA and BA, and exceeded APS on MO.

The Correct Response class reflects retrieval accuracy, rather than spontaneity. Uncorrected Responses reflect the child's inability to use any strategy to retrieve the targeted message from the IntroTalker; or even simple failure to recall from memory, or recognize (using the investigator's script and story book cues) what to say. It was predicted that APS subjects would exhibit proportionally more Correct and fewer Uncorrected Errors because they had been trained to expect and overcome confusion over competing pictures when more than one picture could satisfactorily encode the

targeted message. Evidently, the pictures depicting the three bears provided a good opportunity to test the hypothesis.

Underlying the experimental method of training are two assumptions. The first is that production deficiencies can be reduced by training children to recognize the availability of competing strategies to retrieve items, and the need for discrimination among them. The second assumption is that making errors will cause both the strategy and its associated usefulness in that situation to be remembered by the child. A consequence of the dual encoding of strategy and its usefulness should be that when competing retrieval strategies are inherent in a retrieval situation, the one best associated with past success will surface automatically. The need for automatic cueing of difficult behaviors is predicated on the knowledge that children cannot produce demanding strategies in the context of a novel or multidimensional task requiring the allocation of limited attention across multiple domains.

The small, but consistent pattern of retrieval errors observed on items where the groups would be expected to differ needs to be examined. Recall that the sample of four-year-old children in this study were from a normal population. The behavior of children scoring lower on developmental tests is therefore of greater clinical interest. The qualitative differences in initial performance and improvement between the two training groups raise some interesting questions about the mechanism of the two training methods.

Theoretical Implications of Error Patterns

The conclusion drawn from these error patterns is that the DI group may have experienced an active-problem solving experience during their first attempt at the task, equivalent to or better than that of APS during training. This training, consisting of making errors on ambiguous stimuli, created the need for them to attend to the details of the pictures themselves. In addition, they may have become conscious of using a spatial strategy to increase the accuracy of MO retrieval. This last claim is made on the basis of the miscue analysis where it was found that only one DI miscue on MO consisted of a substitution of a BA/FA item, and only three miscues on the FA/BA items consisted of the substitution of MO. By contrast, there was no pattern to the substitution of APS errors, suggesting neglect or nonuse of location as a cue to identify MO. The absolute numbers are small, and so explanations offered are tentative.

Children receiving APS training had learned the relative values of several message-retrieval strategies through incidental training in the use of spatial location alone ("overlay absent"), perceptual features alone ("overlay present"), and the VEMS. Each phase of training ensured that they would make errors, and that the errors would teach them the limitations of each non-symbolic strategy, thereby increasing the probability that they would use the VEMS as the first strategy to resolve confusion between groups of stimuli.

Production deficiencies may arise when children fail to appreciate two key concepts: the mechanism of the target strategy; and the relationship between production of the strategy and enhanced task

performance. Although every effort had been made to avoid spatial privilege on the overlay, the random assignment of items produced a situation in which location was an excellent cue for MO.

Use of spatial strategies. There is evidence from the literature that for small numbers of items in arrays, spatial location can be a useful cue (Mandler, Seegmiller & Day, 1977; Park & James, 1983; Von Wright, Gebhard & Karttunen, 1975), therefore corner cells were carefully avoided as sites for target pictures. The positioning of items on the array was completed through a random draw of the two types of stimuli (i.e., targets and fillers). By chance, FA and BA pictures were located in diagonally adjacent squares within the same quadrant of the overlay (Figure 3.02), whereas the Mother Bear (MO) picture was in the diagonally opposite quadrant. The Goldilocks (GO) item was centrally placed on the bottom row, separated by one space from MO. The effect of the use of spatial location would be reflected in a higher overall mean score for MO than either FA or BA, provided subjects were not biased against using a spatial strategy. Indeed, this was the case.

Recall from the APS training that children were actually biased against using spatial strategies as a consequence of experiencing retrieval errors in the "no overlay" condition (Second Training Session: APS, Step 3). Any tendency to use even a helpful spatial strategy to reduce the set of ambiguous bear pictures by eliminating the distal one would not have been automatically triggered.

For DI subjects with no such bias, not only would they have been expected to use it, but the de facto problem-solving training on the

first day could have made them conscious of using it. The hypothesized value of the APS method of training would thus appear to be verified.

Use of perceptual strategies. Another explanation for the higher overall retrieval of MO relates to potential perceptual distinctiveness (e.g., distinctive clothing), but inspection of the pictures reveals little in the way of visible clothing. Furthermore, the presence of Baby Bear's sweater on his picture, did not appear to assist in differentiating BA from FA, at least among the subset of children who miscued on those two pictures. Perceptual characteristics did play a role in retrieval, however not necessarily the helpful one that would have been predicted from the fact that the three bear-pictures were taken directly from the same storybook.

Therefore, the next problem concerns the poor performance of the DI subjects on the FA and BA items, relative to their APS peers. Although use of spatial location appears to have been helpful for widely-spaced, similar items, it did not help the discrimination of closely-spaced, similar items. If children rely more on the location of a symbol than the symbol itself, they will be greatly limited in the number of accessible messages. They will also be unlikely to use perceptual details, much less the VEMS. The overgeneralization of spatial location by certain populations (e.g., those with low cognitive development, or autism) has been reported, together with training methods to prevent it (Romski, Sevcik, & Pate, 1988).

In this task, when location was unhelpful, the picture symbol itself should have been used. Although the bear pictures were

identical to the ones in the book, which was within clear view of the children during the task, error-making children, particularly in the DI group had difficulty differentiating one bear from another.

Children in the APS condition were, in effect given a limited amount of specific stimulus discrimination training as part of the training package. After they completed trials in the "no overlay" condition of training, they were asked to guess which messages were under selected pictures that included the father bear picture (overlay present). Recall, the purpose of this phase of training was to make them aware that the appearance of a picture, or what it suggests, may not necessarily be a reliable guide as to the message it encodes. In other words, they were taught the mechanism of discriminating between their best guess, and what they discover is actually under the picture. This act of discrimination may also be seen as a mechanism preventing impulsive, perceptually-based responding. Provided that the children were capable of using a matching strategy to differentiate the father bear from the baby bear picture, the cue to attend to the pictures themselves and reflect on the mnemonic should have been sufficient to effect correct retrieval by the APS subjects.

Making errors in attempting to solve a problem like the three-bear identity appears to automate the mechanism of discrimination. The children in the DI condition were trained with an "error-free" method. Unlike the APS children, they did not get the chance to test their perceptions until they performed the experimental task. The fact that they, too, attained a level performance comparable with the APS group on their second attempt at the task actually provides

further support for the effectiveness of active problem solving. Each time they chose the wrong picture and received no reinforcement (the machine did not "say" anything), they, too, were forced to seek out additional cues; in effect, forced into an active problem-solving situation. Thus, the significant improvement on their performance on perceptually similar items suggests they learned more from a condition in which they made errors, than from an error-free condition.

Additional support for the hypothesis that making errors facilitated performance was noted above in reference to the rapid improvement on the item, "Look." Having made the mistake of relying completely on their knowledge of the three bears story, the children might have increased their attention to the other cues available in the book, and in the story telling of the investigator. If the mechanism of APS training is simply the suppression of impulsive responding typical in this age group, it, too, could parsimoniously account for the difference between the groups.

Spread of Activation Model. The small between-group differences exhibited on the two attempts at the task and involving the three bear items is explained by the model of spreading activation (Anderson, 1985). The APS condition allowed subjects to learn the relative merits of different retrieval strategies, with a bias against non-symbolic strategies, including potentially helpful spatial strategy. It was proposed that the event of confusion should automatically trigger the recruitment of the target strategy. Thus, at some sub-threshold level, spatial, perceptual, and symbolic strategies would compete. If APS training were successful, the

association strengths ("weights") of the VEMS would override the association weights of other strategies, ensuring its automatic activation via successful competition. Furthermore, active problem solving should also activate other strategies where they are valuable, such as the use of location to differentiate an item, provided its use is not biased negatively during training. Given the improvement in the DI group after they had been allowed to make errors, it is fair to conclude that the mechanism of APS training was helpful.

In summary, both groups improved significantly with practice. The general improvement has been attributed in part to a reduction in the novelty of the task, and tentatively to the role of problem solving arising from a conflict between first impressions and newly-learned material. The time-delay imposed between the two trials did not result in loss of strategy knowledge. In fact, the delay may even have served to enhance memory for children who had made many more mistakes on the first day, although stronger results would be needed to permit a firm conclusion. In the next section, additional explanations for the observed overall improvement in retrieval, as well as the apparently different effects of delay on the DI group will be addressed using data from subgroups contained within the APS and DI groups.

Contribution of Developmental Variables to Retrieval

Because each subgroup within each condition was not planned to be balanced in terms of age or PPVT-R score, the latter two measures were used as predictors, together with the components of the symbol and memory variables (i.e., SCCP and memory battery) in a series of

regression analyses. Because age was eliminated as a significant predictor, only PPVT-R was used as a covariate in one MANOVA of Correct Responses used previously with symbol and memory. When the effects of general verbal intelligence were removed from the analysis, the independent contributions of condition, symbol, and memory, were found to be significant within the Correct and Self-corrected Response classes.

Symbol Manipulation/STM/Metamemory (Ignoring PPVT-R)

When the variables, symbol and memory, were used as additional independent variables in the MANOVAs reported previously, a variety of interaction effects were observed, differing according to the particular Response class. Within the Spontaneously Correct class, it was found that on the first day, the low symbol/low memory group reversed category retrieval exhibited by their high symbol/low memory peers and the low symbol/high memory APS children by having more difficulty retrieving Naming items compared to Episodic items. This finding is very consistent with the explanation that they were initially confused by the IntroTalker task, itself. A possible explanation is that they differentiated use of the device for the purpose of talking for the character (saying a repeating line) from using it to supply information as part of the wider context of telling the story.

The same pattern of interaction held within the Prompted Response class, however, only two groups differed significantly, and both were from the DI condition: high symbol/high memory. The relative need for prompting within the high group changed mainly on

Episodic items, whereas within the low group it changed mainly on Naming items. The behavior of the low group is consistent with their change in spontaneity. The high group's reduced need for prompting to use the IntroTalker to speak the repeating lines, in contrast to its relatively unchanged need for prompting to elicit Naming items is probably explained by (a) a ceiling effect for Naming, and (b) an even stronger association than the low group with device use for "talking for the bears."

