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A Role of Problem-Solving in Complex Intraverbal Repertoires

Rachael A. Sautter
Western Michigan University

A ROLE OF PROBLEM-SOLVING IN COMPLEX INTRAVERBAL REPERTOIRES

by

Rachael A. Sautter

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INTRODUCTION

B.F. Skinner was a philosopher and a scientist who had a profound impact on both the conceptual development and application of behavior analysis. Skinner is often referred to as the founder/father of behavior analysis as he was one of the first people to clearly delineate a specific scientific view of behavior (Miltenberger, 1997; Morris, Smith, & Altus, 2005; Sarafino, 2001). In 2005, Morris et al. identified several important areas of Skinner's contributions to the field of behavior analysis. The first of these areas focused on both the style and content of Skinner's scientific approach to behavior. Skinner's style and content was exemplified by the experimental methodology that drove his work. His empirical investigations of both normal and abnormal behavior led to the discovery of the basic principles of operant conditioning. In turn, these principles became the foundation for his new science of behavior. The other areas of contribution identified by Morris et al. included Skinner's interpretation of normal and abnormal behavior, the application of his scientific investigations, and his descriptions of additional applications of the basic operant principles of behavior to human and nonhuman behavior.

In addition to Skinner's contributions, Morris et al. (2005) elaborated on the primary characteristics of Skinner's work. Although these individual characteristics were not each unique to Skinner's work, the integration of these characteristics and their application to the science of typical and atypical behavior is Skinner's most fundamental contribution to the field. One characteristic is that Skinner defined knowledge as engaging in effective action, rather than simple contemplation. He stated that in order for action to be effective, it must involve accurate description, prediction, and control of

behavior. An additional characteristic of Skinner's work is that knowledge must be based on the identification and demonstration of functional relations rather than based on simple correlations between dependent and independent variables. Morris et al. also stated that Skinner's work focused on the functional relations that resulted from within subject research designs and "direct experimental control of the subject matter" rather than relying on group designs and statistical analyses (p.101). These functional relations are considered broadly applicable to human behavior because they were based on the basic principles of operant behavior. In fact, Skinner extended this notion of functional relations and operant behavior to the most complex of human actions, verbal behavior.

Skinner's (1957) *Verbal Behavior* was the culmination of more than 20 years of interest and effort in developing a behavioral delineation of language (Morris et al., 2005). *Verbal Behavior* was one of Skinner's most famous applications of his science of behavior and Skinner himself considered this publication to be his "most important work" (Skinner, 1977, p.379). Skinner provided a conceptual interpretation of the controlling variables of language and also described a variety of potential applications for this functional analysis (Morris et al., 2005). This functional analysis of language includes information on the reinforcement and punishment of different verbal operants, different aspects of stimulus control and motivation which effect the acquisition, development, and maintenance of different verbal operants, and the different critical aspects of both speaker and listener behavior (Morris et al., 2005). Specifically, Skinner defined verbal behavior as behavior reinforced through the mediation of other people and defined a particular verbal operant by its functional relations to antecedents and consequences rather than by topography (Skinner, 1957).

One of the major tenets of Skinner's approach is that an operant is the critical unit of analysis, rather than the traditional units of language (e.g., words, phrases). In his 1957 work, he described the elementary verbal operants to be the mand, tact, echoic, and intraverbal. Skinner stated that each operant must be considered a separate and independent product of relevant environmental variables that control when and if the operant will be emitted (Skinner, 1957, pp.187-190). In *Verbal Behavior*, Skinner provided the basic notion that verbal operants are functionally independent such that the acquisition of one operant does not ensure the use of the same word under different antecedent and consequence conditions. Therefore, Skinner did not assume a general "meaning" of a word but saw each operant as being under the independent control of specific antecedents and consequences. There is growing support for this notion of functional independence (Drash, High, & Tudor, 1999; Henry & Horne, 2000; Partington & Bailey, 1993; Sautter & LeBlanc, 2006; Sigafoos, Doss, & Reichle, 1989), but some research shows that verbal operants are also inter-related such that one functional repertoire can be used to quickly develop other functional repertoires using transfer of stimulus control procedures (Arntzen & Almas, 2002; Braam & Poling, 1983; Braam & Sundberg, 1991; Drash et al., 1999; Nuzzolo-Gomez & Greer, 2004; Sigafoos, Reichle, Doss, Hall, & Pettitt 1990; Sundberg, San Juan, Dawdy, & Arguelles, 1990; Watkins, Pack-Teixeira, & Howard, 1989). The basic operants are briefly reviewed below with a more extensive treatment of intraverbals, which constitutes the emphasis of this paper.

Elementary Verbal Operants

Skinner (1957) stated that the mand is defined by the unique relationship between a response and the reinforcer provided for that response. In addition, Skinner stated that

with a mand, the response specifies the reinforcer and is controlled by the relevant establishing operation of deprivation or aversive stimulation. In a review of empirical studies of Skinner's framework with humans, Sautter and LeBlanc (2006) identified the mand as the most frequently studied operant with 43 studies involving some type of analysis of a mand repertoire. Several studies have demonstrated that once a mand repertoire is developed, it can be used to facilitate the development of other verbal operants (Arntzen & Almas, 2002; Braam & Sundberg, 1991; Drash et al., 1999). A unique feature of the mand is that it directly benefits the speaker, thus providing additional support for Skinner's notion that the mand should be the initial focus of language training. Additional studies on the mand have also provided empirical support for the importance of incorporating relevant establishing operations into training settings (Bowman, Fisher, Thompson, & Piazza, 1997; Sundberg, Loeb, Hale, & Eigenheer, 2002).

Skinner defined a tact as a response that is "evoked by a particular object or event or property of an object or event" (1957, p. 82). Thus, a tact occurs under the functional control of a discriminative stimulus (rather than an establishing operation) and is maintained by social reinforcers from a person's verbal community. Sautter and LeBlanc (2006) identified tacts as the second most frequently studied verbal operant with 22 studies involving a tact repertoire either in isolation or in combination with other verbal operants. Several of the empirical studies on tacts have demonstrated the utility of transfer of stimulus control procedures in language training (Partington & Bailey, 1993; Sundberg et al., 1990; Watkins et al., 1989). Additional studies on tacts have investigated other teaching procedures designed to help overcome barriers to developing

functional tact repertoires (e.g., stimulus overselectivity). These acquisition procedures have included enhancing nonverbal stimuli, and differential reinforcement (Arntzen & Almas, 2002; Partington, Sundberg, Newhouse, & Spengler, 1994; Sundberg, Endicott, & Eigenheer, 2000).

According to Sautter & LeBlanc (2006), the echoic response was the third most frequently studied verbal operant and is defined as a response that is under the functional control of a verbal stimulus with point-to-point correspondence between the stimulus and the response (Skinner, 1957, p. 55). Thus, the response generated by the speaker sounds identical to the stimulus that evoked it. Like the tact, echoic responses are maintained by social reinforcers but there is also reinforcing value in the sound of the "match" between the response and the stimulus that evoked it. To date, studies on echoic behavior have included investigations into the utility of transfer of stimulus control procedures (Drash et al., 1999; Finkel & Williams, 2001), as well as the utility of a stimulus-stimulus pairing procedure on the development of an echoic repertoire (Esch, Carr, & Michael, 2005; Sundberg, Michael, Partington, & Sundberg, 1996; Yoon & Bennett, 2000).

One of the most interesting but problematic verbal operants is the intraverbal. An intraverbal is defined as a response for which there is no formal point-to-point correspondence with the verbal stimulus that evoked it (Skinner, 1957, p. 71). Intraverbal responses are maintained by social reinforcement from a person's verbal community but, unlike the echoic, they are not replicas of the evoking stimuli. Although the intraverbal is a complex operant, encompassing simple word associations as well as complex conversational exchanges (Skinner, 1957), Skinner's 1957 discussion of the

intraverbal spoke mostly to language occurring in the context of intraverbal chains or occurring because of temporal contiguity and a history of reinforcement.

In Chapter 4 of *Verbal Behavior* (1957, pp. 71-80) Skinner described intraverbal responding as trivial social responses under simple stimulus control (e.g., thank you . . . your welcome), responses occurring as part of an intraverbal chain (e.g., the alphabet, reciting a poem), responses occurring as simple "word associations," metaphors and other literary illusions, expressions, and translation. Skinner explained that intraverbal behavior occurs because there has been a temporal contiguity between the stimulus and the response in the past, in which a particular response has been reinforced. He stated that it could be beneficial for people to have responses readily available that could be emitted almost immediately in response to a verbal stimulus. This benefit of intraverbal responding was demonstrated in the traditional word association experiments (Skinner, 1957).

Skinner described word associations as evidence for an extensive history of reinforcement for particular intraverbal responses to particular stimuli. A string of responding to a particular stimulus during a word association task occurs because one verbal response serves as the stimulus for the next response in a chain (p. 73). He also explained that, although specific sequences of intraverbal responses can be directly established, any verbal stimulus should be the occasion for any related (but not directly echoed) response that has occurred with the stimulus in the past. Such associations are seen in the response *animal* to the stimulus *dog*, or the response *anger* in response to the stimulus *yelling* (p. 75). Interestingly, this section on word associations (pp.73-76) is the

only place in the chapter on intraverbal behavior where Skinner references categorization skills, though subsequent researchers have frequently studied categorization.

In 1983, Braam and Poling were the first to extend Skinner's definition of the intraverbal to include answering questions about category membership. Braam and Poling stated that categorization falls into the same context as the analogies and word associations described by Skinner in 1957. In addition, they explained that although these skills are not usually demonstrated in ordinary circumstances, these are skills tested in formal intellectual or language assessments. Formal education also consistently involves the ability to categorize information and remains an area of language that is difficult for individuals with disabilities to master and maintain (Braam & Poling, 1983). This initial study on intraverbal categorization has since started a line of research investigating the utility of different teaching procedures on the acquisition, maintenance, and generalization of these intraverbal responses. These studies will be described in detail later in this paper. Note that throughout this manuscript the term categorization is used to refer to the research preparation of responding to a question such as "tell me some animals" and is not referring to either the behavior analytic or cognitive science work on concept learning (Quinn & Oates, 2004; Zentall, Galizio, & Critchfield, 2002).

Types of Intraverbals

In 1998, Sundberg and Partington distinguished between beginning and advanced intraverbal behavior based on the procedural differences for teaching beginning and advanced conversational skills. They identified several perquisite skills necessary for the development of a functional beginning intraverbal repertoire which included approximately 50 mands, 50 tacts, and initial receptive by feature, function, or class

(RFFC) skills. Sundberg and Partington defined beginning intraverbal behavior as the ability to understand and emit verbal behavior in response to the verbal behavior of other people. The authors also provided a variety of teaching strategies to help develop more functional intraverbal repertoires, such as procedures that transfer stimulus control from responses that already exist in the child's repertoire (e.g., mand, tact, or echoic).

Sundberg and Partington (1998) also included detailed information on advanced intraverbal skills, which focused on teaching fill-in-the-blank responding and answering both simple and complex questions. The authors suggested initially teaching children to provide one verbal response in response to a single verbal stimulus and progressing to multiple verbal responses to a single verbal stimulus, and then multiple responses to multiple stimuli. Although Sundberg and Partington identified these subcategories of intraverbal behavior, the distinction was based on the complexity level of the teaching procedures rather than on the unique features of the responses or specific relationships between the responses and the evoking stimuli.

Although Sundberg and Partington provided a detailed analysis of beginning and advanced intraverbal behavior, there is an additional way of classifying different levels of intraverbal behavior. This alternative classification distinguishes between simple and complex intraverbal behavior based on the relationship between the response and the evoking stimuli as well as the number of possible acceptable and reinforceable responses. According to this classification, simple responses have only a few possible correct or reinforceable responses that typically occur as part of a brief intraverbal chain (e.g., twinkle, twinkle, little ___). Alternatively, complex intraverbals have many correct and reinforceable responses and, arguably involve other complex repertoires such as problem-

solving (explored in detail later). For example, the question "what are some animals" has an almost unlimited number of potentially correct responses to select from, any of which would be reinforced by the person's verbal community.

Simple Intraverbals

With simple intraverbal behavior, all possible acceptable responses could be directly prompted and reinforced, thus not requiring any additional problem-solving skills. Examples of this type of intraverbal behavior can be seen in providing a fill-in-the-blank response to a nursery rhyme or song (e.g., Mary had a little ____), answering personal questions (e.g., name, age, phone number), and answering a variety of other simple questions (e.g., what does a cat say?, what is the opposite of hot?, can you buy gas at a shoe store?). Effective teaching procedures for simple intraverbal behavior have typically involved verbal and/or visual prompts (e.g., echoic, picture, or textual) to teach the highly specific responses. These prompts can be faded quickly and easily and correct responses can be differentially reinforced in order to quickly teach a basic intraverbal repertoire.

To date, empirical studies on simple intraverbal behavior have evaluated the utility of different types of training and prompting procedures on teaching responses to simple questions. Finkel and Williams (2001) compared the effects of textual and echoic prompts on intraverbal responses to direct personal questions related to name, age, address, birthday, or favorite color. The results showed that both forms of prompts were effective at establishing the basic intraverbal responses, with textual prompts being the more effective of the two procedures. Sundberg et al. (1990) investigated intraverbal responding in the context of answering questions about the functions of common objects.

In this study, the researcher explained the function of an object and the participant had to name the item needed to complete the specified function. This type of intraverbal training proved to be an efficient way to establish mands in people with traumatic brain injury. Additional studies on simple intraverbal behavior have also investigated the utility of intraverbal prompts on the acquisition of other functional repertoires (Partington et al., 1994; Sundberg et al., 2000).

Complex Intraverbals

In contrast, complex intraverbal behavior involves responses to more complex verbal stimuli where there are many possible correct and reinforceable responses to select from, any of which would be reinforced by the person's verbal community. With complex intraverbal behavior, it may not be reasonable or even possible to prompt and directly reinforce every possible response. It also may not be reasonable to expect the unprompted and unreinforced responses to occur simply because of programmed generalization or repeated training trials. Examples of complex intraverbal behavior include responses involving features of items (e.g., name 30 things with wheels, tell me all of the animals that have tails), categorization of items (e.g., name a fruit, tell me all the animals found at the zoo), and answering certain open-ended questions (e.g., what do you find in the kitchen?, what did you do this weekend?, name some clothes you wear when it is hot out).

To date, nine studies have investigated complex intraverbal skills in the areas of reading (Daly, 1987; Tenenbaum & Wolking 1989), play statements (Lodhi & Greer, 1989), and categorization (Braam & Poling, 1983; Goldsmith, LeBlanc, & Sautter, 2007; Luciano, 1986; Miguel, Petursdottir, & Carr, 2005; Partington & Bailey, 1993;

Petursdottir, Carr, & Lechago, 2006; Watkins et al., 1989). The studies on intraverbal categorization represent the most linear progression of research and are described in detail below, as this is the basis for this paper.