From visual inspection of the small proportion of responses classified as Corrected, it appears that the memory/symbol combinations may have interacted with training condition, however the floor effects minimize any claims. The high symbol/low memory group within APS produced more self-corrections than lowest and highest memsym groups within APS, and more than all but the low symbol/low memory group in DI. Having higher symbol manipulation ability might predispose them to pay attention to the pictures, and try to use them. However, these children also have low STM and metamemory, suggesting that they may not learn as much from their errors, or alternatively, may require more practice to do so. An explanation for their greater production of Corrected Responses under APS condition might be that they failed to benefit from the problem-solving situations during training, and that these situations served to confuse them.

In the best case, Corrected Responses can be interpreted as a series of acts, beginning with an impulsive, perceptually driven response, but ending with a successfully controlled act resulting in correct retrieval. Self-corrections can also be the result of chance,

where children hit upon the correct item through trial and error. The fact that a child miscues the first attempt suggests a measure of retrieval difficulty.

With the effects of general verbal intelligence (i.e., language ability) removed from the analysis, the independent contribution of the composite memsym factor was identified for the APS group, but not the DI group. The regression analysis on DI scores demonstrated language level, alone, predicted performance on the retrieval task, when all developmental factors were considered simultaneously.

General verbal ability and metamemory have in common an underlying foundation in language. In the following sections it will be argued that the linguistic context of responses and language development exerted a powerful influence on the choices made by children when they made errors, and that the errors were developmentally based. Because children retrieved most items with a high degree of accuracy, particularly by the second day, the available error pool is limited. The consistency of errors within such a small pool provides compelling support for their reliability. Language development must be addressed first because it provides additional evidence that, of the errors not accounted for by task novelty, many were attributable to a general linguistic immaturity and reflect mediation deficiency rather than strategy production deficiency.

The Role of Syntactic and Semantic Development in Error Production

Evidence for a linguistic component to retrieval errors is found in the errors made by children attempting to use Episodic and Visual associations. Within the Episodic category of items, the most common

error class consisted of substituting the speaker (i.e., the grammatical subject of the carrier phrase), for the message spoken, (i.e., the predicate). For example, consider the second occurrence of the "eat" message (EA2):

"Then Baby Bear sat down at the table and saw that someone had been eating his porridge, too, and so he said, '___'.

The target is "Someone's been eating my porridge," encoded by the picture of the porridge bowl. Six miscues were noted for this item, five of which were coded online. All five indicate the picture of the baby bear as the children's first choice. Baby Bear is the speaker and the grammatical subject of the sentence. Children making errors in both groups were inclined to focus on the subject, rather than the predicate of the carrier phrases.

Semantic Implications

The tendency to code a message by its speaker suggests that children organized information about the characters in syntagmatic form, rather than paradigmatic form (Nelson, 1985). Thus, it would be reasonable to use the picture of the baby bear to encode all information pertaining to him, including his possessions, his size, and what he says. Indeed, this pattern is obvious among the children who make errors.

As children develop more adult-like, paradigmatic organizational structures, they are better able to recategorize the specific classes of information about someone (i.e., possessions, appearance, what is said). Evidence for the explanation of syntagmatic storage of information is supported by the fact that there was no occasion on

which children chose the wrong speaker. All three bears are assigned dialogue in the story, and so if the error were related to some other problem, one would not expect children to have chosen the correct speaker with such consistency.

Related to the inability to displace the characteristics from the character was the tendency of children to treat the pictures on the overlay not as representations, but rather as referents in their own right. Thus, their point of reference was the picture on the overlay, rather than the one in the storybook. When these children had to speak for the character, their tendency was to press the character's picture, as if literally to "make the bear say it." Incidental comments made by the children including, "Why won't he say it?" and "He didn't talk," suggest that they truly believed that the picture was a talking bear. Anyone familiar with young children has been charmed by their beliefs about the existence of people in radios, televisions, and electrical speakers. Their behavior during the experiment was typical of preschoolers.

Coordination of Perceptions

Spatial location can provide retrieval information completely independent of the pictures used to provide additional cues. Perceptual information provides a somewhat higher level cue, in that the perceiver must label and evaluate perceptions when items are similar. A picture may represent a real object to the adult observer, and adult is capable of isolating various properties of the object, such as size, color, and so forth, with the help of language.

The level of representation of the picture is more complicated for preschool aged-children, however. They are still tied to a system of logic governed by perceptual, rather than linguistic information. Thus, children could produce the target VEMS (e.g., state it aloud), without benefiting from its potential for mediating the desired retrieval. This situation arises if the child cannot use the logic inherent in the mnemonic. Indeed, children's real-world perceptual knowledge interacted with perceptions of items on the overlay and storybook stimuli to confound some of the children in the study. Specifically, these children understood that to make the device say "Father Bear," they had to press the picture of Father Bear. Two options were available: checking the features of the overlay picture against the ones in the book, visible at all times; or noting the bear indicated on the storybook page by the investigator and seeking a match on the overlay. Instead, some children identified the two bears based on their relative size on the overlay, thus reflecting a problem of developmental logic.

Conservation. Under most conditions, four-year-old children are "non-conservers," in the Piagetian sense. Bruner (1966) observed that when different-sized vessels are both in view of children, and they are asked to evaluate the relative volume, they will choose the taller one (i.e., the one that is "bigger" in the vertical dimension). However, when only one vessel is in view, their judgment improves, and they can sometimes demonstrate conservation skill.

Bruner argued that the ability to conserve under such conditions is highly dependent on the development of language as a means of

representing abstract properties such as relative size. Non-conserving children cannot displace the abstract property of size (mass, volume, vertical height) from the physical objects under examination when perceptual and abstract reasoning conflict. Although Bruner demonstrated that Piaget's finding must be viewed critically, the fact still remains that four-year-old children are unable to demonstrate certain types of knowledge about conservation when there are conflicting stimuli present. Thus, they have difficulty coordinating two dimensions of size. The FA/BA size conflict observed in this study is a clear of example of Bruner's finding.

The concept of size plays a critical role in the story, The Three Bears. Recent studies on the development of the concept, "big," suggest that children define it in terms of salient dimension (Coley & Gelman, 1989). Thus, if the horizontal plane is used, then the item (e.g., a picture on an overlay) occupying the greatest surface area relative to the others is the "big" one. Recall from Figure 3.02 that the picture of the baby bear and the steaming porridge bowl occupied a greater surface area than the father bear picture. This phenomenon of salient dimension could explain why typical classes of Visual errors included the use of the pictures of the porridge bowl and the baby bear as retrieval cues for the message, "big," the choice of BA for FA; and the choice of FA for BA.

The problem with perceptual strategies is that they are susceptible to garden-path effects. In this study a garden-path effect was produced because children could not displace the physical property of the pictures' sizes from the sizes attributed to the three

bear characters. The children's own comments are illuminating. Several children argued persistently with the examiner that the message under the picture was wrong because, "That's big and that's little." They were referring to the fact that because the baby bear picture on the overlay was bigger than the father bear picture, it should be the father bear, and vice versa. Children who made these two errors, or who argued with the examiner about the size issue, persisted in their arguments, despite eventually selecting the correct bear in later trials, thereby demonstrating the capacity to override their native logic.

Nevertheless, the error pattern reveals that normally-developing, verbal four-year old children experience difficulty selecting the appropriate discriminatory cues from a stimulus item to retrieve a message in the presence of competing information. In this task, it was not appropriate to use the size of the picture to establish the identity of the bear; rather, children were told to "press that picture, *because it is his/her picture.*" At no stage were children instructed to use size of picture to identify the naming items, although size was implicated in other pictures (e.g., "That's a picture of a baby, and babies are little. So when you want the machine to say 'little,' press the picture of the baby.")

The subjects were unable to coordinate two size-perspectives simultaneously: (a) the relative size of the three bears in the story and on the pages; and (b) the relative size of the bears' faces on the overlay. These children used an absolute scale of "big" and "little." If the surface area of a picture was big in relation to one in its

immediate context, then it was, indeed, big. However, if the property of being big had to be inferred from additional information and used to override immediate perceptions, (e.g., the knowledge that the Father Bear was the biggest bear in the story must be separated from the fact that the "biggest" bear face on the overlay belonged to the baby bear, not the father bear), certain children had great difficulty.

Language is a symbol system which allows speakers to displace and compare the properties of various objects from the objects themselves. If a child's concept of size is still inseparable from its referent, the actual size of the referent will govern choices in identification contexts. Thus, the relative lack of power of linguistically-driven logic, compared with perceptually-driven logic detracted from the capacity of the spontaneously-produced VEMS to mediate information.

Script context. Another source of error attributable to developmental language was reflected in problems with the syntax of the carrier phrase for ten presentations of the Naming items FA2-4, MO2-5, and BA1-3): "...(bowl, chair, bed) belonged to _____ ." Possession was the most problematic of the presentation contexts within the Naming category, accounting for proportionally more errors than the other classes. All but one of the other items occurred in a request for identity context (i.e., "Who is this?").

Review of the possessive contexts suggests that the most immediate cue provided by the verbal context is size. For example, one context is, "So, first she sat in the big chair that belonged

to______." Errors would therefore be expected to relate to difficulty interpreting the grammatical category, *recipient* following the dative verb, *belongs to*. Subjects who made errors consistently focused their attention on the salient feature of the sentence, namely the kind of chair Goldilocks sat on. They appeared to ignore the grammatically complex relative clause. Thus, they tended to choose pictures likely to elicit the response "big." The keys most often used in error to encode "big" were 1) the picture that truly encoded "big" (The mnemonic stated, "This is a picture of a father, and fathers are big"); or the pictures of the bowl and the baby bear (because both were physically big, according to some children). Twelve of the eighteen errors coded online within the DI group fit this pattern, as did six of the nine APS responses. Thus, responses exhibiting lack of comprehension of the possessive structure were similarly represented in both groups, suggesting the role of language development. When children made errors on the MB items, they tended to be confused over a separate issue: the concept of "middle-sized."

Relational concepts. Another developmental phenomenon is the timing of the emergence of non-polar concepts. Typically, polar concepts, such as big and little, emerge well before intermediate ones, such as "middle-sized." The development of the middle concept is believed to require perceptual isolation of absolute properties and relational thinking (Rabinowitz & Howe, 1994). The former skill consists of the ability to seriate non-ordered arrays when the middle stimulus appears on the left or right.

The script was written to ensure that children were given additional facts to be used to aid the identification of the owners of the objects. Verbal and manual cues were provided to signal additional attributes of the "big" bears' property, such as the numerous pillows on MO's chair, its softness, and its squishiness; and, by contrast, the hardness and absence of pillows on FA's chair. BA's chair alone is uniquely identifiable by size. Thus, they were not be entirely dependent on a concept unlikely to be well-established within their age-group. However, there is little evidence that they took advantage of those cues.