Previous Research on Intraverbal Categorization

Seven of the nine studies on complex intraverbals have investigated intraverbal behavior in the context of categorization. The primary goal of these seven studies was to teach participants to name specific items belonging to predetermined categories, although individual studies also investigated support for functional independence and the role of transfer of stimulus control procedures.

Studies Involving Participants with Disabilities

Braam and Poling (1983) were first to experimentally investigate intraverbal behavior in the form of categorization. This study evaluated the utility of transfer of stimulus control procedures (from tact to intraverbal) with a 17-year-old girl with hearing impairment and severe mental retardation. Training sessions consisted of prompting and direct reinforcement (tokens and praise) for correct, signed intraverbal responses for three different categories (i.e., food, clothes, and school). Each category was trained in isolation and the results showed that the participant learned all of the training stimuli for each category, and maintained these responses at follow-up probes. The participant also produced 14 novel intraverbal responses that were not directly trained but were items that she could tact during pre-testing. The authors concluded that the development of the basic trained intraverbal responses was impressive on its own and the novel responses were "unexpected bonuses" (p. 288).

In a second experiment, Braam and Poling (1983) investigated the utility of errorless learning procedures on intraverbal categorization. The purpose of this experiment was to use a delayed prompting procedure in order to establish correct intraverbal responses without the occurrence of errors. The results showed that the participant was able to acquire intraverbal responses without emitting errors, however, responses were not maintained at follow-up. In the final experiment, the authors assessed the utility of transfer procedures to teach more complex intraverbal behavior involving conditional discriminations (e.g., school people, home people, school things). The results of this experiment showed that both participants emitted the intraverbal responses that were directly trained and reinforced as well as a variety of untrained intraverbal responses.

Luciano (1986) conducted a systematic replication of Braam and Poling (1983) with teenagers with mental retardation. The Luciano study differed from Braam and Poling in that they taught a vocal response, used an errorless discrimination procedure, and used a maximum response latency of 3 seconds, rather than 10 seconds. Intraverbal training sessions involved prompting and direct reinforcement for correct intraverbal responses to category questions about food, drinks, clothes, or vehicles. The results of this study showed that both participants acquired the responses that were directly trained and reinforced. However, the results also showed that Participant 2 never gave more than one response per trial while Participant 1 produced a chain of three correct responses during one of the trials. Follow-up probes indicated minimal response generalization for both participants and the authors concluded that generalization was less likely for the participants who experienced the errorless discrimination procedures. This study

provided additional support for the utility of transfer procedures in the development of intraverbal categorization.

Watkins et al. (1989) investigated the utility of procedures that transferred stimulus control from echoic to intraverbal control in the context of intraverbal categorization. They evaluated these procedures for teaching single and multiple intraverbal responses with children with severe mental retardation. Intraverbal training sessions occurred for adjectives (e.g., color, size, texture), noun classes (e.g., animal, toy, clothing), and multiple responses that include adjectives plus nouns (e.g., big horse, brown couch). The results showed that echoic to intraverbal transfer procedures were effective as establishing both simple and multiple intraverbal responses. However, multiple responding did not emerge after simple tact training procedures. Thus, specific training and direct reinforcement for multiple responses was required. The authors suggested that the lack of novel responding and the difficulty with multiple responding might have been due to repeated exposures with the same training materials or a long history of reinforcement for only simple intraverbal responses.

Goldsmith et al. (2007) conducted a systematic replication of Partington and Bailey (1993) with children with autism (see *Studies Involving Typically Developing Participants* for a description of Partington & Bailey, 1993). This study used transfer of stimulus control procedures and errorless learning to target intraverbal categorization (i.e., naming exemplars belonging to clothes, furniture, colors, or animals). Intraverbal training consisted of tact prompts, errorless learning, and direct reinforcement with schedule thinning for correct intraverbal responses. The results showed that all three participants acquired the targeted intraverbal repertoires with varying numbers of trials to

criterion. In addition, acquisition occurred more quickly for subsequently trained categories then for the first category for all participants. This suggests that intraverbal training may become more efficient across targets. Although good acquisition effects were achieved, maintenance and generalization effects were quite limited.

Studies Involving Typically Developing Participants

Partington and Bailey (1993) were the first to examine intraverbal categorization with typically developing children. In this study, the authors examined the functional independence of tact and intraverbal responses and also investigated the utility of tact prompts on the development of categorical intraverbals (i.e., naming exemplars for toys, fruit, furniture, or cleaning items). An additional purpose of this study was to determine if the transfer procedures that were originally developed for teaching children with disabilities would be effective teaching tools for typically developing children. The results showed little increases in intraverbal responding following tact training but did provide additional support for the utility of tact to intraverbal transfer procedures. Although Partington and Bailey (1993) did demonstrate successful intraverbal responding for those responses that were directly trained and reinforced, their results also showed that none of the participants emitted responses to the untrained stimuli, indicating a lack of generalization.

Partington and Bailey (1993) also examined the effects of multiple tact training (i.e., tacting the item and the class to which the items belongs) on the acquisition of intraverbal categorization. The results of this second experiment showed that half of the participants demonstrated increases in intraverbal responses immediately following multiple tact training sessions, before participating in any intraverbal training sessions.

However, all of the participants quickly acquired the intraverbal responses after participating in only a few intraverbal training sessions. The results also showed some generalized intraverbal responding for two of the participants (i.e., each participant emitted one independent response to the fourth, untrained stimulus). The general findings showed that tacts and intraverbals were functionally independent for typically developing children and multiple tact training produced increases in intraverbal responding for about half of the participants. Although some of the participants showed a few novel or untrained responses, the authors considered response generalization to be extremely limited within and across categories.

Miguel et al. (2005) conducted a replication of Partington and Bailey (1993) and further investigated the effects of multiple tact training on the acquisition of intraverbal categorization (i.e., naming exemplars for tools or musical instruments) with typically developing preschool children. This study also investigated the effects of receptive discrimination training procedures on the acquisition of categorical intraverbals as well as the utility of standard transfer procedures when other training procedures were ineffective. The results showed that neither multiple tact training nor receptive discrimination training procedures produced any substantial increases in intraverbal responding. The authors concluded that a transfer procedure should be the "intervention of choice" because neither multiple tact training, nor receptive discrimination training had a significant impact on "thematically related intraverbal behavior" for typically developing preschool children. The results of this study also showed minimal response generalization to the untrained categories.

Petursdottir, Carr, and Lechago (2006) recently evaluated two different training procedures on the acquisition of categorical responses (i.e., African countries categorized by general location or categories of foreign symbols/characters) with typically developing preschool children. Children were initially taught to tact a number of unfamiliar stimuli, following which they received either intraverbal categorization training or listener categorization training. Intraverbal categorization training consisted of teaching the children to provide the appropriate category name when provided with the names of the four exemplars. Incorrect or no responding was followed by an echoic prompt. During listener categorization training, the child was taught to select the stimuli that represented the two exemplars from each category after the researcher stated the two category names. The results showed no evidence that listener training might result in the emergence of an intraverbal repertoire, or that intraverbal training might result in the emergence of a listener repertoire. There was little evidence that either type of training produced any additional categorization skills and there were little or no effects on the acquisition of untrained categorization skills. The authors also suggested that intraverbal and listener relations are functionally independent of one another.

Although studies on complex intraverbal behavior have demonstrated the ability to teach small and somewhat restricted categorization repertoires, the teaching procedures that are effective for establishing simple intraverbals have not been successful at producing robust or lasting complex intraverbal repertoires. Typical prompting strategies that are successful with simple intraverbal responses are likely to produce only a restricted sample of possible correct responses when teaching complex intraverbals. Prompting strategies such as echoic or tact prompts do not provide participants with a

strategy for consistently generating large numbers of responses or teach them how to independently generate novel responses. Complex intraverbal relations often rely on multiple sources of control and the interaction of other, more basic verbal repertoires (Sundberg & Michael, 2001). This necessitates more complex teaching strategies to ensure the development of well-rounded intraverbal repertories Simply teaching someone to provide a few specific answers without teaching them how to generate the answers themselves, may be one reason why current studies on complex language have produced repertoires that have been said to look rote and robotic with limited generalization.

Current clinical practices with children with language delays do not teach students to engage in the problem-solving behaviors that allow them to independently produce novel or complex intraverbal responses. Rather, the current treatment of complex intraverbal behavior involves the same procedures used to develop simple intraverbal responding. However, the complex nature of advanced conversation skills may require additional consideration. A failure to respond to novel verbal stimuli may not reflect a failure to generalize, but rather a failure in the teaching procedures. The development of advanced teaching procedures may require creativity and the utilization of behavioral procedures other than simple prompts and differential reinforcement. Many types of complex intraverbal responses may rely on covert behavior that involves the speaker generating private stimuli and the related responses. These complex responses also rely on the development of covert intraverbal chains that aid in the identification and selection of a correct intraverbal response (Skinner, 1957).

Although it has been recommended that transfer procedures should be the "intervention of choice" when teaching complex language (Miguel et al., 2005), there has been little-to-no attention paid to the role of covert mediating behaviors, and possible procedures to teach such problem-solving skills. The development of such complex skills is critical for academic success as well as success in social interactions (e.g., songs, stories, conversations) that require relatively complex intraverbal behavior (Partington & Bailey, 1993).

Intersection with Problem-Solving

Traditionally, concepts such as thinking, memory, and problem-solving have been studied by cognitive psychologists. Works in this area have frequently made reference to hypothetical structures such as "memory banks" or "memory storage houses" and explanatory fictions such as "short term memory" and "long term memory" (Delaney & Austin, 1998; Palmer, 1991). Although this mentalistic conceptual approach to complex behavior contrasts strongly with the behavioral view, decades of research by cognitive psychologists have provided an important foundation of information on problem-solving and children. For example, investigations into the use of rehearsal as a memory strategy have revealed that kindergarten and first grade children can successfully use rehearsal to assist with remembering tasks, but do not often use this strategy without prompting by an adult (Hetherington & Parke, 1993). In addition, even when young children have successfully used problem-solving strategies in the past, they still require explicit instructions in order to use the same strategy in a new context (Keeney, Cannizzo, & Flavell, 1967).

Skinner (1957) provided one of the first behavioral conceptualizations of covert behavior and private events. He stated that covert behavior is the same as overt behavior but is occurring on a smaller scale. In addition, the probability or strength of covert behavior should be accounted for in the same way that the probability of any other observable behavior is accounted for (1957). Although covert behaviors cannot be easily observed by others, people engaging in covert behavior are still behaving but in private ways. For this reason, Skinner saw no value in talking about "thinking" as a new or separate phenomenon. He stated that, "There is no point at which it is profitable to draw a line distinguishing thinking from acting on this continuum. So far as we know, the events at the covert end have no special properties, observe no special laws, and can be credited with no special achievements" (1957, p. 438).

The radical behaviorist view of language supports the notion that private events should not require any special considerations or explanations. Thus, the basic principles that apply to overt behavior operate in the same manner on covert behavior. This view provides the conceptual support for the investigation into teaching procedures directed towards covert behavior. Although the teaching procedures commonly used for overt behavior could be effective with covert behavior, the complex nature of these more advanced verbal and nonverbal skills may warrant procedural modifications that directly teach mediating responses such as problem-solving behaviors.

Skinner (1953) defined problem-solving as "any behavior which, through the manipulation of variables, makes the appearance of a solution more probable" (p.247). Problem-solving behaviors involve the speaker generating stimuli that can then supplement other behaviors currently in the person's repertoire. Skinner discussed these

private behaviors in terms of the speaker "prompting and probing his own behavior" (p. 442). Skinner also discussed the possible reinforcing value for engaging in problem-solving behavior. Such behaviors may be of value to the speaker when he or she is able to generate the supplementary stimuli that subsequently occasion a reinforceable response (Skinner, 1957). Thus, the speaker engages in problem-solving behaviors and finds them automatically reinforcing due to a prior reinforcement history and also because these behaviors provide a practical utility for the speaker (i.e., the problem gets solved).

Although people engage in many different forms of covert behavior throughout their day, problem-solving behaviors will only be demonstrated when a true problem presents itself. A "true problem" is one in which the organism has no responses within its immediate repertoire that allows it to escape or avoid deprivation or aversive stimulation (Skinner, 1953). When a "problem" is presented in a typical social situation, there are verbal stimuli that signal the onset of an aversive, social consequence if a response is not made within a reasonable amount of time (Palmer, 1991). Solutions to these problems alter situations so that the strongest responses in a person's repertoire can be emitted. Typically, when people attempt to solve problems, they emit a variety of responses because some of these responses are similar to those that have been reinforced in the past. The presentation of the problem creates a state of deprivation or aversive stimulation, which, in turn, implies a high probability that the person will emit many different responses. This type of problem-solving behavior relies on a significantly different repertoire than random exploration, accidental changes in the environment, or simple trial and error learning (Skinner, 1953).

Palmer (1991) defined the domain of problems that require someone to engage in problem-solving behaviors. This domain requires that a) the response or set of responses are part of a person's repertoire, b) discriminative stimuli are present signaling the availability of reinforcement for a particular response, and c) the response can not be under the direct control of the current discriminative stimuli. Thus, there is no simple, orderly relationship between the discriminative stimulus and the response. A particular question initiates a series of problem-solving behaviors rather than the question directly controlling the production of the response. Palmer states that if the response is in the person's repertoire but not under direct control of the discriminative stimulus, the person must engage in problem-solving behaviors to produce additional discriminative stimuli that will be sufficient in occasioning a reinforceable response. Palmer also points out that the person must be able recognize a correct response, stop the covert problem-solving behaviors, and emit that response.

Often times, effective problem-solving strategies are idiosyncratic such that what is effective for one person may not be effective for someone else or strategies that are effective in one situation may not be successful in a different context (Palmer, 1991). In addition, problem-solving strategies including organizing and grouping stimuli, visual imagery, observing one's own environment, and engaging in covert intraverbal behavior must be specifically taught to children. Thus, children must develop a history of reinforcement so that they too learn how to engage in complex covert behavior. This can be accomplished by adding additional stimuli to the environment to occasion the correct response or by providing specific prompts and fading these prompts in order to shape accurate problem-solving skills (Palmer, 1991). It is also necessary to provide children

with instructions and prompts to use the previously taught problem-solving strategies when they are under different antecedent and consequence conditions. A study by Guevremont, Osnes, and Stokes (1988) showed that preschool children could learn to provide self-instructions on academic tasks but needed reminders and specific instructions to use the strategy in new environments.

Throughout the course of the conceptual debates on problem-solving and other complex covert behaviors, several questions have come to light. There has been some debate on the efficacy of different prompting strategies when attempting to teach problem-solving skills to children. People such as V. Carbone are investigating the effects of direct prompts for specific answers on the ability for one to engage in effective problem-solving skills (personal communication, August 29, 2004). There is also debate about the restrictive nature of formal prompts and the potential utility of thematic prompts to aid in teaching complex intraverbal skills that require the use of problem-solving skills.