When the time came for subjects to identify MO as the owner of a particular chair in the context of the carrier phrase, "This soft, squishy chair belonged to...(MO)," some paused and appeared to consider the question, while others verbally identified it as belonging to either, or both of the other bears, arriving at the correct owner by a process of elimination. That is, they pressed each of the bear keys (auditory feedback canceled) until they either retrieved the right one, or gave up. The old problem of being unable to coordinate more than two concepts simultaneously was evident. Children looked at the storybook page, and appeared to compare each pair of beds, but not all three simultaneously.

Real-world knowledge also plays some part in the "middle-sized" dilemma: from a child's perspective, both parent figures in the story are "big," by definition. The choice of the "big" as the best description of the mother bear's bed would therefore be logical from the child's perspective.

The Role of Language Development in Mediation Deficiency

Is it necessarily true that partial knowledge about strategy use will lead to strategy utilization? It seems that children who attended to the information contained in the mnemonics understood that size could be a useful cue. Recall that children used the phrase "because fathers are big" (the cue for another picture) as an argument for their choice of BA as FA. Thus, they produced the VEMS, but they interpreted it according to their own level of linguistic displacement, thereby negating its usefulness.

It was hypothesized that successful memorization of the sixteen verbally elaborated mnemonics would be a necessary, but not sufficient condition of message retrieval when the mnemonic encoded an abstract relationship existing between picture and message. The level of abstraction of the language encoding such a relationship could exceed the language level of certain children, resulting in a mediation deficiency for that group. This type of mediation deficiency would be distributed across both training groups, and more evident among less mature subjects. The pretest with the clearest implications for language level was the Preparation Object test (POT). Although its primary function was to explore what children knew about strategies for future recall, it also reflected language limitations.

All three metamemory tests, and the POT in particular, were characterized by (a) the use of conditional grammatical structures encoding hypothetical scenarios; (b) the use of future perspective to project these scenarios into the hypothetical future; and (c) the need for subjects to use language to displace their own perceptions and

perspective onto a hypothetical child in a an unfamiliar setting. The modifications to the tests, documented in an earlier chapter, consisted of simplification of the tasks through a reduction in the need for the aforementioned language skills.

Metacognitive development is thought to depend on higher level language, which is the tool needed to reflect upon the perceptual world (Vygotsky, 1978). Children without higher language development would be expected to do poorly on the metamemory tests, and also on the retrieval of items requiring use of abstract language to establish the necessary association between picture and message.

With children separated according their performance on the metamemory battery, it was possible to consider retrieval behavior from a developmental perspective. Note that an assumption is made here that language development was also reflected in performance on the metamemory battery.

Because pretesting revealed no significant difference between the training conditions in terms of performance on the metamemory subtests, it may be assumed that any differences observed between the same level of metamemory skill were the result of the interaction of training method with preexisting skills.

From the previous chapter, the interaction between condition and levels of memory and symbol was significant on Correct and Self-corrected Responses. The rest of this discussion will address the evidence suggesting that mediation deficiencies best describe the retrieval behavior of the low metamemory group. In addition, the experimental training method, APS, which was designed to help children

discriminate among available strategies, will be shown to have achieved its purpose, with different consequences for the high and low metamemory subgroups within the APS group.

Having a low metamemory score made no significant overall difference to the ability to DI subjects to correctly retrieve messages from the IntroTalker to tell the story. Under the APS condition, however, the lower scorers retrieved proportionally fewer items correctly than the high memory scorers. When Self-corrections are considered, the interaction between metamemory and condition reflected the fact that high symbol/low metamemory group within the APS condition produced more than any other subgroup.

One conclusion is that perceptual responding is not susceptible to extinction through the problem-solving method. The salience given to competing cues (e.g., spatial location, verbal mnemonic) during training may have served to confuse the low APS group, and render them unable to profit from the lower level strategies available to them. (See above, the comments on the retrieval of the mother bear item.)

It is relevant that differences between the APS and DI groups on certain Naming items accounted for much of the effect of the interaction between training condition and time delay.

Despite differences between individual Naming items, they were retrieved with greater accuracy overall than the other two categories. When subjects are compared on the basis of retrieval using easy associations, training method emerges as an important factor. By contrast, when retrieval requires the ability, as noted above, to use language to displace various properties from their associated

characters in the story, metamemory, and by extension, language development supersedes training.

It is very striking that on Day 2, the Low DI group had mastered the task with scores ranging from a low of only 83.3% to a high of 100%. One explanation is that these children were unable to use the mnemonic, or perhaps even understand it in the first place, and so completely ignored it, relying instead upon their own strategies to effect retrieval. Vygotsky (1978) included a reference to a child's invention of a relationship between a picture symbol marking a key and the item to be recalled. However, the child used an irrelevant speck on the picture, labelling it "the sun," and used it as the reminder, rather than the adult-suggested association. There is no specific evidence from the children's behavior to suggest that they invented strategies of this type. However, a case has been made to support strategy invention, including use of picture location and picture size.

<u>The Influence of APS Training on VEMS Use</u>

Unequivocal support for the exclusive use of the VEMS by any group was not established, however, overall accuracy of retrieval of Visual items, where its use was obligatory, suggests that children used it. Scores for the second day reflected significant overall improvement, however, interactions involving time, condition, and memory suggested that perhaps children took a while to understand its mechanism and value, but having done so, proceeded to use it with great efficiency after more practice. The reduction in the novelty of the task may have given them greater scope to apply it. It could also

be that mastering the mechanism and value of the strategy automated it, allowing the children to apply their attention to the IntroTalker part of the task. By contrast, it seems that the APS subjects with low memory skill not only failed to benefit from the APS training, but may even have been confused by it. This confusion may have interfered with the use of spontaneously generated strategies.

Is it possible that the verbal mnemonics themselves fed into the developing representational systems of the children and actually created errors? Which group would be more likely to be susceptible to this problem and why? If all errors are considered, it seems clear that mnemonic use requires production at the necessary moment, and the capacity to understand and utilize the information it contains.

At the first level, the child must be able to produce the mnemonic in the context of attempting a retrieval. Because the rate of correct retrieval was high, and children frequently verbalized portions of the mnemonics prior to activating keys, it seems fair to conclude that they produce the VEMS some of the time. Whether it actually facilitated retrieval is another matter.

At a more sophisticated level, mnemonic use relies on the child's capacity to displace covarying conceptual relationships evident in the mnemonics, real-world experiences, story book, and pictures on the overlay. When this knowledge can be displaced, it is available for flexible use. When it cannot be displaced, it does, in fact, lead to predictable garden-path effects, where knowledge from one domain interferes with knowledge from another (e.g., the use of the knowledge that father bear is big to infer that the big bear

picture is the father bear; the knowledge that mothers, too, are big used to select "big" to encode a description of her bed). This interference undermines the value of the mnemonic to children who are unable to displace conceptual knowledge about a referent from the referent itself. Because there was a small set of stimulus items, children generally overcame initial errors through a process of elimination. Those with high metamemory who received active problem-solving training had the capacity to benefit from the training and to continue to improve over time. Children with low metamemory ability may perform best when left to their own devices to invent retrieval strategies (Low DI). Finally, children with low metamemory development are at risk for unnecessarily poor performance if the strategies taught to them are developmentally inappropriate.

In this case, it is being suggested that the capacity to understand the mechanism of the verbal mnemonic may not be present, or may be barely emerging. Children may feel confident about strategy use, even to the point of arguing about the correctness of their reasoning, while at the same time failing to understand it. This problem is known as a mediation deficiency. As to whether active problem solving assists in the acquisition of information necessary to transform the child's knowledge base, the question remains open. The extent to which DI subjects improved on the second day compared with the APS group suggests that this group experienced an APS condition during the first trial, thereby supplementing the benefits of rote learning they had acquired during the error-free experiences. Moreover, the APS subjects were given only a few opportunities to make

errors during training (i.e., on four items). The DI subjects had as many opportunities as presentations of stimulus items (i.e., fifty-eight).

The Role of Impulsive Behavior on Retrieval

This study permitted the investigator to observe and note several behaviors: impulsive responding, distractibility, failure to follow directions carefully, and need for external reinforcement. These problematic behaviors are also captured on the experimental protocols by way of the levels of prompting implied by the scores assigned to responses. For example, children who verbalized a correct response spontaneously, but failed to use the IntroTalker, were assigned a score of "2." These children required a verbal prompt to use the device.

An informal review of task performance by children identified on the PPVT-R protocols as having exhibited problematic behaviors was conducted. It was found that these children were indeed the ones who required constant verbal prompting to use the device. They also required considerable encouragement to stay on task. They were reminded that the purpose of the task was to show the little boy they had seen on the videotape how to use the device to tell a story. With one notable exception, these "problematic" subjects performed very poorly on the experimental task, even on the second day, when most subjects showed significant improvement, particularly in the spontaneous use of the device. The one exception was a female subject whose scores fell within the top three scores on the memory tests (7.4 on MET; 5 strategies noted; and STM of 7).

The Matching Familiar Figures Test (MFFT) would be a useful way of pretesting children prior to running the experimental task again to investigate the negative learning effects of impulsive responding. It is has been found that impulsive responding serves to further slow down a child's ability to develop metacognitively (Borkowski, Peck, Reid, & Kurtz, 1983). Impulsive responding is disproportionately represented in the neurologically-impaired population that requires augmentative communication and its associated picture encoding systems. Specific treatment for the reduction of impulsive responding may therefore be indicated as precondition of successful acquisition of the mnemonic system.

These problematic behaviors appear to exist independently of other measures, such as PPVT-R score, although there does appear to be a relationship with memory. Numbers were too small to perform valid statistical analyses on every possible combination of variables. The fact that only one of the children characterized as impulsive had very high scores supports Borkowski et al.'s (1983) claim that impulsive children may have lower metamemory skills.

An interesting finding was the tendency of the four-year olds in this study to precede or accompany all key presses with the corresponding verbalization of the response, particularly on the first day. A constant concern expressed by parents and teachers of children for whom augmentative devices have been recommended is that device use will inhibit speech production. From the behavior of the children in this study, the only conclusion to be drawn is that stopping them is highly unlikely.

The difference between days one and two of the experiment is most obvious, not just in the change of error, but in the ability to use the device spontaneously on the second day. The investigator was often pleasantly surprised and relieved when children who had been dependent on verbal prompts to use the device on the first day, returned and had no trouble with the task the next day. The combined reduction in overall error, and increase in spontaneity may be interpreted as a further reflection of the four-year-old child's limited ability to coordinate multiple new tasks; that is, the child's limited processing capacity. What is encouraging is the speed with which most children learned the task. The imposition of the one-day delay appears to have been helpful, at least in terms of accommodating the use of the device to the already familiar storybook task.

Would the children have performed differently had the task been repeated after a shorter delay? Two observations suggest that children would probably have refused to participate. Many children were generally reluctant to sit down to the same task the next day, and heavily reliant on the rewards (stickers, gum, or candy) to be given only after task completion. Many children, even those who performed the task quickly and accurately, asked whether they would soon be finished, and so forth.

These observations suggest that the task was demanding, and not one they could attend to for great lengths of time, or on multiple occasions in a day. One has to put these observations into the context of the handicapped four-year-old user who has the added complexity of neuromuscular and sensory differences with which to

contend. How are we to reconcile the conflicting demands for device usage across contexts and the need for massed practice to master aspects of device use with what appear to be the expected limitations of four-year olds? At the very least, it is suggested that the behavioral characteristics noted in these subjects be used by therapists to differentiate normal limitations from limitations imposed by a child's physical and sensory impairments.

While it is true that access to a device should be available throughout the day, the demand made by some professionals and parents for children to use it in every available opportunity is likely to be highly unreasonable for young children, and could lead to a complete rejection of the device. Indeed, this is a frequently voiced clinical concern that expensive devices are recommended, but that the devices are subsequently rejected by the user because they are "too hard" to use. There is a possible conflict of interest for young children who must use visual symbols as a means of retrieving preprogrammed messages to convey wants and needs. Should we attempt to hasten the developmental process, or should we instead work with the child's current level so as to maximize successful message retrieval and the concomitant social/cognitive gain?

Spatial location may serve as a useful first step in narrowing down the range of pictures that are likely targets. In fact, there are many examples of this procedure (e.g., modified use of Fitzgerald key to group pictures) (Bruno, 1993). The DI children's lack of confusion of the mother bear with the other bears suggests that they used the information that the mother bear picture was "at the bottom"

to rule it out as a choice when they were searching for the other two bears.

Conclusion

This study considered the broad issue of developmental appropriateness of the use of picture encoding, and to a lesser degree, verbally elaborated mnemonics, as retrieval strategies for messages stored in a dedicated microcomputer with digitized speech output. The second and third issues consisted of the superiority of a problem-solving approach to encoding and strategy production over an error-free learning approach; and the effects of a delay upon learning. Children's performance on a variety of pretests was used to ensure that training groups were balanced in terms of those skills, and stimulus items were chosen carefully to ensure a range of difficulty. Initial analysis revealed only modest differences for training methods, and extensive within-group variability for the more difficult items. This within-group variability was not surprising, given that the initial groups were comparably heterogeneous across a variety of skills. The heterogeneity warranted further exploration of the contribution of preexisting skills to various aspects of task performance, including perceptual garden-pathing, recovery from errors,, and improvement over time. Some modest interactions were noted, suggesting that certain groups of children may benefit more from training under one method that the other. Because all subjects attained such high levels of accuracy after a day's delay, it may be concluded that the task was easy for them. Features of the task that are noteworthy include:

(1) There was a strict script to be followed by adult and child, and script may be described as a well-known.

(2) There were only 16 items to learn, and of the 16, only 14 which were elicited. The children had a very small set of messages.

(3) An interesting observation from the perspective of the role of VOCAs in speech development was that the more the children attended to the story, the more they produced simultaneous verbalizations. This observation is documented because it provides more evidence that use of VOCAs does not inhibit speech. In fact, their use may even encourage it. For example, one child said nothing at all throughout the pretesting session, except for responding to direct questions on some of the tests. Her teacher described her as nonverbal with unfamiliar people. The moment the child began the IntroTalker task, she began talking, accompanying every key-press with speech.

Modifications. This study could have been improved by the inclusion of thirty-two items on the overlay. The conservative approach used to improve the chances that children would participate resulted in a task that made only minimal demands to use the VEMS. The checkerboard array is typically used by beginners, but is restrictive. Children usually require far more than sixteen messages to promote communication.

More subjects would have permitted groups balanced across all of the domains considered in pretesting. Four-year-old children exhibit differing abilities, and widely differing composite profiles.

Individual stimulus materials performed very differently from expectations about them based on Bruno's semantic association data,

particularly the items chosen to be easily retrieved. Pretesting of experimental items by four-year-old children would provide information about how children classified pictures. Bruno's task of serial association to picture and word stimuli (i.e., the latter corresponding to the preprogrammed messages) would yield this type of data. Moreover, the pictures should be presented in the array to be used in the study, to identify artifactual features, such as the collocation of the Father Bear and Baby Bear pictures and the displacement of the Mother Bear picture. Additionally, adult responses to the same task would assist in confirming adult biases brought to the task.

Consideration was given to allowing children to select their own pictures for the task, however, this strategy raised too many design problems. However, successive group discussions with children about a pool of pictures to be used for encoding and retrieving could yield informative data on the stability to their choices over time.

Future research. Many questions have been raised by the results of this study. One of the most interesting is the need to identify interrelationships among the developmental skills measured by the tasks on the metamemory battery, SCCP, STM, and PPVT-R. The metamemory battery used in this study was adapted to meet the linguistic limitations of four-year-old children. It would be interesting to collect a data base of scores and responses of three through five-year-old children on the three selected tests. Because metalinguistic knowledge was clearly implicated in the IntroTalker task, more information is needed on its developmental course in

younger children. A related question is whether males and females differ in terms of the developmental metamnemonic course. This study did not attempt to balance groups in terms of gender, however, there was evidence that more females than males scored in the higher metamemory range; or that males were disproportionately represented in the lower level.

Other questions about the interaction of the multidimensional context of IntroTalker use and message retrieval via single pictures seem very important. These contexts include the linguistic context, the context of the entire array of pictures in relation to any single picture, the context of visually similar and spatially close pictures, the social context, the context of real-world knowledge brought to the task by the children, and the context of the script used. Each of these contexts can add a measure of complication to the task. This complication appears to be underestimated or ignored in the literature. Bruno's (1988) foundation study suggested that four-year-old children's responses to word and picture stimuli differed. It would seem that an important consideration in training children to use speech synthesizers is recognizing that the encoding and retrieval paths may be very different. That is, a child may readily accept that a given picture encodes a particular message. However, later when the child wishes to retrieve the message, some other picture may, at the moment of speaking, suggest itself more strongly because of contextual discourse, or other distractors.

REFERENCES

Ackerman, B. P. (1985). Children's retrieval deficit. In C. J. Brainerd & M. Pressley (Eds.), Basic processes in memory development (pp. 1-46). New York: Springer.

Acredolo, L. P., Pick, H. L., & Olsen, M. G. (1975). Environmental differentiation and familiarity as determinants of children's memory for spatial location. Developmental Psychology, 11, 495-501.

American National Standards Institute (1989). American national standard specification for audiometers (ANSI S3.6-1989). New York: ANSI.

American Speech-Language-Hearing Association (1989). Competencies for speech-language pathologists providing services in augmentative communication. ASHA, 31, 107-110.

Anderson, J.R. (1985). Cognitive psychology and its implications (2nd ed.). New York: W.H. Freeman & Company.

Angelo, J. (1987). A comparison of three coding methods for abbreviation expansion in acceleration vocabularies. Unpublished doctoral dissertation, University of Wisconsin-Madison. Cited in Beukelman, D. R. & Mirenda, P. (1992). Augmentative and alternative communication. Baltimore, MD: Paul H. Brookes.

Atkinson, R. C. & Schiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds.), The psychology of learning and motivation: Advances in research and theory. (Vol.2). New York: Academic Press.

Baddeley, A. D. (1986). Working memory. Oxford: Clarendon Press.

Baker, B. R. (1983). Communication disabilities - an overview. Byte, Summer, 3-7.

Baker, B.R. (1985). The use of words and phrases on a MINSPEAK communication system, Communication, 7, 8-11.

Baker, B. R. (1986). Using images to generate speech. IEEE/Eighth Annual Conference of the Engeneering in Medicine and Biology Society Conference Proceedings, 1805-1808.

Belmont, J.M. & Borkowski, J.G. (1988). A group-administered test of children's metamemory. Bulletin of the Psychonomic Society, 26, 206-208.

Beukelman, D. R., Jones, R., & Rowan, M. (1989). Frequency of word usage by nondisabled peers in integrated preschool classrooms. Augmentative and Alternative Communication, 5, 243-248.

Beukelman, D. R. & Mirenda, P. (1992). Augmentative and alternative communication. Baltimore, MD: Paul H. Brookes.

Beukelman, D. R. & Yorkston, K. (1984). Computer enhancement of message formulation and presentation for communication augmentation system users. Seminars in Speech and Language, 5, 1-10.

Bjorklund, D. F. (1985). The role of conceptual knowledge in the development of organization in children's memory. In C. J. Brainerd & M. Pressley (Eds.), Basic processes in memory development: Progress in cognitive development research (pp. 103-142). New York: Springer.

Bjorklund, D. F. (1987). How age changes in knowledge base contribute to the development of children's memory: An interpretive review. Developmental Review, 7, 93-130.

Bjorklund, D. F. (1989). Children's thinking. Pacific Grove, CA: Brooks/Cole Publishing Company.

Bjorklund, D. F. & Harnishfeger, K. K. (1987). Developmental differences in the mental effort requirements for the use of an organizational strategy in free recall. Journal of Experimental Child Psychology, 44, 109-125.

Blackstone, S. (1990a). Infant, toddler, and preschool applications. Augmentative Communication News, 3 (1), 1-5.

Blackstone, S. (1990b). For consumers: Examining issues of rate and rate enhancement in AAC. Augmentative Communication News, 3, (5) 1-3.

Blair, R., Perlmutter, M., & Myers, N. (1978). Effects of unlabeled and labeled picture cues on very young children's memory for location. Bulletin of the Psychonomic Society, 11, 46-48.

Blewitt, P. (1982). Word meaning acquisition in young children: A review of theory and research. Advances in Child Development and Behavior, 17, 139-195.

Bock, R.D. (1975). Multivariate Statistical Methods in Behavioral Research. New York, NY: McGraw-Hill Publishing Company.

Borkowski, J. G., Peck, V., Reid, M. K., & Kurtz, B. (1983). Impulsivity and strategy transfer: Metamemory as mediator. Child Development, 54, 459-473.

Borkowski, J. G. & Turner, L. A. (1990). Transitional characteristics of metacognition. In W. Schneider & F. E. Weinert (Eds.), Interactions among aptitudes, strategies, and knowledge in cognitive performance. New York: Springer-Verlag.

Bray, N. (1990). A cognitive model for Minspeak. Fifth Annual Minspeak Conference Proceedings. Wooster, OH: Prentke Romich Company.

Broadbent, D. E. (1958). Perception and communication. London: Pergamum Press.