Skinner (1957) defined formal prompts as textual and echoic prompts that can be used when a previously strong intraverbal connection is not currently at strength. Skinner also stated one of the benefits to formal prompts is that textual and echoic prompts are quite common in social situations because people are "especially inclined to echo any verbal stimulus under conditions in which prompting is useful" (1957, pp. 255-256). However, these stimuli will only function as effective prompts if the intraverbal responses had been at strength in the person's repertoire some time in the past. If these intraverbal relationships had never been at strength (i.e., the person never "knew" the

answer), then the responses would be purely echoic or textual behavior and not actually prompted behavior at all.

In contrast, thematic prompts can be conceptualized as hints to the answer rather than providing the answer directly as seen with more formal prompts. Skinner defined thematic prompts as "supplemental sources of strength in the form of a tact or intraverbal response." (1957, p. 258). Thematic prompts involve a set of verbal or visual stimuli that have frequently evoked terms relevant to the topic in the past. For example, a kindergarten teacher can use thematic prompts of a happy sun or a sad cloud to prompt students to talk about what types of activities they can or cannot do during different types of weather. Although these types of prompts can be more easily disguised than formal prompts, Skinner states that they are often less effective at producing the specific desired response. Therefore, it may be beneficial to utilize both formal and thematic prompts when attempting to occasion more complex intraverbal responses.

Empirical investigations in the area of covert behavior and problem-solving skills have begun to investigate the precurrent behaviors that are necessary for the development of more complex repertoires. Currently, people are speculating about the role of matching, sorting, and arranging stimuli as prerequisite behaviors for the development of effective intraverbal repertoires (Delaney & Austin, 1998; Palmer, 1991). Palmer suggests that people sort and organize stimuli in their environment on a daily basis. For example, people organize items on a grocery list by food group or location in the store, they arrange their playing cards by suit, or group Scrabble tiles according to consonants and vowels (Palmer).

Investigations are also being conducted on the importance of observing responses as precurrent behaviors and the role they play in the acquisition and maintenance of more complex repertoires. Observing responses involve searching the environment for relevant discriminative stimuli that can help occasion a reinforceable response. These environmental stimuli provide verbal and nonverbal sources of control and provide additional cues for the identification of a correct response. It has been hypothesized that observing responses are one of the critical building blocks for the development of problem-solving skills and a more complex intraverbal repertoire (V. Carbone, personal communication, August 29, 2004).

In addition to organizing stimuli and engaging in observing responses, other suggested precurrent behaviors include visual imagery skills as well as the ability to engage in private intraverbal behavior. In the behavioral literature, visual imagery is discussed in terms of conditioned perception or conditioned seeing. Skinner (1953) described this phenomenon as seeing an item when no item is present. He states that a person may "see" an item when the item is present or when there are stimuli present that have frequently accompanied that item in the past. The additional stimuli come to control these conditioned perceptual responses in the absence of the item through conditioning and a history of reinforcement (Skinner, 1953). Skinner (1953) and Palmer (1991) both stated that conditioned seeing is a common mediating behavior that people engage in to help them generate and emit correct intraverbal responses. These responses are partly under intraverbal control but also partly under tact control such that the person is tacting the private stimuli that are "observed" during imagery.

An additional precurrent behavior is the ability to engage in private/covert intraverbal behavior. This involves people asking themselves questions and providing the correct covert intraverbal responses to these questions. This process of self-intraverbal prompting may initially occur overtly but contacts social contingencies such that the behavior is shaped so that it occurs on the covert level (Skinner, 1953). This ability to prompt and probe one's own repertoire could be a critical skill that can facilitate the development of more complex repertoires. However, currently there is little empirical support for the role of private intraverbal behavior on the development of problem-solving skills and complex language.

Rationale and Purpose of the Study

To date, studies on intraverbal categorization have found that transfer procedures are the only effective procedures for establishing consistent and correct intraverbal responding. However, these procedures have only been effective at producing small and somewhat restricted repertoires. In addition, these studies have not investigated the role that problem-solving strategies may play in the acquisition of complex language. To date, it has been unclear if we can effectively teach young children to select and produce many different reinforceable intraverbal responses from a variety of acceptable responses on a consistent basis. It is also unclear if teaching a problem-solving strategy would help increase performance with respect to intraverbal categorization.

The purpose of the current study is to provide an initial investigation into the role of problem-solving on the acquisition of categorization skills and to contribute to the behavioral literature on problem-solving strategies with children. This study evaluates if teaching children to use a problem-solving strategy will enhance categorization skills,

and if these procedures will be more effective than relying solely on simple transfer procedures. Specifically, this study investigates if preschool children can learn to self-prompt as a strategy for answering complex questions, and if this strategy will be readily transferred to similar categorization tasks without additional mediating response training.

METHOD

Participants and Setting

Four typically developing preschool children, John (56 months), Jessica (47 months), Christopher (39 months), and Alexa (59 months) participated in this study. All sessions were conducted in the children's preschool and occurred in a quiet area, behind a divider. The child was seated next to the experimenter at a small table and an additional data collector was present during the majority of sessions, but did not directly interact with the child. All sessions were videotaped and a visual countdown timer was present to illustrate the remaining duration of the session. Sessions lasted approximately 15 min and were conducted 3-5 days per week, 1-2 times per day.

Materials

The primary training materials consisted of 3 1/2" x 3 1/2" laminated, color photographs of the individual items pertaining to one of three categories. Each picture card depicted the training item on a white background with no other distracting images within the picture. Additional materials included a prize bin containing a variety of small, potentially reinforcing items (e.g., stickers, stamps, edibles, party favors) for potential selection by the participant. Items in the prize bin were included based on parental and participant report. The child selected a prize at the beginning of each

session and received the prize at the completion of the session contingent on general compliance and participation.

Categories of Stimuli

Three categories (i.e., vehicles, animals, and kitchen items) were evaluated during baseline probes. Two of the three categories were selected for each participant based on baseline levels of responding while the fourth participant received training for each of the three categories. Each category was divided into three subcategories (referred to as "groups") and each subcategory contained four individual items, yielding a total of 12 individual target items for each category. For example, vehicles (training category) had three subcategories (land, water, and air) with four items in each (land: car, truck, bus, and motorcycle). See Table 1 for a complete list of the categories, subcategories, and individual target items.

Animals		
Farm	**Ocean**	**Zoo**
Cow	Dolphin	Giraffe
Horse	Fish	Lion
Pig	Lobster	Monkey
Sheep	Shark	Tiger
Kitchen Items		
Appliances	**Dishes**	**Utensils**
Dishwasher	Bowl	Fork
Microwave	Glass	Knife
Refrigerator	Mug	Spatula
Stove	Plate	Spoon
Vehicles		
Air	**Land**	**Water**
Airplane	Bus	Canoe
Hang Glider	Car	Jet ski
Helicopter	Motorcycle	Kayak
Hot Air Balloon	Truck	Ocean Liner

Table 1. Complete List of All Training Categories, Subcategories, and Individual Items.

Dependent Variables and Data Collection

The primary dependent variable was the number of correct, target intraverbal responses during intraverbal probe trials. During a probe trial, the experimenter recorded each response verbatim. Responses were coded as independent (all phases) or prompted (prompting phase only) and independent responses were graphed. A correct response was scored when the child independently named one of the target category items. A prompted response was scored when the experimenter provided a tact or echoic prompt to occasion a correct target response following an incorrect response or no response within 5-7 s.

During training sessions, additional dependent measures included the number of 1) independent correct tacts per trial-block during multiple tact training, 2) independent correct target intraverbal responses during intraverbal training, and 3) correct rule statements for mediating response training. Responses were scored as either independently correct or prompted. For multiple tact training, a correct response was scored when the child provided both tacts independently. A prompted response was scored if the experimenter provided an echoic prompt for one or both tacts for the relevant training item. For intraverbal training, a correct response was scored when the child independently named one of the target items for the relevant training category/subcategory. A prompted response was scored if the experimenter provided a tact or echoic prompt to occasion the correct response or complete response set. For mediating response training, a correct response was scored when the child independently emitted the relevant rule statement and/or information related to that rule. A prompted

response was scored if the experimenter provided echoic or tact prompts to occasion the correct response or complete response set.

During prompting sessions, additional dependent measures during each trial included the number of 1) problem-solving prompts provided by the experimenter and 2) overt self-prompts emitted by the participants. Problem-solving prompts were defined as broad prompts (e.g., "use your rules," "what about the last rule") provided by the experimenter instructing the child to use the problem-solving strategy. Participants' overt self-prompts were defined as the statement of a group name aloud immediately followed by one or all of the target responses. Each self -prompt was recorded verbatim on a data sheet and all responses that followed the prompt within 10 seconds were also recorded verbatim.

Interobserver Agreement (IOA) and Procedural Integrity

The experimenter collected data during all sessions. A trained second observer independently scored at least 25% of all sessions for all categories for each participant. Every item within a trial had to be scored identically for the trial to be scored as an agreement. Agreements were divided by agreements plus disagreements and multiplied by 100% to yield the overall agreement. For baseline and post-training intraverbal probes, an agreement was defined as two observers recording all participant responses verbatim on each probe trial. For multiple tact training sessions, an agreement was defined as two observers scoring each of the target responses to a picture exactly the same (e.g., independently correct or prompted) on each training trial. For intraverbal training sessions, an agreement was defined as two observers recording and scoring each intraverbal response exactly the same for each training trial. For mediating response

training, an agreement was defined as two observers scoring the participant's response to the experimenter's instruction to use the mediating response exactly the same (e.g., independently correct or prompted) for each training trial.

For intraverbal probes that occurred during the prompting phase, an agreement was defined as two observers scoring every component of a prompting trial the same. These components included the occurrence of problem-solving prompts, the verbatim statements of audible self prompts, as well the recording and scoring of all intraverbal responses. All items within a trial had to be scored identically for the trial to be scored as an agreement and agreements were divided by agreements plus disagreements and multiplied by 100% to yield the overall agreement (see Table 2 for the specific IOA results for each participant). Across phases and categories, all agreement measures were above 95% and occurred for at least 40% of sessions for all participants.

		John	**Jessica**	**Christopher**	**Alexa**
Baseline and Post-Training Probes	Sessions	71%	63%	62%	21%
	Average	**96%**	**100%**	**100%**	**97%**
	Range	(67-100)			(67-100)
Multiple Tact Training	Sessions	54%	87%	44%	23%
	Average	**99.6%**	**97%**	**100%**	**100%**
	Range	(97-100)	(75-100)		
Intraverbal Training	Sessions	40%	67%	56%	17%
	Average	**100%**	**98%**	**99%**	**100%**
	Range		(93-100)	(88-100)	
Mediating Response Training	Sessions	65%	57%	33%	15%
	Average	**99.5%**	**96%**	**100%**	**100%**
	Range	(93-100)	(80-100)		
Prompting	Sessions	33%	37%	20%	19%
	Average	**95%**	**87%**	**100%**	**100%**
	Range	(75-100)	(75-100)		
Average across all phases and all categories	Sessions	**56%**	**58%**	**44%**	**47%**
	Average	**98%**	**95.8%**	**99.7%**	**99.3%**

Table 2. Interobserver Agreement Results for Each Participant Across Stages and Categories.

A trained observer also independently scored at least 25% of all sessions to assess for correct implementation of the training and probe procedures. Each trial was evaluated according to a checklist of activities that were required to occur in order for the trial to be implemented correctly. During each trial, each item on the checklist was evaluated and the observer scored either "Yes," "No," or "N/A" (not applicable) depending on whether the necessary behaviors occurred. A second independent observer also scored at least 25% of the sessions previously scored for procedural integrity to determine IOA. Each trial was scored as an agreement or disagreement and an agreement was defined as two scorers scoring all checklist items identically for an entire trial. Overall agreement was calculated by using the formula agreements divided by agreements plus disagreements multiplied by 100% (see Table 3 for the specific procedural integrity results for each participant). All integrity measures were at least 99% and agreement on integrity data was at least 95% for all participants.

	John	**Jessica**	**Christopher**	**Alexa**
Steps implemented correctly	99.6%	100%	100%	99.8%
Sessions with procedural integrity	26%	25%	25%	31%
IOA on procedural integrity checks	96.4%	95%	97.3%	100%
Sessions with IOA	25%	31%	26%	27%

Table 3. Procedural Integrity Results for Each Participant Across Stages, Phases, and Categories.

Experimental Design

A concurrent multiple baseline design across two (John, Jessica, and Christopher) or three (Alexa) categories was used to assess the effects of prerequisite skills training and mediating response training on intraverbal categorization. Using staggered lengths of

baseline data collection, this design allowed for control of historical and maturational confounds while replicating treatment effects across participants. As appropriate to experimental single-case designs (Kazdin, 1982), data were graphed following each session and visual inspection methods were used for data analysis.

Procedures

Screening

The initial inclusionary and exclusionary criteria were described to the preschool director and she identified potential participants who met these criteria. Initial inclusion in this study was determined by parent/caregiver responses to the participant-screening questionnaire that was administered by the experimenter over the phone. This questionnaire contained questions about the typicality of the child's development and language, compliance with demands, and potential items that could be included in the prize bin (See Appendix A). If the initial screening questionnaire revealed that the child had no known developmental or language delays, was compliant with most simple demands, could label things in the environment, and answer simple questions; the experimenter met with the child and conducted a basic language assessment to further screen for appropriateness for the study. Children that were able to tact at least 40 of the 50 pictures of common items, and provide several basic intraverbal responses (including at least one correct response to one simple categorization question) progressed on to the baseline intraverbal probe sessions. These criteria were based on the prerequisite skills necessary for a basic intraverbal repertoire, identified by Sundberg and Partington (1998).

Intraverbal probes

The child's ability to tact items belonging to the training categories was sampled throughout the analysis to select the most appropriate training categories for each child and to evaluate the effects of the intervention. The experimenter asked the participant to name items belonging to each category presented in random order. The experimenter asked the participant to "Tell me some [category name]" and allowed 5 s for a response. Once responding ceased for 3-5 s, the experimenter prompted "anything else?" and waited an additional 3-5 s for responses. When responding ceased the process was repeated with the remaining two categories. General statements of acknowledgement (e.g., "uh huh") were provided for all responses regardless of accuracy. No other systematic consequences were provided for responses, but compliance was praised periodically.

For each participant, the experimenter selected categories for training based on individual baseline levels of responding during probe sessions. Each category was targeted in turn for training in a series of skills that served as prerequisites to learning the mediating response, which was then followed by specific training procedures for the mediating response. Probes continued throughout training and occurred after and sometimes during each training phase.

Prerequisite skills training: Multiple Tact Training

Multiple tact training (MTT) was conducted in two stages and ensured that children could tact the target items, their subcategory or "group" as it was termed to the children, and overall category. In the first stage, participants provided the item name and group name when shown a picture. The experimenter provided a brief instruction (i.e., "when I show you a picture say the name of it and what group it goes in"). For example,

when participants were shown a picture of a spoon, the correct response was "it's a spoon and a utensil." A trial began when the experimenter held up a picture card, stated "Tell me about this" and allowed 5-7 s for a response. If the participant emitted the item name and group name, the experimenter provided descriptive praise (e.g., "That's right, it is a car, and it's a land vehicle"), placed the picture face down on the table, and held up the next picture. If the participant emitted no response or an incorrect/incomplete response (one or both parts missing or incorrect), the experimenter provided the relevant echoic prompt(s) and immediately re-tested that item (e.g., "It's an airplane and it's an air vehicle. What is it? That's right, it is an airplane and an air vehicle") until a correct response occurred. Each subcategory was trained to mastery (correct independent multiple tacts for all four items, two consecutive times) in isolation and in random order. When all three subcategories were mastered, all 12 pictures were shuffled together and presented in random order until the same criterion was met (all items correct, two consecutive times).

The second stage of multiple tact training began with brief instructions (i.e., when presented with a picture, say the subcategory/group name and a category reference). For example, when participants were shown a picture of a fork, the correct response was, "It's a *utensil* and it goes in the *kitchen*". All 12 pictures (across the three groups) were shuffled together and presented in random order. Independently correct multiple responses were followed by descriptive praise and incorrect or incomplete responses were followed by the relevant echoic prompt(s) and then re-tested for independent responding. Sessions continued until the participant was able to independently provide

both tacts (i.e., subcategory name and category name) for all 12 pictures, two consecutive times.

Prerequisite skills training: Intraverbal Training

Intraverbal training (IVT) was conducted in two stages. The first stage required the participant to tact all of the individual items belonging to the first randomly selected subcategory when queried, "Tell me some [subcategory name]". The second stage required the participant to name all of the subcategories for a category when queried, "Tell me some *groups* of [category name]". The experimenter presented the question, allowed 5 s for a response, recorded all responses verbatim, and prompted "any more" if there was a pause in responding. Independent correct responses were scored if the child provided the name of one of the relevant responses without the use of tact or echoic prompts. All correct responses were followed by descriptive praise and incorrect or incomplete response sets were followed by tact or echoic prompts (stage 1) or echoic prompts (stage 2).

For the first stage, a complete response set included the four target items that were trained for the relevant subcategory (e.g., ocean liner, canoe, kayak, and jet ski when asked, "Tell me some water vehicles"). The order of training for subcategories was randomly determined and subcategories were trained in isolation until the participant provided independent complete response sets, two consecutive times. The correction procedure for an inaccurate item (e.g., naming an airplane as a water vehicle) was a simple corrective statement (e.g., "nope, an airplane is not a water vehicle") and the procedure for incomplete response sets was tact and echoic prompts as necessary to occasion the omitted target items. After the criterion was met for each subcategory in

isolation, the experimenter began intraverbal training for the next randomly selected subcategory.

For the second stage, a complete response set included all three subcategory names (e.g., land, water, and air when asked, "Tell me the groups of vehicles?"). The experimenter provided the instruction, allowed 5 s for a response, prompted "any more?" at a pause in responding and recorded all responses verbatim. All correct responses were followed by descriptive praise (e.g., "That's right, land, water, and air are the three groups of vehicles"). Incorrect or incomplete response sets were followed by echoic prompts for the names of the subcategories that the participant omitted. Training continued until the participant provided independent and complete response sets, two consecutive times.

Immediately after mastery of an intraverbal response in either stage, review sessions were conducted for previously mastered intraverbals to promote retention of intraverbal responses. Review sessions occurred after mastery of the second and third targets in stage 1. Participants were asked to name the individual items belonging to the previously mastered subcategories (e.g., "You're right, those are all zoo animals, now tell me again all of the farm animals you can think of"; "You're right, those are all ocean animals, now tell me again all of the zoo animals you can think of." "Now, how about the farm animals?"). When the participant mastered stage 2 ("land, air, water" in response to "what are some groups of vehicles?"), stage 1 review sessions were conducted for the items belonging to each of the those subcategories (e.g., "tell me again all of the land vehicles"). Correct responses were praised and incomplete response sets or inaccurate responses resulted in a booster-training session using tact and echoic prompts.

Booster sessions were conducted until the participant provided an independently correct and complete response set.

Mediating response training (MRT)

The mediating response was a series of rule statements used as self-prompts for subcategory membership (i.e., land, water, air) in response to the intraverbal probe for items belonging to one of the training categories ("tell me some vehicles"). The experimenter provided a brief introduction to the task and explained that the participant would learn rules that he/she could use when faced with a categorization question. For the first stage of mediating response training, children were taught to say the four main rule statements "say the three groups," "pick a group," "pick a different group," and "say the last group" as a chain. The experimenter asked, "what are your four rules?", allowed 5 s for a response, and scored the participant's responses as independently correct or prompted for each of the four rule statements separately. Correct responses (i.e., right rule, right order) resulted in praise and an incomplete or incorrect chain was followed by echoic prompts until the participant provided an independent, correct response. Training continued until the participant independently provided a complete response chain, two consecutive times.

In the second stage of MRT, the experimenter taught the participant to apply each rule to the relevant training category. Participants were taught to provide the rule statement and then the information related to the specific rule. For example, the experimenter would ask, "what is your first rule?" and the participant had to respond, "say the three groups" and then list the names of the three groups for the category (e.g., "land, water, air"). For rules 2-4, correct responses had to include the rule statement, the

name of the selected group, and the names of the four relevant target items. For example, the experimenter would ask, "what is your second rule?" and a correct response for vehicles was, "pick a group. I pick air. Airplane, helicopter, hot air balloon, and hang glider." The child was allowed to select the order of the groups for training. If the participant wanted to name items belonging to another group during training for a rule, the experimenter reminded him/her of the selected group and that they were going to work on only that group for the moment; however, they would work on the other groups when they talked about the other rules. All correct responses were followed by descriptive praise and all incorrect or incomplete response sets were followed by echoic prompts to occasion correct rule statements and group names and tact prompts for individual target items. All four rules were trained in isolation until the participant provided an independently correct, and complete response set, two consecutive times. See Table 4 for a description of complete response sets for all three categories for stage 2 of MRT.

	Animals	**Vehicles**	**Kitchen Items**
Rule 1	"Say my 3 groups. Farm, zoo, & ocean"	"Say my 3 groups. Land, water, & air"	"Say my 3 groups. Appliances, dishes, & utensils"
Rule 2	"Pick a group. I pick [farm, zoo, or ocean], and names the 4 animals belonging to that group."	"Pick a group. I pick [land, water, or air], and names the 4 vehicles belonging to that group."	"Pick a group. I pick [appliances, dishes, or utensils], and names the 4 items belonging to that group."
Rule 3	"Pick another group. I pick [farm, zoo, or ocean], and names the 4 animals belonging to that group."	"Pick another group. I pick [land, water, or air], and names the 4 vehicles belonging to that group."	"Pick another group. I pick [appliances, dishes, or utensils], and names the 4 items belonging to that group."
Rule 4	"Say the last group. [Farm, zoo, or ocean], and names the 4 animals belonging to that group."	"Say the last group. [Land, water, or air], and names the 4 vehicles belonging to that group.	"Say the last group. [Appliances, dishes, or utensils], and names the 4 items belonging to that group."

Table 4. Complete Response Sets for All Categories During Stage 2 of MRT.

When the mastery criterion was met for stage 2, stage 1 review sessions were conducted for the intraverbal chain of the four rules without the related information. The experimenter asked "what are your four rules?", praised correct responding, and provided a booster training using echoic prompts for incomplete or incorrect responses. Booster training sessions were conducted until the participant provided an independently correct and complete response set.

The final stage of mediating response training was modeling the entire correct response to the intraverbal probe. The experimenter conducted this as a separate session preceded and followed by intraverbal probes. The experimenter stated that she would demonstrate how to use the rules when asked to categorize and then the participant would get a chance to practice using the rules. The participant was prompted to watch the experimenter while the experimenter modeled the complete use of the strategy for the targeted category one time (see Appendix B for the mediating response training script used for vehicles).

Prompting

If the participant failed to independently provide a complete response set during the intraverbal probe, two types of prompts were used to occasion the remaining target items. Problem-solving prompts were broad, general prompts for the participant to use the mediating strategy (i.e., "use your rules", "what about your next rule") and were used if no responses were emitted to the instruction, if there was a pause of more than 7 seconds, or if some but not all 12 target items were provided. For example, if the experimenter queried about animals and the participant named the four zoo animals and stopped responding, the problem-solving prompt was "what about your next rule"

followed by a pause for additional responding. Tact prompts were provided when the participant provided a large number of the target responses from all three categories, but omitted a few individual items. For example, tact prompts were used if the participant named the majority of the land vehicles, air vehicles and water vehicles, however he/she omitted one or two target items (e.g., kayak, hang-glider).

RESULTS

Training Trials to Mastery Criterion

Table 5 depicts the total number of training trials required for each participant to master each phase of training for each individual training category and the average for each participant across categories. John required an average of 465 trials to reach criterion for all phases of training. Similarly, Jessica required an average of 435 trials and Christopher required an average of 424 trials to reach criterion. Alexa required far fewer trials than the other children on average (300) to reach criterion for her three categories.

Name (age)	**Category**	**Order**	**MTT** Stage 1	**MTT** Stage 2	**IVT** Stage 1	**IVT** Stage 2	**MRT** Stage 1	**MRT** Stage 2	**Total**
John (56 mos.)	Vehicles	1	380	84	33	6	55	57	**615**
	Kitchen	2	120	108	21	20	8	39	**316**
	Mean								465.5
Jessica (47 mos.)	Kitchen	1	328	60	25	20	25	70	**528**
	Vehicles	2	188	84	11	11	16	32	**342**
	Mean								435
Christopher (39 mos.)	Animals	1	128	72	69	11	21	60	**361**
	Vehicles	2	300	84	20	8	3	72	**487**
	Mean								424
Alexa (59 mos.)	Vehicles	1	212	36	13	7	31	36	**335**
	Animals	2	88	48	19	12	2	21	**290**
	Kitchen	3	208	36	20	12	N/A	N/A	**276**
	Mean								300

Table 5. The Total Number of Trials to Mastery for Each Training Phase for Each Category.

Figure 1 depicts the trials to criterion examining order of training in the top panel and specific category content in the bottom panel. The top panel shows a linear decrease in trials to criterion for category order, with the first category requiring slightly more trials to criterion than the second and the second requiring slightly more than the third (single implementation). Christopher was the only participant who required more training trials for his second category than he did with his first (see Table 5) and his stated familiarity and preference for animals may have accounted for the short training time for this particular category. The bottom panel shows that, on average, vehicles required the greatest number of trials to criterion followed by kitchen items and animals despite counterbalancing for order of training. It is notable that, across participants, water vehicles (i.e., canoe, kayak, jet ski, ocean liner) required many more trials to mastery during multiple tact training (M = 25.75; range 17-33) than the other two subgroups of vehicles (mean for land = 5.5; mean for air = 8.5) (see Table 5).

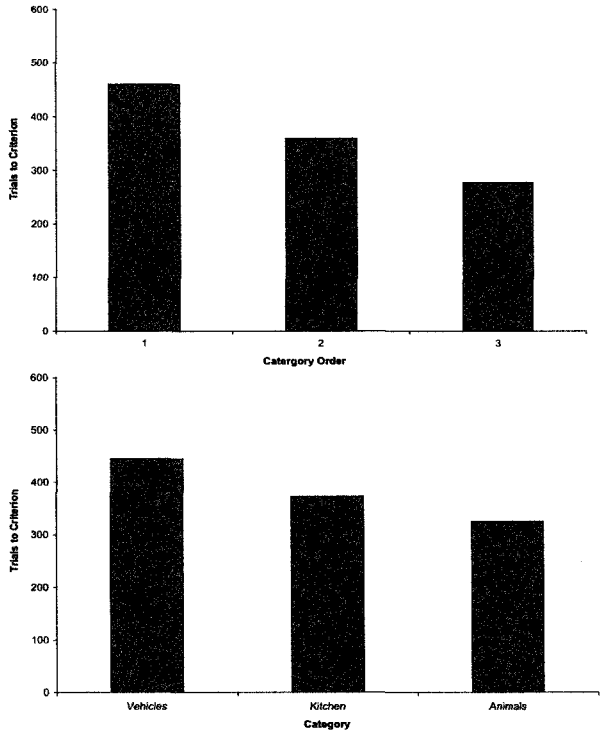

Figure 1. The total number of trials to criterion examining order of training (top panel) and specific category content (bottom panel), averaged across participants

All participants required the greatest number of trials to mastery for the MTT sessions (see Table 5), particularly the first stage of MTT (i.e., item name and group name). This pattern held true for all four participants regardless of which category was being trained. A slightly different pattern was observed with intraverbal training. The combined trials to mastery for the two phases of IVT (i.e., naming the individual items belonging to each subcategory, and naming the three subcategories belonging to the overall training category) showed a linear decrement from category 1 to 2 for Jessica (45 - first, 22 - second) and Christopher (80 - first, 28 - second). However, John's training trials were approximately equal (40 - first, 41 - second) across categories and Alexa required slightly fewer on the first category (20) than the subsequent two (31, 32).

The data in Table 5 also show that participants required fewer trials to mastery for the two phases of MRT with their second category than with their first. John required 112 trials to meet criterion with his first category but needed only 47 trials to master this same task with his second category. Jessica required 95 trials for the first category compared to only 48 for the second. Christopher presented a bit of an anomaly in that he required a similar number of trials for each category (i.e., 81 - first; 75 - second). Alexa required 67 trials for the first category, 23 for the second, and none for the third (MRT was not conducted for her third category).

Target Responses: Intraverbal Probes

For each participant, performance was examined in three respects. First, the total number of correct independent target responses to the intraverbal probe "Tell me some ____" was monitored throughout baseline, all phases of training, and the final prompting phase. Second, the flexibility of each child's responses was examined by scrutinizing the

order of the child's responses across subcategories for each probe. Third, the participant's self-prompts related to the use of the mediating responses were graphed across the final phase of each category to determine if there were overt instances of the use of the new problem-solving strategy. These three types of data will be presented for each participant.

John

Figure 2 depicts John's responses to the intraverbal probes across all phases. The first category, vehicles, is presented in the top panel. John did not provide any of the target intraverbal responses during baseline probe trials with a slight increase in correct responding during post-training probes (MTT & IVT). During MRT John emitted as many as seven target responses on one occasion, but the increases in responding were variable and short-lived. As observation of the experimenter modeling the use of the mediating response and prompts to "use the rules" were introduced, an immediate increase in correct responding was observed. John provided approximately 10 of the 12 target responses for the majority of prompting trials ($M = 10.7$). Early in this final phase, two to three prompts were required, but prompts were successfully eliminated by the end of the prompting phase. Four follow up probes resulted in consistent maintenance of the target intraverbal responses with one or no prompts.