Brown, A. L. & DeLoache, J. S. (1978). Skills, plans, and self-regulation. In R. Siegler (Ed.), Children's thinking: What develops? Hillsdale, NJ: Erlbaum.

Bruner, J. S. (1966). On the conservation of liquids. In J. S. Bruner, R. R. Olver, & P. M. Greenfield, Studies in cognitive growth. New York: Wiley.

Bruner, J. (1983). Child's talk: Learning to use language. Oxford: Oxford University Press.

Bruner, J. & Kennedy, H. J. (1966). On multiple ordering. In J. S. Bruner,R.R. Olver, & P. M. Greenfield, Studies in Cognitive Growth. New York: Wiley.

Bruno, J. (1986). Customizing Minspeak for use with young children. Proceedings First Annual Minspeak Conference. Wooster, OH: Prentke Romich Company.

Bruno, J. (1988). Picture and word association performance in preliterate children and adults. Ann Arbor, MI: U.M.I.

Bruno, J. (1988). Interaction, Education, and Play: A Minspeak Application Program. Wooster, OH: Prentke Romich Company.

Burkhart, L. (1982). More homemade battery devices for severely handicapped children with suggested activities. Wauconda, IL: Don Johnston Developmental Equipment.

Burkhart, J. (1988). Using computers with speech synthesis to facilitate communicative interaction with young and/or severely handicapped children. Wauconda, IL: Don Johnston Developmental Equipment.

Buzolich, M. & Wiemann, J. (1988). Turn taking in atypical conversations: The case of the speaker/augmented communicator dyad. Journal of Speech and Hearing Research, 31, 3-18.

Carlson, F. (1981). A format for selecting vocabulary for the nonspeaking child. Language, Speech, and Hearing Services in Schools, 12, 140-145.

Cavanaugh, J. C. & Perlmutter, M. (1982). Metamemory: A critical examination. Child Development, 53, 11-28.

Chi, M. T. H. & Koeske, R. D. (1983). Network representation of a child's dinosaur knowledge. Developmental Psychology, 19, 29-39.

Coley, J. D. & Gelman, S. A. (1989). The effects of object orientation and object type on children's interpretation of the word *big*. Child Development, 60, 372-380.

Cox, B. D., Ornstein, P. A., Naus, M., Maxfield, D., & Zimler, J. (1989). Children's concurrent use of rehearsal and organizational strategies. Developmental Psychology, 25, 619-627.

Craik, F. J. M. & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. Journal of Verbal Learning and Verbal Behavior, 11, 671-684.

Creech, R. (1984). MINSPEAK: Reflection of thought. Communication Outlook, 6, 24-26.

DeLoache, J. S. (1980). Naturalistic studies for memory of object location in very young children. In M. Perlmutter (Ed.), Children's memory: Vol. 10. New Directions for Child Development. San Francisco: Jossey-Bass.

DeLoache, J. S. (1985). Memory-based searching by very young children. In H. M. Wellman (Ed.), Childen's searching. Hillsdale, NJ: Erlbaum.

Dempster, F. N. (1985). Short-term memory development in childhood and adolescence. In C. J. Brainerd & M. Pressley (Eds.), Basic processes in memory development: Progress in cognitive development research. New York: Springer.

Edwards, A.L. (1968). Experimental Design in Psychological Research. New York Holt, Rinehart & Winston.

Elder, P. (1987). Assessment for semantic compaction competency. Proceedings of the 2nd Annual Minspeak Conference. Wooster, OH: Prentke Romich Company.

Elder, P. Goossens', C., & Bray, N.W. (1990). The Semantic Compaction Competency Profile (SCCP) (Experimental Edition). Unpublished manuscript.

Fabricius, W. V. & Cavalier, L. (1989). The role of causal theories about memory in young children's memory strategy choice. Child Development, 60, 298-308.

Flavell, J. H. (1970). Developmental studies of mediated memory. In H. W. Reese & L. P. Lipsitt (Eds.), Advances in Child Development and Child Behavior (Vol. 5, pp. 181-211). New York: Academic Press.

Flavell, J. H. (1971). Stage-related properties of cognitive development. Cognitive Psychology, 2, 421-453.

Flavell, J. H. (1977). Cognitive Development. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Flavell J. H. & Wellman, H. M. (1977). Metamemory. In R. V. Kail, Jr. & J.W. Hagen (Eds.), Perspectives on the Development of Memory and Cognition. Hillsdale, NJ: Erlbaum.

Fuller, D.R. & Lloyd, L.L.(1990). Toward a common usage of iconicity terminology. Augmentative and Alternative Communication, 7, 215-220.

Glennon, S. (1986). Early language training using Minspeak concepts. Proceedings: First Annual Minspeak Conference, 19-26. Wooster, OH: Prentke-Romich Company.

Glennon, S. (1989). Guidelines for customizing communication aids for children. Proceedings: Fourth Annual Minspeak Conference, Wooster, OH: Prentke Romich Company.

Glennon, S. & Calculator, S. (1985). Training functional communication board use: A pragmatic approach. Augmentative and Alternative Communication, 1, 134-142.

Goossens', C. & Crain, S. (1987). Guidelines for customizing Minspeak-based communication systems in a cost and time efficient manner. Proceedings: Second Annual Minspeak Conference, Wooster, OH: Prentke-Romich Company, 29-36.

Goossens', C. & Crain, S. (1986). Augmentative Communication Intervention Resource. Wauconda, IL: Don Johnston Developmental, Inc.

Goossens', C., Elder, P. S., & Bray, N. W. (1990). A preliminary validity study of the Semantic Compaction Competency Profile. Fifth Annual Minspeak Conference Proceedings, Wooster, OH: Prentke Romich Company.

Guttentag, R. E. (1984). The mental effort requirement of cumulative rehearsal: A developmental study. Journal of Experimental Child Psychology, 37, 92-106.

Haake, R. J., Somerville, S. C., & Wellman, H. M. (1980). Logical ability of young children in searching a large-scale environment. Child Development, 51, 1299-1302.

Hardy, J. (1983). Cerebral Palsy. Englewood Cliffs, NJ: Prentice Hall.

Harris, D. (1982). Communicative processes involving nonvocal physically handicapped children. Topics in Language Disorders, 2, 21-37.

Higginbotham, D. (1989). The interplay of communication device output mode and interaction style between nonspeaking persons and their speaking partners. Journal of Speech and Hearing Disorders, 54, 320-333.

Higginbotham, D., Maithy-Laikko, P., & Yoder, D. (1988). Studying conversations of augmentative communication system users. In L. E. Bernstein (Ed.), The vocally-impaired: Clinical practice and research (pp. 265-294). Philadelphia: Grune & Stratton.

Istomina, Z. M. (1977). The development of voluntary memory in preschool-age children. In M. Cole (Ed.), Soviet developmental psychology. White Plains, NY: M.E. Sharpe.

Kail, R. V. & Bisanz, J. (1982). Information processing and cognitive development. In H. W. Reese & L. P. Lissitt (Eds.), Advances in child development and behavior, Vol. 17, (pp.45-81). New York: Academic Press.

Kowal, S., O'Connell, D.C., & Sabin, E.F. (1975). Development of temporal patterning and vocal hesitations in spontaneous narratives. Journal of Psycholinguistic Research, 4, 195-207.

Leontyev, A. N. (1977). Probleme der Entwicklung des Psychen. Kronberg, TS.: Athenaum. Cited in W. Schneider & M. Pressley (1989). Memory Development between 2 and 20. New York: Springer-Verlag.

Light, J., Lindsay, N., Siegel, L., & Parnes, P. (1990). The effects of message coding techniques on recall by literate adults using AAC systems. Augmentative and Alternative Communication, 6, 184-201.

Light J., Collier, B., & Parnes, P. (1985a). Communication interaction between young nonspeaking physically disabled children and their primary caregivers: Part I. Discourse patterns. Augmentative and Alternative Communication, 1, 74-83.

Light, J., Collier, B., & Parnes, P. (1985b). Communication interaction between young nonspeaking physically disabled children and their primary caregivers: Part II. Communicative function. Augmentative and Alternative Communication, 1, 98-107.

Light, J., Collier, B., & Parnes, P. (1985c). Communication interaction between young nonspeaking physically disabled children and their primary caregivers: Part III. Modes of communication. Augmentative and Alternative Communication, 1, 125-133.

Light, J. (1989). Encoding techniques for augmentative communication systems: An investigation of the recall performance of nonspeaking physically disabled adults. Unpublished doctoral dissertation, University of Toronto. Cited in Beukelman, D. R. & Mirenda, P. (1992). Augmentative and alternative communication. Baltimore, MD: Paul H. Brookes.

Lodico, M. G., Ghatala, E. S., Levin, J. R., Pressley, M., & Bell, J. A. (1983). The effects of strategy monitoring on children's selection of effective memory strategies. Journal of Experimental Child Psychology, 35, 263-277.

Lucas, E. V. (1980). Semantic and pragmatic language disorders: Assessment and remediation. Rockville, MD: Aspen.

Lucariello, J. & Nelson, K. (1985). Slot-filler categories as memory organizers for young children. Developmental Psychology, 21, 272-282.

Lyons, J. (1977). Semantics, 1. Cambridge: Cambridge University Press.

Mandler, J., Seegmiller, O., & Day, J. (1977). On the coding of spatial information. Memory and Cognition, 5, 10-16.

Mandler J., & Stein, N.L. (1974). Recall and recognition in pictures by children as a function of organization and distractor similarity. Journal of Experimental Psychology, 102 , 657-669.

McCormick, L. & Schiefelbusch, R. L. (1990). Early language intervention: An introduction. (2nd ed.). Columbus, OH: Merrill.

McGilly, K. & Siegler, R. S. (1989). How children choose among serial recall strategies. Child Development, 60, 172-182.

Meacham, J. A. (1977). Soviet investigations of memory development. In R. V. Kail & J. W. Hagen (Eds.), Perspectives on the development of memory and cognition (pp. 273-295). Hillsdale, NJ: Erlbaum.

Miller, P. H., Woody-Ramsay, J., & Aloise, P. A. (1991). The role of strategy effortfulness in strategy effectiveness. Developmental Psychology, 27, 738-745.

Mirenda, P. & Locke, P. (1989). A comparison of symbol transparency in nonspeaking persons with intellectual disabilities. Journal of Speech and Hearing Disorders, 54, 131-140.

Mizuko, M. & Esser, J. (1991). The effect of direct selection and circular scanning on visual sequential recall. Journal of Speech and Hearing Research, 34, 43-48.

Mizuko, M. Reichle, J. (1989). Transparency and the recall of symbols among intellectually handicapped adults. Journal of Speech and Hearing Disorders, 54, 627-633.