For John's second category, kitchen items (middle panel), a similar pattern of responding was observed. Baseline responding was low and stable ($M = 1.6$). Responding in PST began low and increased to a high of nine correct responses (trial 16) but deteriorated during MRT (trials 17-18). Modeling and prompts to "use the rules" resulted in an immediate increase in responding to an average of 10.9 correct responses

throughout the phase as prompts were faded and eliminated. John only required a single, problem-solving prompt on 3 of the 16 trials to produce consistent and correct responding across all three subcategories. Responding in the control category remained lower throughout the baseline phase though a slight upward trend was noted in the final third of the phase. However, responding never occurred at a level commensurate with the trained categories.

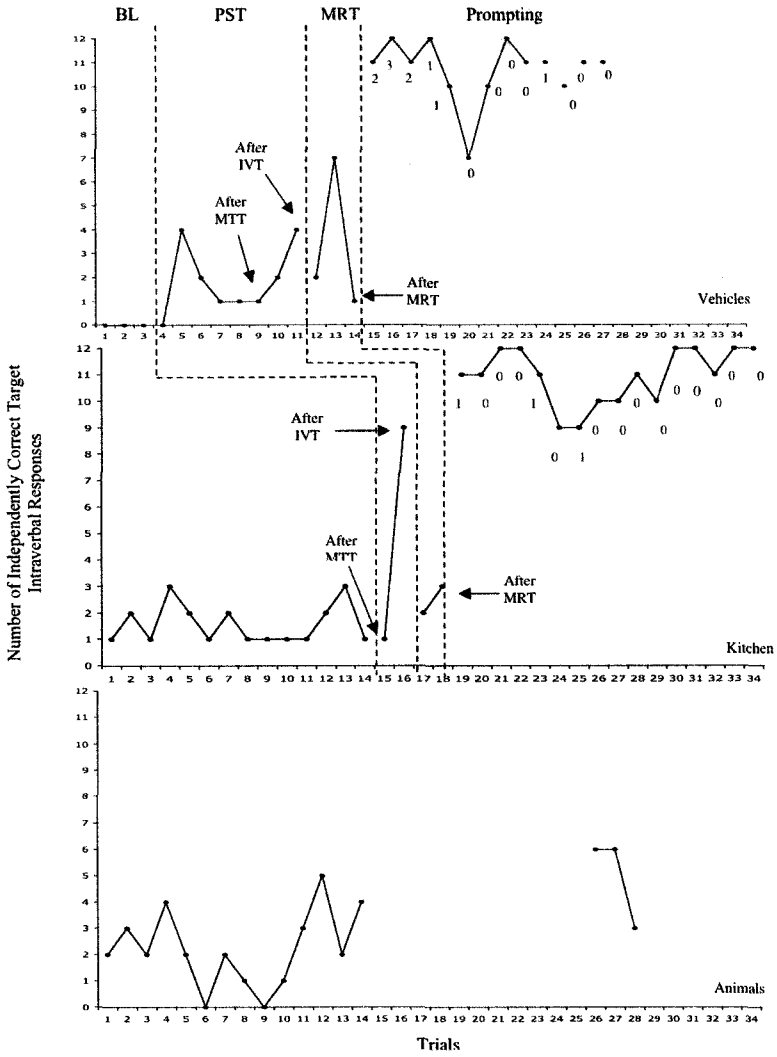

Figure 2. The total number of independently correct target intraverbal responses to the intraverbal probe questions, across all categories and phases for John

Figure 3 shows the order and pattern of John's target responses during the final phase for vehicles (top panel) and kitchen items (bottom panel) (i.e., flexibility of responding). Each bar represents a trial and each individual target response within a trial is depicted by one of the 12 boxes. The shaded box that corresponds to the one on the y-axis depicts John's first response and the colored boxes moving up the relevant bar depict the order and content of subsequent responses. For example, during trial 8, John emitted three land vehicles followed by four water vehicles and finished by naming four air vehicles. John's intraverbal responses were consistently grouped and orderly, yet flexible in that John started his responding with different groups on different trials (land – trials 8 & 14, water –trials 9 & 19, air – all other prompting trials) and his individual responses within the groups occurred in different orders.

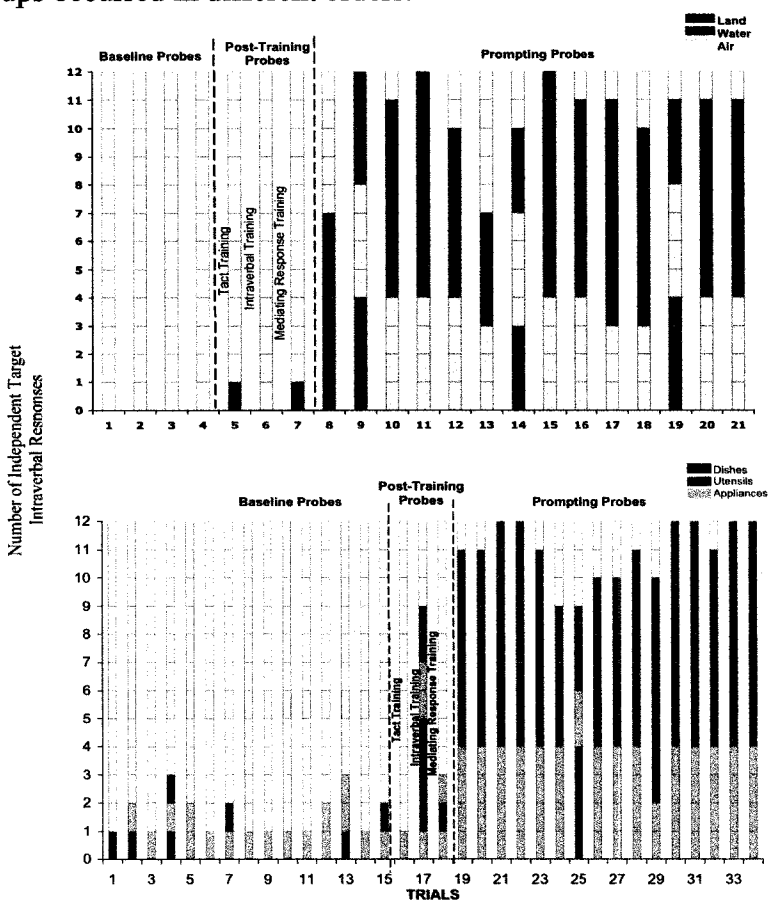

Figure 3. The order and pattern of John's responses to the intraverbal probes for his two training categories

Figure 4 depicts the number of audible self-prompts John emitted during the final phase of probe trials, across his two training categories. These data show that initially, John was overtly prompting his own intraverbal responses by stating a group name at each opportunity. For example, after the experimenter asked him to name vehicles, he stated a group name (e.g., land) and listed all of the land vehicles, then stated the next group name (e.g., water) and listed all of the water vehicles, and then stated the last group name (e.g., air) and listed all of the air vehicles. John initially prompted himself for most of the group names, but these prompts decreased so that he was only providing the target responses aloud by the end of each category. Note that his responding to the intraverbal probes remained orderly (see Figure 3) after overt self-prompts stopped.

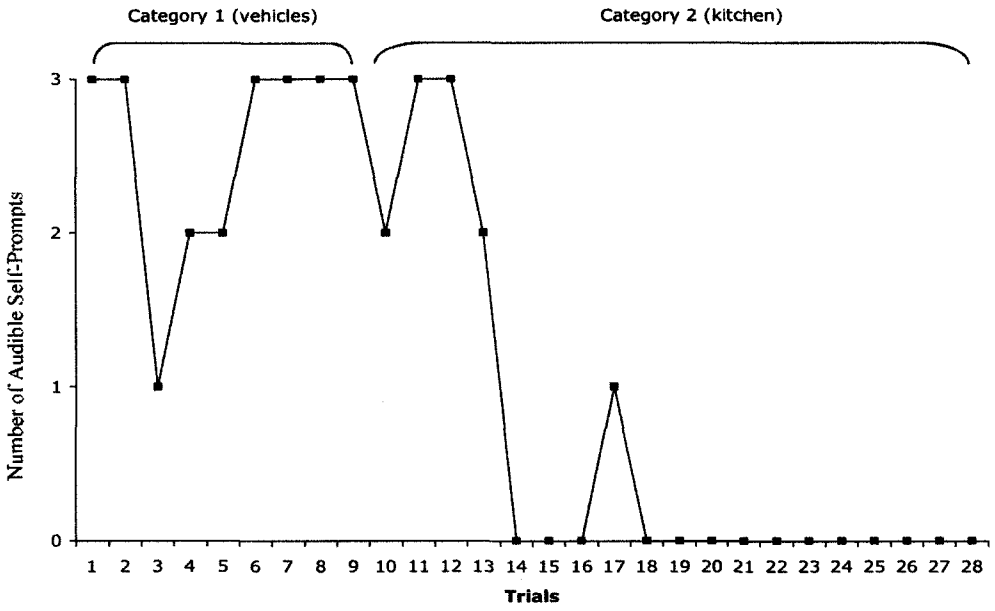

Figure 4. The total number of audible self-prompts John emitted during the prompting phase, across both training categories

Jessica

Figure 5 depicts Jessica's performance on the intraverbal probes across all phases. The first category, kitchen items, is presented in the top panel. Jessica provided only one

target intraverbal response during one of the baseline probes, with a small increase in responding during the post-training probe following IVT. After MRT, Jessica showed only a slight increase in correct target intraverbal responses; however, after the experimenter modeled use of the problem-solving strategy and prompts to "use the rules" were provided, an immediate increase in target responding was observed. Jessica provided all 12 target intraverbal responses on the majority of trials ($M = 11.8$). Periodically throughout the final phase, Jessica required problem-solving prompts; however, these prompts were successfully eliminated by the end of the prompting phase. Seven follow up probes resulted in consistent maintenance of the target intraverbal responses with only a few prompts on three of these trials.

For Jessica's second category, vehicles (middle panel), a similar pattern was observed. She provided no target intraverbal responses during any of the baseline or post-training (MTT, IVT, MRT) probes. Modeling and prompts to "use the rules" resulted in an immediate increase in responding, which remained consistent throughout the prompting phase ($M = 11.9$). Again, problem-solving prompts were quickly faded and eliminated by the end of the phase. Jessica required prompts on three of the eight trials, and only required more than one prompt on one occasion to produce consistent and correct responding across all three subcategories. Responding in the control category was consistently variable across baseline, training, and prompting phases, and never occurred at a level commensurate with the trained categories.

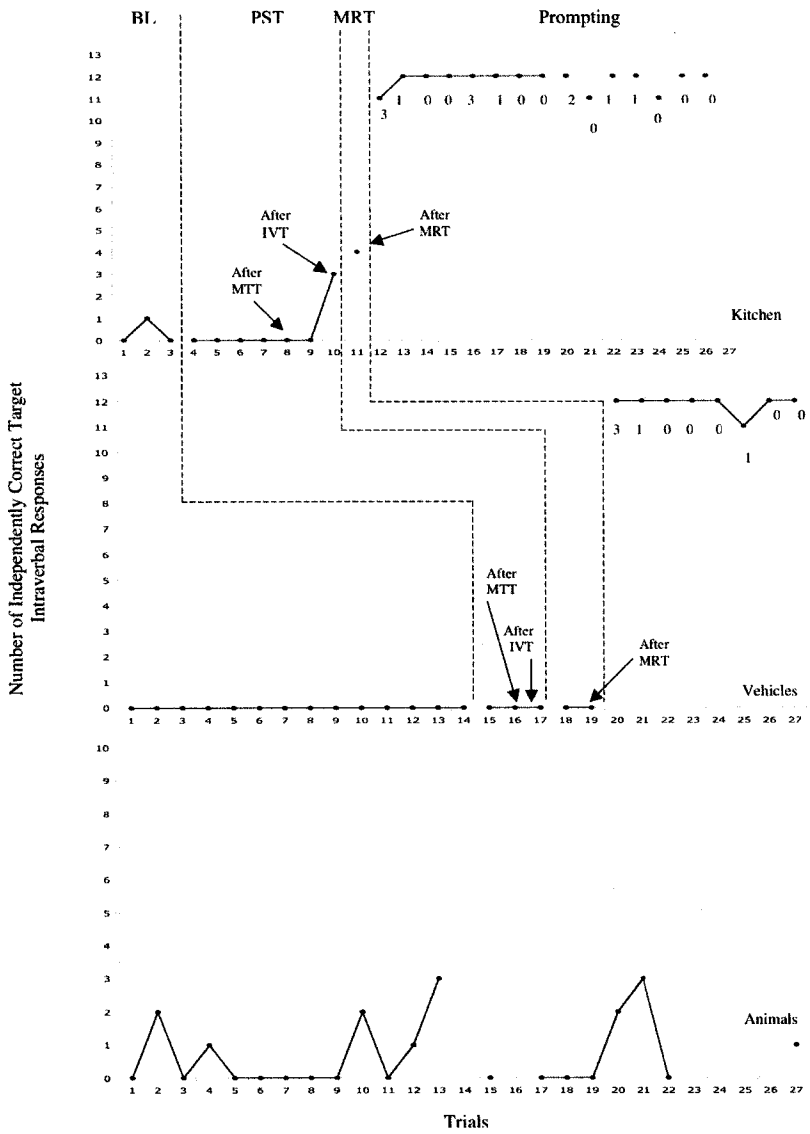

Figure 5. The total number of independently correct target intraverbal responses to the intraverbal probe questions, across all categories and phases for Jessica

Figure 6 shows the order and pattern of Jessica's target responses during the intraverbal probes for kitchen items (top panel) and vehicles (bottom panel). Following modeling and problem-solving prompts, Jessica's intraverbal responses increased significantly and her responses were consistent and orderly, yet flexible. Similar to John's response patterns, Jessica frequently started her responding with different groups

and her individual responses within the groups often occurred in different orders. For example, for vehicles (bottom panel), Jessica started her responding with land vehicles for five of the eight trials (trials 19, 22, 23, 25, & 26), water for two of the trials (trials 20 & 24), and air vehicles on one trial (trial 21). In addition, her individual responses within the groups also occurred in different orders.