Musselwhite, C. (1986). Adaptive play for special needs children: Strategies to enhance communication and learning. San Diego: Singular.

Musselwhite, C. (1992). Emergent literacy fun: Using devices and computers for interactive bookreading and story construction. Southeast Augmentative Communication Conference, 2430 11th Avenue, Nth., Birmingham, AL 35234.

Musselwhite C. & St. Louis, K. (1988). Communication programming for persons with severe handicaps. (2nd ed.). Boston: College-Hill Press.

Musselwhite, C. & Ruscello, D. (1984). Transparency of three symbol communication systems. Journal of Speech and Hearing Research, 27, 436-443.

Nelson, K. (1983). The derivation of concepts and categories from event representations. In E. K. Scholnick (Ed.), New trends in conceptual representation: Challenges to Piaget-theory (pp. 129-149). Hillsdale, NJ: Erlbaum.

Nelson, K. (1985). Making sense: Development of meaning in early childhood. New York: Academic Press.

Nelson, K. (1986). Event knowledge and cognitive development. In K. Nelson, Event Knowledge (pp. 1-20). Hillsdale, NJ: Erlbaum.

Nelson, K. & Hudson, J. (1988). Scripts and memory: Functional relationships in development. In F. E. Weinert & M. Permutter (Eds.), Memory development: Universal changes and differences. Hillsdale, NJ: Erlbaum.

Nelson, K. & Lucariello, J. (1985). The development of meaning in first words. In M. Barrett (Ed.), Children's single-word speech. Sussex, England: Wiley.

Ninio, A. (1983). Joint book reading as a multiple vocabulary acquisition device. Developmental Psychology, 19, 445-451.

Norusis, M.J. (1990). SPSS/PC+ Advanced Statistics 4.0. Chicago, IL: SPSS.

Ornstein, P. A., Medlin, R. G., Stone, B. P., & Naus, M. J. (1985). Retrieving for rehearsal: An analysis of active rehearsal in children's memory. Developmental Psychology, 21, 633-641.

Ornstein, P. A., Naus, M. J., & Liberty, C. (1975). Rehearsal processes in children's memory. Child Development, 26, 818-830.

Pascual-Leone, J. A. (1970). A mathematical model for transition in Piaget's developmental stages. Acta Psychologica, 32, 301-345.

Pascual-Leone, J. A. (1984). Attentional, dialectic, and mental effort. In M. L. Commons, F. A. Richards, & C. Armon (Eds.), Beyond formal operations. New York: Plenum.

Paris, S. G., (1988). Motivated remembering. In F. E. Weinert & M. Perlmutter (Eds.), Memory development: Univeral changes and individual differences. Hillsdale, NJ: Erlbaum.

Paris, S. G., Newman, R. S., & Jacobs, J. E. (1985). Social contexts and functions of children's remembering. In M. Pressley and C. J. Brainerd (Eds.), Cognitive learning and memory in children (pp. 81-115). New York: Springer-Verlag.

Park, D. & James, C. Q. (1983). Effects of encoding instructions on children's spatial and color memory: Is there evidence for automaticity? Child Development, 54, 61-68.

Park, D., Cortis, J., & Mason, C. Q. (1983). Effect of encoding instructions on children's spatial and color memory: Is there evidence for automaticity? Child Development, 54, 61-68.

Parker, L. (1992). Guest editorial. Aug-Communique, 9, 4.

Peirce, C. S. (1932). Ground, object, and interpretant. In C. Hartshorne & P. Weiss (Eds.), Collected papers of Charles Sanders Peirce. Cambridge:Harvard University Press.

Perlmutter, M., Schork, E. J., & Lewis, D. (1982). Effects of semantic and perceptual orienting tasks on preschool children's memory. Bulletin of the Psychonomic Society, 19, 65-68.

Pressley, M. (1982). Elaboration and memory development. Child Development, 53, 269-309.

Pressley, M., Borkowski, J. G. & Schneider, W. (1997). Cognitive strategies: Good strategy users coordinate metaacognition and knowledge. In R. Vasta & G. Whitehurst (Eds.), Annals of Child Development, Vol. 5 (pp. 89-129). New York: JAI-Press.

Pressley, M., & MacFayden, J. (1983). Mnemonic mediator retrieval at testing by preschool and kindergarten children. Child Development, 54, 474-479.

Pressley, M., Forrest-Pressley, D. L., Elliott-Faust, D., & Miller, G. (1985). Children's use of cognitive strategies, how to teach strategies and what to do if they can't be taught. In M. Pressley

and C. J. Brainerd (Eds.), Cognitive Learning and Memory in Children (pp. 1-48). New York: Springer-Verlag.

Pressley, M., Forrest-Pressley, & D. L., Elliott-Faust, D. (1988). What is strategy instructional enrichment and how to study it: illustrations from research on children's prose memory and comprehension. In F. E. Weinert & M. Perlmutter (Eds.), Memory development: Universal changes and individual differences. Hillsdale, NJ: Erlbaum & Associates.

Pressley, M., Heisel, B. E., McCormick, C. B. & Nakamura, G. V. (1982). Memory strategy instruction with children. In C. J. Brainerd & M. Pressley (Eds.), Progress in cognitive development research (Vol.2): Verbal processes in children. New York: Springer-Verlag.

Rabinowitz, F. M., & Howe, M. L. (1994). Development of middle concept. Journal of Experimental and Child Psychology, 57, 418-448.

Rohwer, (1973). Elaboration and learning in childhood and adolescence. In H.W. Reece (Ed.), Advances in child development and behavior (Vol. 8), (pp. 1-57). New York: Academic Press.

Reese, H. W. (1962). Verbal mediation as a function of age level. Psychological Bulletin, 59, 502-509.

Romski, M., Sevcik, R., & Pate, J. (1988). Establishment of symbolic communication in persons with severe retardation. Journal of Speech and Hearing Disorders, 53, 94-107.

Schleser, R., Cohen, R., Meyers, A. W., & Rodick, J. (1984). The effects of cognitive level and training procedures on the generalization of self-instructions. Cognitive Therapy and Research, 8, 187-200.

Schneider, W. & Pressley, M. (1989). Memory development between 2 and 20. New York: Springer-Verlag.

Siegler, R. & Shipley, C. (1990). A general strategy choice model: Examples from arithmetic and memory development. Unpublished manuscript. Cited in McGilly, K. & Siegler, R. G. The influence of encoding and strategic knowledge on children's choices among serial recall strategies. Developmental Psychology, 26, 931-941.

Silverman, F. (1989). Communication for the Speechless (2nd Ed.). Englewood Cliffs, NJ: Prentice Hall.

Somerville, S. C. & Haake, R. J. (1985). The logical search skills of infants and young children. In H. M. Wellman (Ed.), Children's searching. Hillsdale, NJ: Erlbaum.

Sophian, C. (1984). Developing search skills in infancy and early childhood. In C. Sophian (Ed.), Origins of cognitive skills. Hillsdale, NJ: Erlbaum.

Todaro, M. R. (1990). Minspeak using textures. Fifth Annual MINSPEAK Proceedings. Wooster, OH: Prentke Romich Company.

von Wright, J. M., Gebhard, P., & Karttunen, M. (1975). A developmental study of the recall of spatial location. Journal of Experimental Child Psychology, 20, 181-190.

Tullos, D. C. (1986). Semantic compaction: Implications. Proceedings: First Annual MINSPEAK Conference. Wooster, OH: Prentke Romich Company.

Tulving, E. (1972). Episodic and semantic memory. In E. Tulving & J. Donaldson (Eds.), Organization of Memory. New York: Academic Press.

Vanderheiden, G.C. (1984). Technology needs of individuals with communication impairments. Seminars in Speech and Language, 5, 59-67.

Vihman, M. M. & McLaughlin,B. (1982). Bilingualism and second language acquisition in preschool children. In C. J. Brainerd & M. Pressley (Eds.), Verbal Processes in Children. New York: Springer-Verlag.

von Wright, J. M., Gebhard, P., & Karttunen, M. (1975). A developmental study of the recall of spatial location. Journal of Experimental Child Psychology, 20, 181-190.

Vygotsky, L. S. (1978). Mind in Society. Cambridge, MA: Harvard University Press.

Wellman, H. M. (1985). A child's theory of mind. In S. Yussen (Ed.), The Growth of Reflection. New York: Academic Press.

Wellman, H. M., Fabricius, W. V. & Sophian, C. (1985). The early development of planning. In H. M. Wellman (Ed.), Children's Searching. Hillsdale, NJ: Erlbaum.

Wellman, H. M. & Somerville, S. C. (1980). Quasi-naturalistic tasks in the study of cognitions: The memory-related skills of toddlers. In M. Perlmutter (Ed.), New directions for child development: Children's memory, No.10. San Francisco: Jossey-Bass.

Wellman, H. M., Ritter, K., & Flavell, J. H. (1975). Deliberate memory behavior in the delayed reactions of very young children. Developmental Psychology, 11, 780-787.

Wertsch, J. V. (1985). Vygotsky and the social formation of mind. Cambridge, MA: Harvard University Press.

APPENDIX A

Semantic Compaction Competency Profile (SCCP) (Experimental Edition)

(Elder, Goossens', & Bray, 1990).

Materials

The assessment materials consisted of 18 clear plexiglass plates measuring 10 x 16 inches, colored line drawings of common environmental objects, arranged in two rows of four pictures each. Pictures were separated from each other by 2 inches on all sides. The pictures for the test were obtained from Elder, and color-copied and affixed to plexiglass sheets according to the arrays needed for testing.

Description of Subtests

The following description was provided by Elder:

> "The Semantic Compaction Competency Test was designed to explore skills in five major competency areas: Icon Association Flexibility, Icon Association Strategies, Two Icon Sequencing, Three Icon Sequencing and Icon Theming. A description of each subtest is outlined below:

I. Icon Association Flexibility

Icon Association Flexibility probed the child's ability to pair verbal concepts to icons. Three tasks were presented in which (a) a verbal stimulus was associated with a variety of icons or (b) a single icon was associated with a variety of verbal concepts. An initial test plate of 8 icons was used to acquaint the child with the required pointing task.

A. Multiple Icon - Single Meaning

Six plates (Plates 2,3,4,5,6,7) were presented. With each plate of eight icons the child was required to identify three exemplars of a specific referent verbally presented by the examiner. (e.g., "Find all the shirts." "Find all the apples." - APPLE (red), APPLE (green), APPLE (yellow))

B. Multiple Icon - Category

Six plates (Plates 8,9,10,11,12,13) were presented. With each plate the child was required to identify 3 referents within a category verbally presented by the examiner. (e.g., "Find all the clothes." - PANTS, SHIRT, SOCKS)

C. Single Icon - Synonymous Meaning

Three test plates (Plates 14,15,16) were presented 6 times in a series for a total of 18 presentations. With each plate the subject was required to identify the best picture for a synonymous concept presented by the examiner. Across the 18 presentation, 3 synonymous meanings are probed for 6 target icons. (e.g., "Find the best picture for 'big'." - TREE "Find the best picture for 'large'." - TREE "Find the best picture for 'huge'." - TREE).

II. Icon Association Strategies

Icon Association Strategies probed the child's ability to (a) associate multiple meanings with a single icon and to (b) use a variety of icon association strategies. Icon Association Strategies describe the nature of the perceived relationship between the verbal stimulus and the icon. The twelve Icon Association Strategies probed are defined below.

A. Function - The verbal stimulus described what an agent does to or with the referent reflected in the target icon or what the agent reflected in the target icon does. (e.g., "What makes you think of 'smell'?" - FLOWER "What makes you think of 'help'?" - POLICEMAN)

B. Attribute - The verbal stimulus described a salient descriptive property (exclusive of color and shape) associated with the target icon. (e.g., "What makes you think of 'cold'?" - ICE

C. Color - The verbal stimulus described the visual, perceptual attribute of the principal color of the target icon. (e.g.,"What makes you think of 'red'?" - TRUCK; icon is colored red)

D. Shape - The verbal stimulus described the visual, perceptual attribute of shape of the target icon. (e.g.,"What makes you think of 'circle'?" - SUN)

E. Category - The verbal stimulus named the classification of the target icon. (e.g., "What makes you think of 'food'?" - ICE CREAM)

F. Co-ordinate - The verbal stimulus named a referent having shared membership with the target icon within a category. (e.g., "What makes you think of 'cat'?" - DOG)

G. Substance - The verbal stimulus described the physical composition of the target icon. (e.g., "What makes you think of 'brick'?" - HOUSE)

H. Co-existence - The verbal stimulus named a separate entity frequently found in physical proximity to the target icon. (e.g., "What makes you think of 'purse'?" - MONEY)

I. Visible Part - The verbal stimulus named a readily visible part of the target icon. (e.g., "What makes you think of 'letters'?" - BOOK)

J. Inferred Part - The verbal stimulus named an assumed by not visible part of the target icon. (e.g., "What makes you think of 'door'?" - HOUSE)

K. Sounds Like - The verbal stimulus rhymed with the name of the target icon. (e.g., "What sounds like 'block'?" - CLOCK)

L. Looks Like - The verbal stimulus named a referent which resembled the target icon. (e.g., "What looks like 'ball'?" - SUN)

One hundred verbal concepts are presented for icon association. These one hundred verbal concepts provided the subject with (a) six opportunities to use each of the twelve Icon Association Strategies and (b) exposure to additional concepts used in subsequent parts of the test. Concepts were probed in two parts (Part A and Part B) using two test plates (Part A - Plate 17, Part B - Plate 18).

III. Icon Sequencing

Icon Sequencing probed the child's ability to combine icons to for two- and three-icon sequences to represent a sentence verbally presented by the examiner.

A. Two-Icon Sequencing - The child was required to select and order of two-icon sequence to denote a two-concept message presented by the examiner. Test sentences reflected either a pivot linguistic structure (e.g., "Find two pictures to say 'Don't...buy.'" - POLICEMAN...MONEY; "Find two pictures to say 'Don't...go.'" - POLICEMAN - TRUCK) or a nonpivot linguistic structure (e.g., "Find two pictures to say 'Smile ...pretty.'" - SUN...FLOWERS; "Find two pictures to say 'Go...eat.'" - TRUCK...ICE CREAM)

B. Three-Icon Sequencing - The child was required to select and order of three-icon sequence to denote a three-concept message presented by the examiner. Test sentences reflected either a pivot linguistic structure (e.g., "Find three pictures to say 'It's time...to...get dressed.'" - CLOCK...TRUCK...POLICEMAN; "Find three pictures to say 'It's time...to go...eat.'" - CLOCK...TRUCK...ICE CREAM) or a nonpivot linguistic structure (e.g., "Find three pictures to say 'The weather's ... not ... pretty.'" - SUN...POLICEMAN...FLOWERS; "Find three pictures to say 'Smell...the hot...food.'" - FLOWERS...SUN...ICE CREAM)

Concepts were probed in two parts (Part A and Part B) using two test plates (Part A - Plate 17, Part B - Plate 18).

IV. Icon Theming

Icon Theming probed the child's ability to use a theme structure and to make repeated theme shifts/ A theme structure required the child to select one icon representing a situational theme to which the message belongs and then, a second icon representing the principal concept of the message (e.g., Find two pictures, when we're eating, to say 'MMM...Smell

that.'" - ICE CREAM...FLOWERS "Find two pictures, when were eating to say 'Let's take it home.'" - ICE CREAM...HOUSE). A theme shift required the child to maintain the theme structure while shifting between theme boundaries (e.g., "Find two pictures, when we're eating, to say 'It's too hot.'" - ICE CREAM...SUN; "Find two pictures, while we're shopping, to say 'Let's stop here.'" - MONEY...POLICEMAN).

The order of test administration was as follows:

1. Icon Association Flexibility
2. Icon Association Strategies, Part A
3. Icon Sequencing, Part A
4. Icon Association Strategies, Part B
5. Icon Sequencing, Part B
6. Icon Theming"

NOTE: The following modification to scoring was made by the investigator because of lack of access to the computerized scoring program.

SCORING

Each child's test protocol was scored by hand. A grid was compiled to allow simple scoring of the Icon Association subtest.

" The first four subtests (Multiple Icon - Single Meaning, Multiple Icon - Category, Single Icon - Synonymous Meaning, and Icon Association Strategies) the child's choice was scored as correct if it matched the standard icon(s) predetermined by the investigators/ For the remaining subtests, an item was scored as correct if all choices matched the standard icons of if they were consistent with previous choices of the same concept on the Icon Association Strategy subtest."

Note. This is an experimental version of the SCCP. It was obtained from the second author.

APPENDIX B

Metamemory Protocol

SUBJECT ID____ SITE ID____ DATE_____ TIME____

MEMORY ESTIMATION TEST (Adapted from Kurtz, Reid, Borkowski, & Cavanaugh, 1982).

1ST ESTIMATE (P_1)

PLACE THE FIRST STACK OF CARDS IN A PILE, WITH THE TOP CARD TURNED OVER, FACE-UP. ASK THE CHILD "HOW MANY OF THESE CARDS COULD YOU REMEMBER IF I GAVE YOU SOME TIME TO LOOK AT THEM ALL? MOVE AS MANY AS YOU THINK YOU COULD REMEMBER OVER HERE." (INDICATE ANOTHER PLACE ON THE TABLE) COUNT THE CARDS SET ASIDE BY THE CHILD, WRITE DOWN THE NUMBER, AND THEN PUT THEM BACK TO FORM A COMPLETE STACK.

MEMORY TEST (A) (This portion of MET used for STM test)

HERE IS ANOTHER STACK OF PICTURES. SEE? IT'S AS BIG AS THIS ONE (INDICATE FIRST STACK). I'M GOING TO SHOW YOU EACH PICTURE, ONE AT A TIME, AND LET YOU LOOK AT IT FOR A FEW SECONDS. TRY HARD TO REMEMBER AS MANY PICTURES AS YOU CAN." (DISPLAY EACH PICTURE FOR THREE SECONDS, AND THEN PLACE IT FACE DOWN IN A STACK.) INSTRUCT THE CHILD, "TELL ME THE NAMES OF AS MANY OF THESE PICTURES AS YOU CAN. I'M GOING TO HOLD ALL THE PICTURES, BUT I WILL PUT EACH ONE YOU REMEMBER IN A PILE HERE (INDICATE). START NOW, AND I WILL TELL YOU WHEN TO STOP. ALLOW THE CHILD FIVE MINUTES.

SECOND ESTIMATE (P_2)

SHOW THE CHILD A THIRD STACK OF PICTURES WITH ONE TURNED FACE-UP ON TOP. TELL THE CHILD "THIS TIME, SHOW ME HOW MANY YOU THINK YOU COULD REMEMBER IF I SHOWED YOU ALL THE PICTURES JUST AS BEFORE."

P_1 = NUMBER OF FIRST ESTIMATE: ______

A = ACTUALLY RECALLED:

1. __________ 2. ____________ 3. _____________ 4. ____________

5. __________ 6. ____________ 7. _____________ 8. ____________

9. __________ 10. ____________ 11. _____________ 12. ____________

13. __________ 14. ____________ 15. _____________ 16. ____________

P_2 = NUMBER OF SECOND ESTIMATE: _____

PREPARATION OBJECT TEST (Adapted from Belmont & Borkowski, 1988).

(Original: attempt)

"A boy/girl wants to go skating tomorrow after school. If you were that boy/girl, what might you do tonight to help you remember to take your skates to school the next day? Tell me as many things as you can."

(Modification: If child does not respond, use the next scenario.)

"Tell me how you remember to bring your swimsuit to school for splash day. What do you do so that you do not leave it at home?"

EXAMPLE CLASS 1: Make written or pictorial reminders. Score ______

EXAMPLE CLASS 2: Have somebody else remind them. Score _____

EXAMPLE CLASS 3: Strategically place the skates. Score ______

EXAMPLE CLASS 4: Rehearse or use some other in-the-head method. Score ______

STORY LIST (Adapted from Belmont & Borkowski, 1988).

The child is presented with a set of eight, 2" x 2" black and white line-drawings (Mayer-Johnson) (man, bed, tie, shoes, table, dog, hat, car) and asked:

"Would these pictures be easier to remember after I say their names, of after I tell you a story that has all of them in it?"

Check child's response or write in other ideas:

Naming ____________ Story ____________
Other ______________________________________

APPENDIX C

Experimental Story Script

Experimental Story Script of <u>The Three Bears</u> to Accompany First Little Golden Book Version (1983)

<u>Page 1</u>
Once upon a time there were three bears. The father bear was great big. The mother bear was middle sized. And the baby bear was wee little. He got off his little, bitsy chair and sat on the rug. Now he's coloring with his crayons. He's got the same colors as her --- green, yellow, blue, red. He doesn't want to play with his toy panda bear. While he's coloring, mother bear is working. She's making a sweater out of yarn for father bear. What colors does she have? Green, red, yellow, blue.
*Who's this?____(mother bear:1)
What about the father bear? He's sitting on his big, hard chair. Look! He hasn't got a pillow to sit on. Owee---that chair must be so hard. He's busy reading his newspaper.