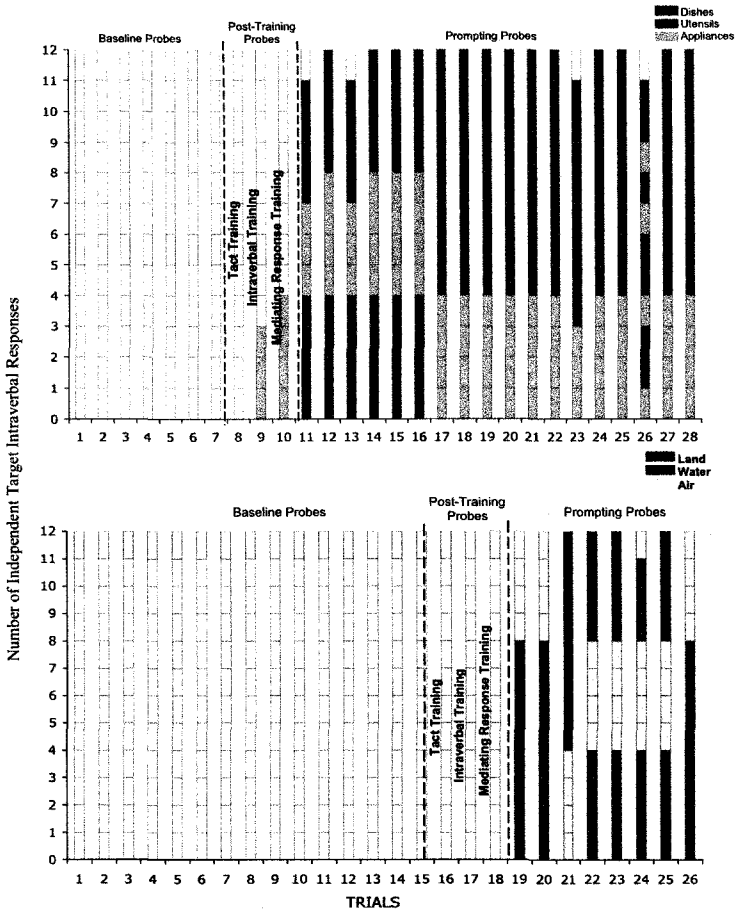

Figure 6. The order and pattern of Jessica's responses to the intraverbal probes for her two training categories

Figure 7 depicts the number of audible self-prompts Jessica emitted during the final phase of intraverbal probes across her two training categories. These data show that Jessica was overtly prompting her own intraverbal responses by stating a group name at each opportunity for the majority of probes for her first category. However, as the probe

trials progressed, these overt prompts decreased such that by the last probe for her first category, Jessica was stating all of the target responses without stating the related group names. These data also show that when Jessica began the final phase for her second category, she again self-prompted to assist in providing correct and complete response sets for vehicles. Jessica emitted fewer self-prompts with her second category and these prompts decreased more rapidly. Note that her responding to these probes remained orderly (see Figure 5) regardless of the occurrence of self-prompts.

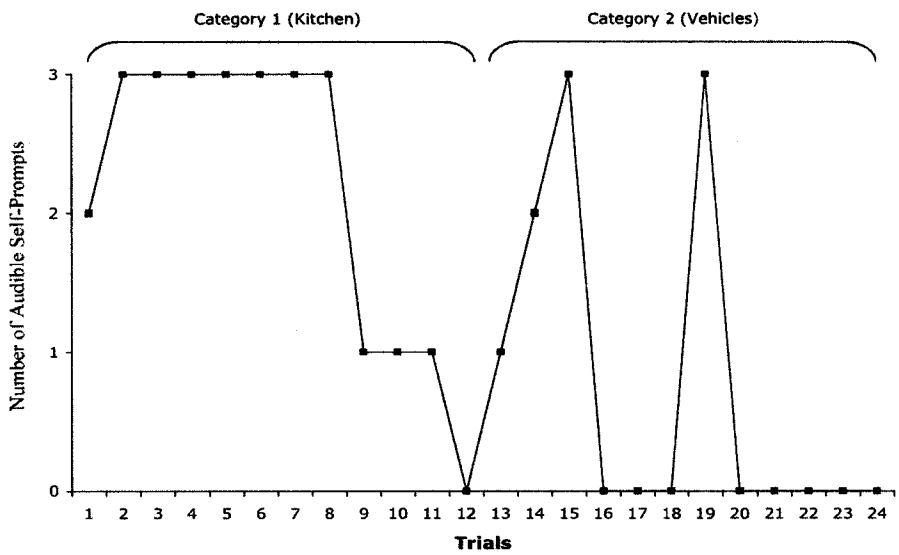

Figure 7. The total number of audible self-prompts Jessica emitted during the prompting phase, across her two training categories

Christopher

Figure 8 depicts Christopher's responses to the intraverbal probes across all phases. His first category, animals, is presented in the top panel. Baseline responding steadily decreased to low and stable rates ($M = 0.6$), with slight increases in correct responding during the post-training probes during PST and MRT. Christopher showed an immediate increase in correct responding after observing the experimenter's model of the

mediating response. Christopher's target intraverbal responses increased to an average of 11 across prompting trials. Initially, no prompts were needed to occasion organized responding across the three subcategories. However, at the beginning of the second testing session (trial 15) Christopher did not immediately start responding, requiring the experimenter to prompt him to "use the rules." These prompts were effective at immediately occasioning most or all of the target responses. Seven follow up probes resulted in consistent maintenance of the target intraverbal responses with prompts needed on only one of these trials.

For the second category, vehicles (middle panel), a similar pattern was observed. Baseline responding was consistently low and stable, stating "car and truck" on every trial with the exception of trial 2 ($M = 1.9$). Christopher provided no additional correct, target responses after MTT and IVT. After MRT, Christopher showed only a slight increase in target responding. On this final post-training probe, Christopher named the remaining two land vehicles in addition to the two land vehicles he named throughout baseline and PRT probes. Modeling and prompts to "use the rules" resulted in an immediate increase in responding to an average of 10.8 correct responses throughout the prompting phase. Christopher only required prompts on 3 of the 13 prompting trials and these prompts were quickly faded and eliminated by the end of the phase. Responding in the control category remained consistently low and stable across all phases conducted with the two trained categories.

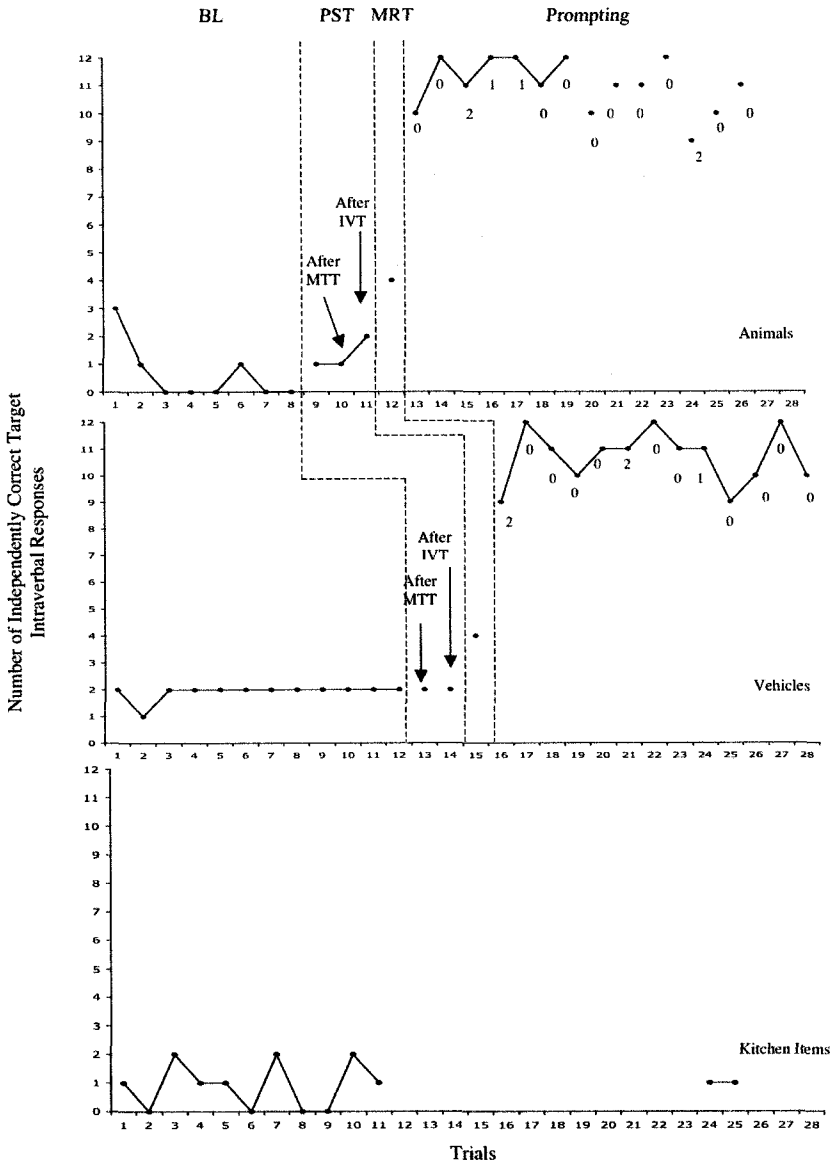

Figure 8. The total number of independently correct target intraverbal responses to the intraverbal probe questions, across all categories and phases for Christopher

Figure 9 shows the order and pattern of Christopher's responses to the intraverbal probes for animals (top panel) and vehicles (bottom panel). The top panel shows that although Christopher provided only a few of the target responses during baseline and post-training probes, these responses occurred across the three subcategories at different points throughout the probe trials. Similar to John and Jessica, Christopher's responses

during the prompting phase were consistent and orderly, yet flexible. For example, during probes with vehicles, Christopher started responding with air vehicles on three trials (trials 16, 26, and 28), water vehicles on one trial (trial 19), and land vehicles on all other testing trials.

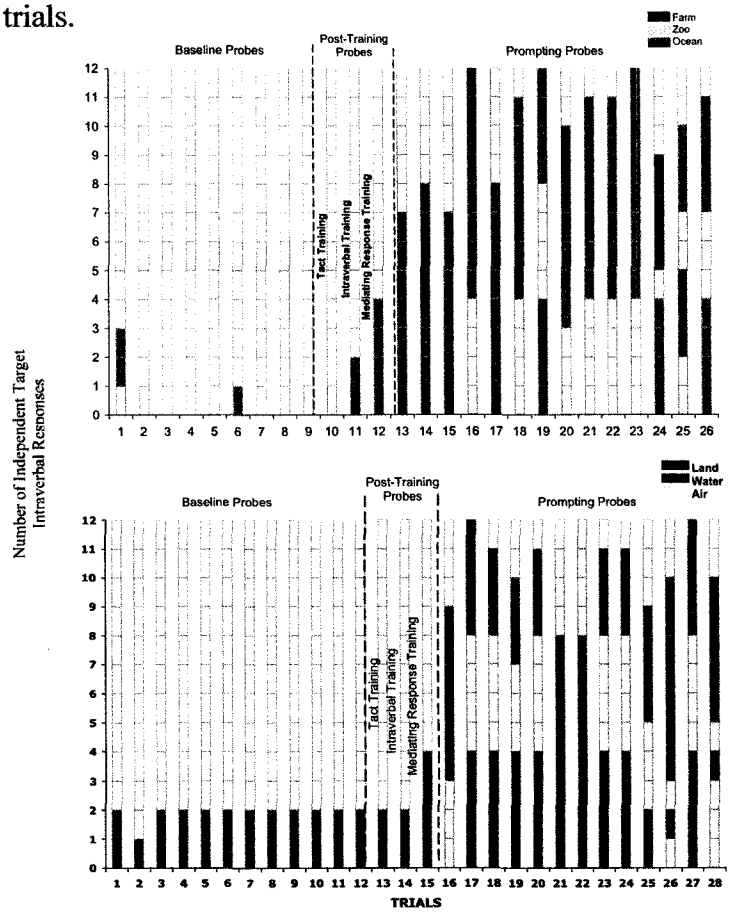

Figure 9. The order and pattern of Christopher's responses to the intraverbal probes for his two training categories

Figure 10 depicts the number of audible self-prompts Christopher emitted during the final phase of probes across both training categories. These data show that initially, Christopher was prompting his own intraverbal behavior on the majority of opportunities available during the first seven prompting trials. However as the probe trials with animals progressed, his self-prompts quickly decreased so that Christopher was stating all of the target responses without stating the related group names. When Christopher

began the prompting phase with his second category, he emitted target responses across the three subcategories without providing any audible self-prompts. Christopher also emitted significantly fewer self-prompts with his second category, with prompts occurring for only 1 of the 13 trials. Note that in the absence of these audible self-prompts, Christopher's responses during the prompting phase remained orderly on all trials (see Figure 9).

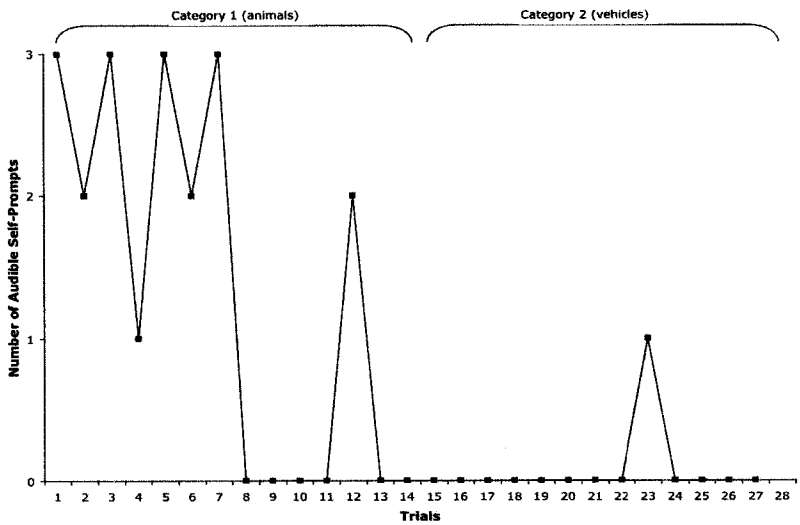

Figure 10. The total number of audible self-prompts Christopher emitted during the prompting phase, across both training categories

Alexa

Figure 11 shows the final participant's performance on the intraverbal probes across all phases, and across all three categories. The first category, vehicles, is presented in the top panel. Alexa did not provide any of the target intraverbal responses during the probes that occurred during baseline and all post-training trials (MTT, IVT, and MRT). However, after Alexa observed a model of the experimenter using the problem-solving strategy, she provided all 12 of the target responses with no additional prompts by the experimenter. At the beginning of the second prompting session (trial

14), there was an initial lull in responding, which required the experimenter to prompt Alexa to "use the rules." This prompt then occasioned 11 of the 12 target responses. These results were similar to Christopher's in that both participants were able to initially name all of the target items after only viewing the model, but then needed the prompts to occasion responding when time had elapsed since the model was viewed. Alexa averaged 11.7 correct intraverbal responses across prompting trials and only two of these trials required experimenter prompts. Similar to all previous participants, follow up probes resulted in consistent maintenance of the target intraverbal responses with one or no prompts.

The middle panel of Figure 11 shows Alexa's responses during the intraverbal probes for her second category (animals). Baseline responding was low and stable (M = 1.3). Responding to the post-training probes began low and increased to a high of 4 correct responses (trial 12) but decreased following MRT (trial 13). Modeling and prompts to "use the rules" resulted in an immediate increase in target intraverbal responses. Responding remained high and consistent (M = 11.8) across prompting trials and only one prompt was needed to occasion a correct and complete response set. For the third category (kitchen, bottom panel), a similar pattern of responding was observed. Again, baseline responding was low and consistently variable (M = 1.1). Levels of responding during the post-training probes (MTT & IVT) were similar to baseline levels of target responding. The first prompting probe trial was conducted immediately after mastery of intraverbal training. Responding during the prompting phase shows that Alexa immediately increased the number of target intraverbal responses following the experimenter's model of the strategy and prompts to "use the rules" even though she had

not experienced explicit training in the application of the rules to the new category. Alexa's responding was consistently high throughout this phase ($M = 11.7$) and prompts were decreased quickly so that she was independently providing correct and complete response sets for the final six trials.

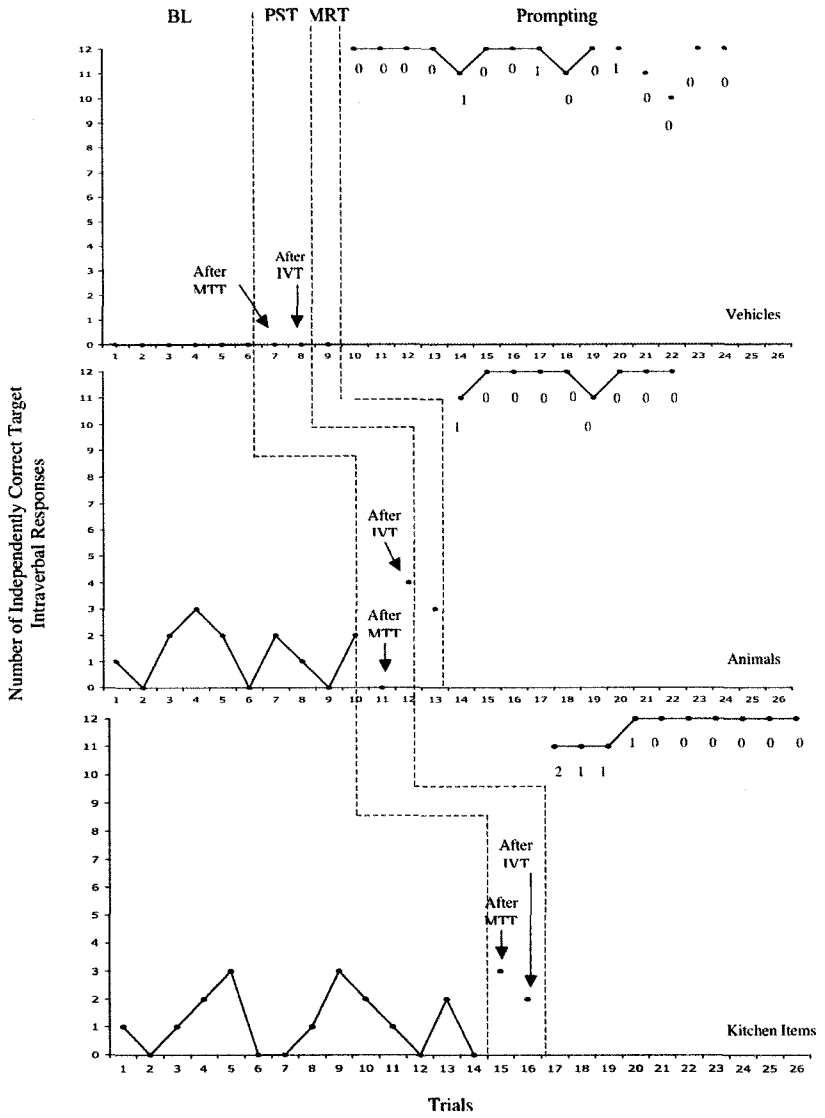

Figure 11. The total number of independently correct target intraverbal responses to the intraverbal probe questions, across all categories and phases for Alexa

Figure 12 shows the order and pattern of Alexa's target intraverbal responses to the probe questions across her three training categories. All three panels show that

responding to the baseline and post-training probes was sporadic, inconsistent, and centralized primarily within one or two of the subcategories. The data for the prompting probes show that across all three categories, Alexa's responses were consistent and orderly, yet flexible. Within each category, the order of Alexa's response varied greatly. For example, with vehicles (top panel) she started responding with water vehicles on four prompting trials (trials 11, 14, 16, & 20), land vehicles on two of the trials (trials 10 and 13), and air vehicles on the other nine trials. Similar response patterns were replicated with animals as well as kitchen items.

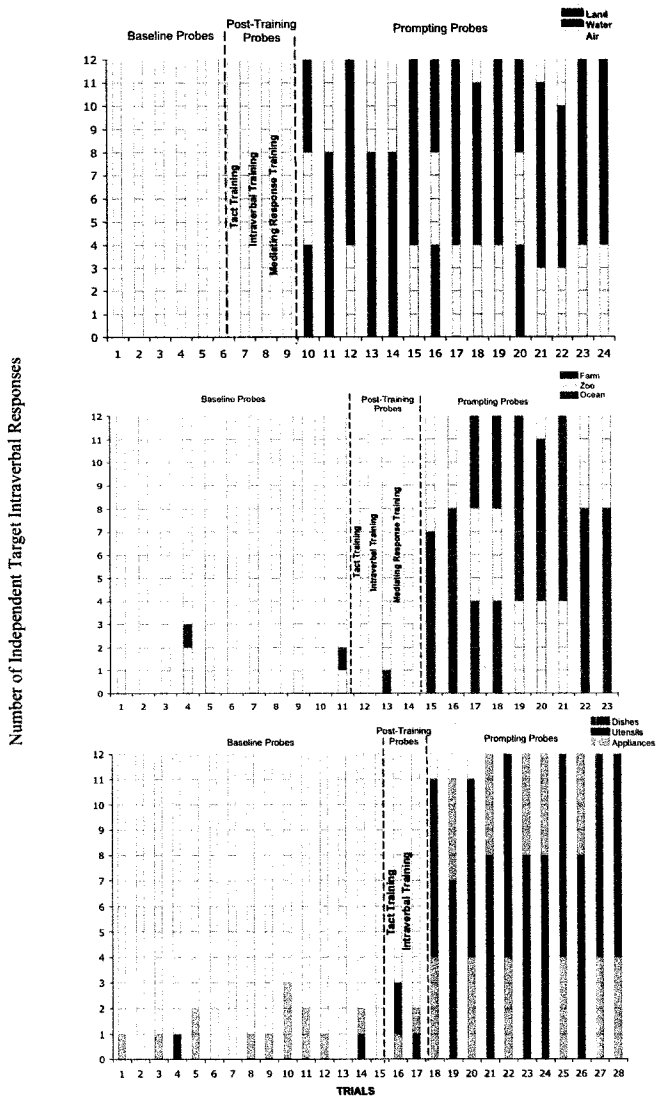

Figure 12. The order and pattern of Alexa's target intraverbal responses to the probe questions across her three training categories

Figure 13 shows the number of audible self-prompts that Alexa emitted during the prompting phase, across the three training categories. These data show that Alexa consistently emitted audible self-prompts on all but one trial (trial 21), across all three categories. Alexa prompted herself aloud with all three group names for 26 of the 34 trials. She provided an average of 2.6 self-prompts across the three training categories and these prompts never completely decreased to the point where she was only naming the target responses without stating the relevant group names.

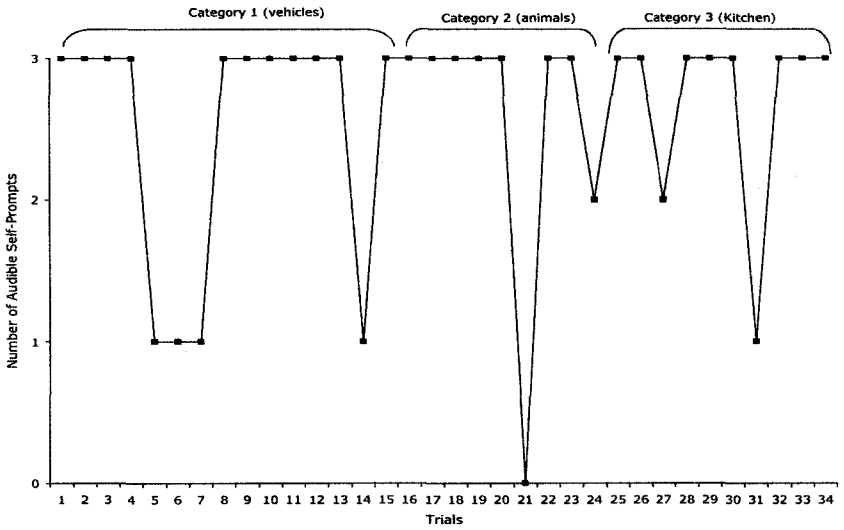

Figure 13. The total number of audible self-prompts Alexa emitted during the prompting phase, across her three training categories

Non-Target Responses

All participants provided correct and related, non-target intraverbal responses to some or all of the category probes. That is, across the intraverbal probe trials, all participants made some correct and related responses that fell outside the list of the 12 target responses identified by the experimenter (see Table 1 for the complete list of targets). For example, on a trial where Christopher was asked to name animals, he named "crab" and "whale." While both of these animals are correct intraverbal responses,

neither is found in the list of target ocean animals. Although the experimenter noted such responses verbatim, they were not included in any of the reported results for any of the participants.

Other examples of frequently observed non-target responses included all participants naming food and/or beverage items when asked to name things found in the kitchen. Participants also frequently named non-target furniture items found in the kitchen (e.g., table, chair, cupboards, drawers). Although these were initially common responses to the question about kitchen items, all participants steadily decreased the number of these non-target responses across training and prompting probes, until they were only providing the intraverbal responses targeted in this study. In addition, all four participants named a variety of non-target animals across the intraverbal probes for this category. These appropriate, yet non-target responses frequently involved "zoo" or "jungle" animals (i.e., giraffe, elephant, zebra, etc), as well as additional ocean animals. Christopher was the only participant who consistently named non-target ocean animals and these responses continued to occur in addition to the target responses during the final prompting phase.

For vehicles, Christopher was the only participant who provided any related, yet non-target, intraverbal responses during baseline probes. Periodically during baseline and post-training probes, Christopher provided responses that were related to transportation and travel. For example, on several occasions, Christopher provided responses such as "tunnel," "sidewalk," "hill," and "tractor" when asked to name vehicles. These non-target responses also decreased to zero once the final prompting probes began. Alexa was the only other participant who provided any appropriate

responses during the post-training probes with vehicles. For four of her post-training probes, Alexa stated "land," "water," and "air" when asked to name vehicles. However, she did not provide any of the 12 target vehicles until the final prompting phase began.

DISCUSSION

The purpose of this study was to provide an initial investigation into the role of problem-solving on the acquisition of categorization skills with typically developing preschool children. Previous studies (Braam & Poling, 1983; Goldsmith et al., 2007; Luciano, 1986; Miguel et al., 2005; Partington & Bailey, 1993; Watkins et al., 1989) have demonstrated that for the most part, procedures such as multiple tact training, listener training, and direct intraverbal training are unsuccessful in producing more than 6 to 8 categorical responses to questions about common items. The results of the current study showed that children between the ages of 3 and 5 were only able to emit a large number of the target category responses after they mastered a mediating response strategy, observed a model use the strategy, and were prompted to use the strategy in the relevant context. These results provide evidence for the utility and benefits of procedures other than simple transfer of stimulus control procedures for establishing large and consistent categorization repertoires. These results also provide initial empirical support for the role of self-intraverbal prompting as an important precurrent behavior in the development of more complex intraverbal repertoires (Skinner, 1953).

Five aspects of this study warrant discussion. First, all children showed few increases in target responding after elaborate and extensive training procedures with all training categories. Second, although three of the participants showed significant reductions in the number of training trials from their first categories to their second, none

of the participants showed any generalized responding across categories. Third, statements by one of the participants (Alexa), and the significant reductions in the number of problem-solving prompts for subsequent categories for all participants may be related to the automatically reinforcing value of applying the problem-solving strategy. Fourth, although 3 of the 4 participants showed decreases in training trials across categories, Christopher was the only participant to begin training with animals and was the only participant to show an increase in training trials from his first to his second category. Finally, all participants showed significant increases in responding immediately following the general problem-solving prompts by the experimenter. These five aspects, as well as an alternative conceptualization of categorization, the clinical implications of this conceptualization, and directions for future research are all discussed below.

Independence of Repertoires within Categories

All four participants showed few increases in target intraverbal responding after mastering both stages of multiple tact training and both stages of intraverbal training. These findings are consistent with the results obtained by Partington and Bailey (1993) and again by Miguel et al. (2005). The current study further elaborated on the Miguel et al. procedures to include separating the category into groups and teaching the child to tact the item name plus the group name (MTT Stage 1) and also the group name plus the overall category name (MTT Stage 2). Similar to Miguel et al., this study showed little-to-no benefits for these additional procedural variations. In addition to the extensive tact training procedures, participants in the current study also received extensive intraverbal training. Participants were required to master the individual intraverbal responses when

asked to name items belonging to a particular group (IVT Stage 1) and name the three groups when asked about the groups that belonged to a particular category (IVT Stage 2). All participants, with the exception of John (second category), experienced little-to-no increases in responding to the intraverbal probes after mastering both stages of intraverbal training. Although John did show a significant increase in responding to the probe question after IVT with kitchen items, responding quickly returned to baseline levels during the probes that occurred during MRT.

Although the current study used training procedures that were more extensive, complicated, with stricter mastery criteria than most programs designed at teaching intraverbal categorization, no significant gains in target categorization responses were demonstrated. Programs designed for teaching categorization skills to children with developmental disabilities such as those found in Sundberg and Partington (1998), describe teaching procedures that involve simple transfer procedures to transfer stimulus control from a tact to an intraverbal. These procedures are then systemically eliminated until the child is expected to list category items solely in response to the instruction "Tell me some [category name]" in the absence of any pictures. However, such programs do not explain how to establish and maintain complex repertoires involving 10 or 15 different responses or how to deal with rote responding that involves the child listing the same few items, in the same order, on every trial.

In addition to multiple tact training and intraverbal training, this study also investigated the utility of mediating response training on intraverbal categorization. These results showed that all participants were able to learn the problem-solving rules and the information related to each rule in the context of their relevant training category;

however, training alone did not produce any significant increases in intraverbal categorization for any of the participants. Again, this shows that training procedures alone are not sufficient at establishing complex, categorization repertoires with typically developing children. In fact, it was not until participants were instructed and shown how to apply the previously mastered skills that they were able to consistently and independently provide the desired response sets.

Independence of Repertoires Across Categories

Three of the four participants required fewer trials to master the training tasks with their second categories than their first. These results replicate a similar effect demonstrated by Goldsmith et al. (2007). None of the participants in the current study showed a generalized application of the problem-solving strategy from their first category to their second. In fact, only Alexa expressed a recollection of the training procedures during IVT for her second category (i.e., "can I use my rules?"), though she subsequently failed to use the strategy until explicitly trained to do so with that category. The other three participants never mentioned a familiarity with the rules during training with their second categories or demonstrated any spontaneous usage of these rules. These results are supported by their lack of overt self-prompting and lack of organized response patterns, both of which were demonstrated during responding to the intraverbal probes in the prompting phase.