***(turn the page, please:1)

<u>Page 2</u>
One morning, the mother bear made some porridge for breakfast. See that hot, sticky stuff? Sometimes we call it oatmeal. Well, mother bear knew that her family LOVED porridge, and so she cooked lots in her <u>great, big</u> cooking pot. Look!
* Her cooking pot was very, ____(big:1).
* Steam's coming out because the porridge is so ____ (hot:1).
Baby bear is just little, and so he's got to stand up on a chair so he can smell that good porridge. "Mmmm mmmm!" Mother bear did not like it when the baby bear climbed up on chairs by the stove, because that was a dangerous thing to do. She always said, "No, no! Don't do that!"
*Mother bear filled a great, big, brown bowl for father bear because he was ___(big:2);
a middle sized bowl for herself because she was middle sized;
*and so baby bear had this bowl because he was so __(little:1).
Mother bear wanted to check the porridge to make sure it was just right. So she got a spoon and had a little taste from all the bowls. But you know what ?
*The porridge was way too ___ (hot:2).
*Who's this? ___ (father bear:1)
Father bear sat down to eat and saw that someone had been eating some of his porridge.
*He thought baby bear had done it, and so father bear said, ____ (Someone's been eating my porridge!:1)
Then baby bear sat down at the table and saw that someone had been eating *his porridge, too, and so he said ____(Someone's been eating my porridge!:2)
Mother bear just laughed and said, "Oh! I've been checking your porridge, and it's way too hot. We'll have to wait until it cools down."

Father bear said, "Let's go for a walk outside and look at the pretty trees and flowers. When we get back, we can eat it because by that time it will *not be too ____." (hot:3)
Baby bear loved to go walking outdoors with his father and mother and so he was very happy.
So the three bears decided to go. They went out the door and shut it (BANG!). They didn't want anyone to go snooping in their house. No indeed!

*** (Turn the page, please:2)

Page 3

But --- do you know what? While the bears were out walking, a little girl came to the house. She was wearing a pretty pink dress and her name was Goldilocks. Goldilocks was lost and so she went up to the door of the house even though she did not know who lived there. Goldilocks' Mom was just like the mother bear because she did not like Goldilocks to do things that are dangerous.
*If Goldilocks' Mom could see Goldilocks knocking on the door, she might say _____ (No, no. Don't do that!:1).
But Goldilocks' Mom wasn't there, and so Goldilocks' went on the porch. First of all she knocked on the door (gesture): knock, knock, knock. Of course no one answered because the bears had gone for a walk to see the ***flowers and trees that were ____(outside:1).
Can you believe this? She opened the door and walked right in, and she didn't even know the three bears.

*** (Turn the page, please:3)

Page 4

Goldilocks saw three bowls of porridge on the table: Mother bear's bowl was middle-sized.
*Father bear's bowl was ___(big:3).
*And the baby bear's bowl was____(little:2).
Mmm mmmm---it smelled so good that someone decided to taste it.
*I wonder who it was? ___________(Goldilocks:1.)
You're right, it was Goldilocks. She shouldn't be eating the bears' breakfast.
If Goldilocks' mother were *there, she might say, ___(No,no! Don't do that!:2)
First, Goldilocks ate *some porridge from the Father Bear's bowl which was very ___ (big:4) -but ouch!
*It was way too _______ (hot:4).
Next she ate some porridge from the middle sized bowl, but it was way too cold. Then she ate some porridge from the baby bear's bowl and it was just right.

***(Turn the page, please:4)

Page 5

Now that she's not hungry anymore, someone wants to sit down.
*Who could it be? __________ (Goldilocks:2)
She was very tired from all that walking.
*So into the den went ____ (Goldilocks:3) and she saw three chairs.
**The first chair was great ____ (big:5), because it belonged to the _______ (father bear:2).
*This one was middle-sized, because it belonged to the ________ (mother bear:2).
*And this one was wee _______ (little:3),
*because it belonged to the _______ (baby bear:1).
Uh oh! I think she's going to sit in all the chairs.
*What would her mother tell her? __________ (No, no, don't do that!:3)
Father bear's chair so big, Goldilocks had to climb up onto it.
*So, first she sat in the big chair that belonged to _____ (father bear:3), but it was too hard because there was no soft pillow on it. She jumped off and pushed it away. Ouch!
*Then, she sat in the middle-sized chair that belonged to _______(mother bear:3), but it was too soft and squishy.
There were so many pillows on it, that it was too soft and squishy. So that naughty girl just threw them on the floor and made a mess.
*Then she sat in the little chair that belonged to _________(baby bear:2), and it was just right.
*But uh oh! It was only a little chair, and Goldilocks was too ____(big:5) and she broke the chair.
*Now baby bear's chair is _________ (broken:1) all to pieces. She should have thought about what her mother used to tell her about using other people's stuff.
*Her mother always said, ________ (No, no, don't do that!:4)

*** (turn the page, please:5)

Page 6

Goldilocks went upstairs and found three beds. She was tired after her walk outdoors in the woods.
So she decided to take a nap. Look! Now that naughty girl is going to lie down on their beds.
Her mother would say ________ (No, no don't do that:4)
First, Goldilocks climbed onto the big bed that belonged to _____(the father bear:4), but it was too hard.
Then she climbed onto the middle-sized bed that belonged to ___ (mother bear:4), but it was too soft.
[point] Mother bear's bed was middle-sized; father bear's bed was big; and baby bear's bed was ___ (little:4)
Baby bear kept his teddy bear on the bed.

*** (Turn the page, please:6)

Page 7

*So she climbed into the little bed that belonged to ____ (baby bear:3). She didn't have her own cuddly toy. So Goldilocks hugged the teddy bear and she went to sleep.
***The three bears finished walking and looking at trees and flowers that were _______ (outside:2)
and they come home. But the father bear told everyone, "Stop!" He said [point] "Look! The door is open. I know I shut it. It went "bang". Poor little baby bear was scared, and so he hid behind his mother. They did not go inside.
***They waited _____ (outside:3)
The mother bear wondered who was in her house. You know who is in there.
*It's____ . (Goldilocks:4) That's right. The father bear looked inside, but he couldn't see anyone. So they all went in.

*** (Turn the page, please:7)

Page 8

*Remember! The three bears had gone for a walk before because their porridge was too ___ (hot:5)
Right away, the three bears saw that someone had been eating their porridge.
*The father bear said ______ (Someone's been eating my porridge.:3).
This time, his spoon was all messy, and there was porridge spilled all over the table. He was very grouchy, because he was so hungry and he had waited a long time for his breakfast.
***All that walking to see the flowers and trees that were ____ (outside:4) made him very, very hungry.
He wasn't the only one who felt hungry. Mother bear went to sit down on her chair and she found sugar and porridge all over it. Yuck! What a sticky mess. She was not a messy bear. Someone else had been messy.
*The mother bear said ___ (Someone's been eating my porridge:4)
Baby bear wasn't really listening. He had already picked up his bowl. He looked and looked inside it, but the porridge was all gone. The bowl was completely empty. There was none left for him, and he was a hungry little bear. He was very sad.
*Now baby bear said ___ (Someone's been eating my porridge:5) And they ate it all up!

*** (Turn the page, please:8)

Page 9

The three bears went into their den.
*Who's this? _______ (father bear:5)
Right! He saw what had happened. Someone had moved his chair to the wrong place. [Fixed gesture to picture of FA pointing] Father bear pointed to his very big, hard chair and told everyone to look.
*He said ____ (Look!:1).

*Then he pointed to his chair and said ______(Someone's been sitting in my chair!:1)
Whose chair is this?
*It belongs to ______ (mother bear.:5)
Mother bear's chair didn't have pretty pillows on it any more [refer back to page 5].
*Mother bear pointed at her chair and told everyone to ____ (Look:2).
*Then mother bear fussed about her chair and said ____ (Someone's been sitting in my chair:2)
Mother bear was not happy.
*Who's this? _____ (baby bear:4) Yes. That is baby bear.
*The baby bear said "Look! And then he said _____ (Someone's been sitting in my chair:3)
*and now it's all ________(broken:2)
All the bears saw that something was wrong in their house! What was wrong with baby bear's chair?
*It was ____ (broken:3)
The three bears were not happy. Mother bear said, "Someone's been in our house. They ate our porridge; broke a chair and made a mess".
*What did father bear say when he saw his chair? ___ (Someone's been sitting in my chair.:4)

***(Turn the page please: 9)

Page 10

So, they all went upstairs to the bedroom. Guess what? More mess! The beds were all messy.
*Father bear pointed and said ______(Look!:3)
Someone's been sleeping in my bed!"
*Mother bear pointed and said _____("Look! :4)
Someone's been sleeping in my bed!

*** (Turn the page please:10)

Page 11

*"Someone's been sleeping in my bed and there she is" said _________(baby bear:5).
*The three bears were talking loudly and they woke up _________(Goldilocks:5)
She opened her eyes and saw three bears standing there. She felt scared. She knew she had been naughty and so she jumped out of bed
***and ran downstairs, opened the door, and went ____(outside:5).

*** (Turn the page, please:11)

Page 12

*The three bears hurried to the window and Father Bear pointed and said, "______ (look:5), there's that girl.

Mother bear told baby bear not to go into strangers' houses. Baby bear said thought it might be fun, but father bear and mother bear shook their *fingers at him and said _____ (No, no don't do that:5) The three bears watched Goldilocks run away from the house as fast as she could run. they never saw her again because never again did she go for a walk in the woods all by herself. Goldilocks ran away and never came back.

THE END

Note. Parentheses indicate the target and the numeral indicates which presentation it was. Most items were presented five times.

[] indicate a direction to the reader.

* denotes a sentence containing a target.

** denote a sentence containing two targets.

*** denote a filler item.

Double-underlining denotes that the word or phrase is spoken with emphasis.

Page numbers correspond to the storybook. The actual script use by the investigator had page physical page breaks consistent with the book to prevent children from being confused by asynchrony arising from the script changing page, but not the book.

VITA

Judith Danute Oxley received her B.A.(Hons.) in History from the University of Tasmania in Australia in 1974. She moved to the United States of America in 1982 with her husband and two children and completed her M.A. in Communication Disorders at Louisiana State University, Baton Rouge, Louisiana in 1988. She works as a clinical supervisor in the Department of Communication Sciences and Disorders at LSU, Baton Rouge, specializing in the area of Augmentative and Alternative Communication.

DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Judith Danute Oxley

Major Field: Communication Disorders

Title of Dissertation: The Effect of Developmental Factors on the Use of an Electronic Communication Device

Approved:

Janet Norris
Major Professor and Chairman

J. Shelby Larkin
Dean of the Graduate School

EXAMINING COMMITTEE:

Paul A. Hoffman

J. McDonald

Ann M. Troudale

Janna B. Oetting

Date of Examination:

03/31/95