These findings suggest that although all participants demonstrated a successful use of the strategy with their first category, this success was not sufficient in establishing a generalized use of the problem-solving strategy with subsequent categories. One possible reason for this lack of immediate, generalized responding was the lack of direct

reinforcement for correct responding during the intraverbal probes. During these trials, the experimenter simply acknowledged responding (e.g., "uh huh") and recorded the responses. Thus, correct responses that resulted from successfully using the strategy were not differentially reinforced. The experimenter avoided reinforcing these specific responses to determine if responding occurred because of a history of direct reinforcement or because of the application of the strategy, which may have been automatically reinforcing in its own right (see *Reinforcing Value of Strategy Application* below). Although direct reinforcement of the target responses may have produced more immediate responding with subsequent categories, it would have also made it difficult to determine the true conditions under which responding was occurring.

Reinforcing Value of Strategy Application

Although there was no direct reinforcement for strategy application or the resulting correct responses, all participants independently emitted correct and close to complete response sets for all probe trials, including the follow up probes that occurred once a week or less frequently. In addition, all participants required a significantly greater number of problem-solving prompts from the experimenter for their first categories than for their subsequent categories. It is possible that participants' success with responding to the prompts with the first category was automatically reinforcing for them. That is, the question to name items belonging to a category posed a true problem for the participants. The problem-solving prompts to use the rules and the subsequent application of these rules allowed participants to emit the correct target responses and successfully solve the problems that were initially presented to them. As Skinner (1953) described, the ability to solve a problem that one was not initially able to solve, can be

automatically reinforcing for the person tackling the problem. Thus, using a strategy that was beneficial in solving a problem in the past served a practical utility for the child when the problem was posed again with subsequent categories (i.e., the problem was solved quickly).

In addition to significant reductions in problem-solving prompts and maintained high levels of target responding, Alexa's statements to the experimenter provide additional evidence for the automatically reinforcing value of the strategy application. On two separate occasions (during IVT for her second and third categories) Alexa asked about "using her rules" and told the experimenter that she liked using the rules to help her answer the questions. Alexa contacted the automatically reinforcing contingencies from being able to solve a true problem through the application of the problem-solving strategy, despite the lack of direct reinforcement provided by the experimenter. Although the other three participants never made overt statements about the benefits of using the strategy, their performance data show that all participants successfully used the strategy with fewer and fewer prompts from the experimenter in the absence of any direct reinforcement contingencies.

Category Selection

As mentioned previously, Christopher was the only participant who required a greater number of training trials for his second category and was also the only participant whose first training category was animals. Christopher demonstrated more variability in responding during baseline and post-training probes with animals than he did during probes for his second category (vehicles). He also expressed an interest and preference

for animals and the related training materials at the beginning of the multiple tact training sessions with his first category.

The results obtained with Christopher may be due to the fact that animals are a more familiar category than vehicles or kitchen items with preschool children and thus, requiring fewer training trials regardless of the training order. In fact, throughout the several months of training time with Christopher, his preschool covered units on dinosaurs, elephants, and alligators. Although the information covered in these units was never reflected in any of Christopher's in-session responses, this does show that animals are a common category discussed with preschool aged children. In contrast, the preschool never covered units on vehicles or kitchen items (outside of cooking units related to specific foods) throughout the eight months that the experimenter was conducting sessions.

Benefits of Thematic Prompts

In addition to all participants significantly increasing target responding during the prompting phase, the problem-solving prompts were effective at occasioning bouts of responding on all occasions for all participants. These broad prompts met Skinner's definition of thematic prompts in that they were hints to the answers rather than direct prompts for the target answers themselves (Skinner, 1957). These intraverbal prompts served to prompt the participants to prompt and probe their own behavior in order to emit correct and complete response sets (Skinner, 1953). In addition, these prompts were effective at occasioning correct responding for all participants because they evoked terms (i.e., group names) that were made relevant to responding during the extensive prerequisite training sessions. For example, the simple prompt "use the rules" evoked the

group names, "land, water, and air", and these group names evoked most or all of the related target responses because of the previous training which established the relevance of these terms. Thus, the problem-solving prompts would not have been effective without the prerequisite skills training for the individual item names, the related group names, and the rules as they related to the specific category information.

It appears that the current study provides initial support for the utility of thematic intraverbal prompts when targeting complex categorization responses. It can also be speculated that an added benefit of the broad thematic prompts was the flexible nature of the response patterns that they produced. Since these prompts occasioned participants to apply the strategy rather than emit specific responses, responses could occur in any order within or across category groups. This allowed participants to select whichever group they preferred and name the items belonging to that group in any order. All participants demonstrated these flexible, yet consistent and orderly response patterns. Again this provides support for the notion that participants' responses were occurring due to overt and/or covert application of the problem-solving strategy, rather than because of rote memorization.

Alternative Conceptualization for Categorization

The outcomes obtained in this study seem to require a different conceptualization of categorization than previously provided by clinicians and researchers (as outlined by Sundberg and Partington in 1998). Although these categorization tasks do meet Skinner's (1957) definition of intraverbal behavior, the independent emission of correct and complete response sets in this study required additional procedures beyond simple prompting and differential reinforcement. Success with these categorization tasks

required participants to prompt and probe their own behavior. These results suggest that it is critical for preschool children to be taught to provide self-intraverbal prompts rather than relying solely on external prompts and reinforcement from an experimenter or teacher. Thus, in order for preschool children to be able to consistently provide 10-12 category items, they needed to be taught *how* to come up with this information on their own. Although Braam and Poling (1983) took a necessary fist step in extending Skinner's notion of the intraverbal to include categorization, it may be necessary to conceptualize categorization as something more complicated than the traditional intraverbal chain or fill-in-the blank responding.

The previous conceptualization of intraverbal categorization has been that categorical responses are simple intraverbals that occur in response to verbal stimuli. Approaches to teaching these responses have been consistent with strategies and procedures used to establish and maintain other simple types of intraverbal behavior (e.g., stating one's name, favorite color, address). However, the large number of possible reinforceable responses suggests that procedures in addition to simple tact prompts and differential reinforcement are necessary to occasion the complex repertoires. In addition, given the results of the current study, it seems unrealistic to expect that novel responses within or across categories would occur simply due to programmed generalization or repeated training trials. The extensive training trials plus the development of a problem-solving strategy was not sufficient at establishing generalized categorical responding in the current study. These findings suggest that even more complicated procedures are warranted in order to produce these additional results. The totality of findings from this study provides initial evidence for the benefits of reconceptualizing complex intraverbal

behavior. It seems that intraverbal responding that relies on complex, covert behavior may necessitate conceptual and procedural alterations that directly take these complex behaviors into account.

Applied Implications of Alternative Conceptualization

Reconceptualizing intraverbal categorization as something more than simple intraverbal responding requires a reconsideration of the way these skills are targeted clinically. Currently, procedures targeting intraverbal behavior with children with autism or other developmental delays do not vary the teaching procedures based on the complexity level of the particular intraverbal skill being taught (Sundberg & Partington, 1998). That is, simple prompts and differential reinforcement are used whether the child is being taught to recite their phone number, name items belonging to a category, or engage in simple conversational behaviors. Additionally, many applied programs are attempting to teach 4 or 5-year-old children with severe delays how to name items belonging different categories. Many clinicians may be expecting children to develop expansive and complex categorization repertoires through these simple teaching procedures and programming for generalization.

The results from the current study demonstrate that typically developing children between the ages of 3 and 5 required extensive training, modeling, and prompting before they were able to consistently provide the complex response sets. In addition, this study shows that mediating response training, involving the ability to master and use complex rule statements, was critical to the children's' success with the categorization task. This suggests that these procedures would only be appropriate for children who demonstrate rule-governed behavior and the ability to engage in complex speaker and listener

behaviors. Thus, it may be unreasonable to expect children with severe delays to master the procedures used in this study and be able to consistently name more than 4 or 5 category members.

The applied implications of the findings from this study and the clinical impact of adopting an alternative conceptualization of intraverbal behavior are twofold. First, if an applied program decides to target categorization with younger, more severely delayed children, the typical transfer procedures may still be the intervention of choice, as recommended previously by Miguel et al. (2005). A reasonable target outcome of these procedures may be the production of only a few responses that occur in a highly systematic way, most likely due to the development of strong and highly specific intraverbal chains. Secondly, if categorization skills are being taught to older, high-functioning children who demonstrate rule-governed behavior, it may be beneficial to consider using the procedures described in this study. Although this preliminary investigation was demonstrated with typically developing children, similar procedures may prove more useful at establishing complex repertoires than the traditional intraverbal teaching procedures have been able to demonstrate.

Future Directions

There are many areas that may be of interest for future research into the role of problem-solving and intraverbal categorization. One area of future research could investigate the prerequisite skills necessary to successfully acquire and use the mediating response addressed in the current study. It may be helpful to determine which specific prerequisite skills are needed in order to successfully use the mediating response. This type of component analysis may be a more meaningful way for people to determine when

individuals with disabilities are ready for this type of intraverbal programming, rather than relying on recommendations based on age. It has been speculated that significant tact, and simple intraverbal repertoires are necessary before teaching more complex intraverbal skills such as categorization. It has also been suggested that participants should be able to demonstrate rule-governed behavior and complex speaker and listener repertoires before teaching the rule statements and strategy application to children. It is critical for these prerequisite skills to be empirically evaluated before definitive statements can be made about which children will benefit the most from complex procedures similar to those described in this study.

It would also be beneficial to empirically investigate the utility of problem-solving strategies other than the one utilized in the current study to teach categorization tasks. For example, procedures such as visual imagery or observing the environment could be strategies that prove useful in establishing complex categorization repertoires. Both of these other strategies have been suggested to be beneficial tools that could aid in complex responding (V. Carbone, personal communication, August 29, 2004; Palmer, 1991). The strategy used in this study was only one of the possible tools that could aid in the successful development of a categorization repertoire. Investigations of these other strategies may reveal additional benefits that were not observed in the current study (e.g., the development of a generalized problem-solving repertoire).

One additional area for future research could involve investigating additional procedural changes that may facilitate a generalized use of the mediating response. One possible way that a generalized problem-solving repertoire could be established may be through teaching participants how to organize information into groups themselves. In the

current study, the experimenter selected the categories, subcategories, and individual target items that were trained. It is possible that generalized responding may be facilitated by having the participant play an active role in identifying the relevant groups for each category, as well as selecting the individual items belonging to each group.

The lack of generalized responding may be due to the fact that participants did not know how to group the information for the untrained categories. For example, it is reasonable to assume that responding for the untrained category of kitchen items would not spontaneously emerge because the groups the experimenter selected (i.e., appliances, utensils, and, dishes) are relatively unfamiliar to most typical preschool aged children. However, if the participants had assisted in selecting the groups for kitchen items, the subcategories may have been things in the cupboard, things in the refrigerator, and things in drawers. These groups may have facilitated faster acquisition of the target responses and possibly even produced generalized responding. Such procedural modifications could begin with presenting the participant with a stack of pictures of category items and having participants sort them into the groups that they select. These procedures could then be followed by having participants tact the names of the groups that they selected and then using this individualized information during the subsequent training conditions.

Conclusions

Although this study is an initial investigation into the role of overt and covert behaviors in the acquisition and maintenance of complex language, the results obtained in the current study are promising. In addition to providing further empirical support for some of the findings from previous studies on intraverbal categorization, this study has also replicated some of the findings from the initial studies on problem-solving. Similar

to the studies by Keeney, Cannizzo, and Flavell, (1967) and Guevremont, Osnes, and Stokes (1988), the young children in this study were able to successfully learn how to provide themselves with instructions during tasks, but they too needed explicit instructions and prompts to use the same strategy under new conditions.

These preliminary findings proved to be consistent across all participants with all training categories. The consistent and significant levels of behavior change indicate that this is a promising area for further investigation. These results may also help answer some questions about how to best teach complex language that relies on more complicated and covert skills. Hopefully this notion of an alternative conceptualization of intraverbal behavior will contribute to the ongoing discussions about complex covert behavior. In addition, it is hoped that these initial findings warrant further conceptual and empirical investigations into the role of problem-solving on the development of naturalistic categorization repertoires.

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Appendix A

Participant Screening Questionnaire

1. Does your child have any known developmental or language delays?

2. Does your child have any physical disabilities that will make it difficult for him or her to participate in this study (hearing impairment, visual impairment)?

3. Did your child crawl, walk, and talk around the typical developmental age range?

4. Does your child have any difficulty naming common objects in the environment or answering simple questions (what's your name, how old are you)?

5. Is your child relatively compliant with most simple demands? Will he or she be able to sit at a table for about 15 minutes at a time, look at pictures, and answer questions without engaging in major disruptive/noncompliant behavior?

6. What are some small toys, and/or treats that your child likes that could be included in our prize bin (favorite movie or TV characters)?

7. Please list any toys and/or food that you do NOT want included in your child's prize bin.

8. What, if any, allergies does your child have?

Appendix B

Mediating Response Training Script for Vehicles

A. Instructions:

- "Remember how we just learned about different groups of vehicles and all of the different things that are called vehicles? Your rules can help you tell me a lot of different things when I ask you to 'Tell me some vehicles". When someone asks you to name a bunch of vehicles, you can first remind yourself of the different groups of vehicles, and then list many things that you can think of that belong to each group. Now I am going to show you how I would use my rules if someone asked me to name a bunch of vehicles. Make sure to watch me while I use my rules".

B. Modeling:

- "So if someone asks me to tell them all of the vehicles I can think of, I would first say my 3 groups of vehicles. Land, water, and air".
- "Then I would pick a group. I pick water. Ocean liner, kayak, canoe, and jet ski."
- "Now I will pick another group. I pick air. Airplane, helicopter, hot air balloon, and a hang glider.
- "And then I would say the last group. Land. And then say all of the land vehicles: car, truck, motorcycle, and bus.
- "Now it's your turn to try. Tell me all of the vehicles you can think of."

Appendix C

HSIRB Approval Letter

WESTERN MICHIGAN UNIVERSITY

Human Subjects Institutional Review Board

Date: September 25, 2006

To: Linda LeBlanc, Principal Investigator
Rachael Sautter, Student Investigator for dissertation
Allison Jay, Student Investigator

From: Amy Naugle, Ph.D., Chair

Re: HSIRB Project Number: 06-08-04

This letter will serve as confirmation that your research project entitled "The Role of Problem-Solving in Complex Language Repertoires" has been **approved** under the **full** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may **only** conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: August 16, 2007

Walwood Hall, Kalamazoo, MI 49008-5456
PHONE: (269) 387-8293 FAX: (269) 387-8276