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TRAINING PRESCHOOL CHILDREN TO USE VISUAL IMAGINING AS A PROBLEM-SOLVING STRATEGY FOR COMPLEX CATEGORIZATION TASKS

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It has been suggested that verbally sophisticated individuals engage in a series of precurrent behaviors (e.g., covert intraverbal behavior, grouping stimuli, visual imagining) to solve problems such as answering questions (Palmer, 1991; Skinner, 1953). We examined the effects of one problem solving strategy—visual imagining—on increasing responses to intraverbal categorization questions. Participants were 4 typically developing preschoolers between the ages of 4 and 5 years. Visual imagining training was insufficient to produce a substantial increase in target responses. It was not until the children were prompted to use the visual imagining strategy that a large and immediate increase in the number of target responses was observed. The number of prompts did not decrease until the children were given a rule describing the use of the visual imagining strategy. Within-session response patterns indicated that none of the children used visual imagining prior to being prompted to do so and that use of the strategy continued after introduction of the rule. These results were consistent for 3 of 4 children. Within-session response patterns suggested that the 4th child occasionally imagined when prompted to do so, but the gains were not maintained. The results are discussed in terms of Skinner's analysis of problem solving and the development of visual imagining.

Key words: intraverbals, mediating response, tact training, problem solving, visual imagining

Skinner (1957) defined the intraverbal as a response that is evoked by a verbal discriminative stimulus and is maintained by generalized reinforcement from the individual's verbal community. He also provided several instances in which intraverbal behavior commonly occurs. These include social responses under the control of verbal stimuli (e.g., "How are you?" … "fine"), responding that occurs as part of a chain (e.g., saying the alphabet, singing a song), metaphors, translation, and word associations (e.g., "cat" → "dog," "black" → "white"). According to Skinner, word associations are the result of one verbal response serving as a discriminative stimulus that evokes another verbal response. If asked, "What are the colors in the American flag?" an individual might first respond with "red," which serves as the stimulus that evokes the response "white," which then evokes the response "blue." Frequently, the responses involved in word associations are controlled by numerous verbal stimuli. For example the response "dog" might be under the control of various verbal stimuli such as "cat" or "man's best friend."

Braam and Poling (1983) were the first to suggest that Skinner's (1957) analysis of the intraverbal, and in particular his analysis of

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word associations, could be extended to include item classification or categorization. They defined categorization as a group of related responses that are evoked by a particular verbal stimulus. For instance, the verbal stimulus ''animal'' might evoke the responses ''pig, lion, fish, and monkey.'' Because each response is a member of the same response class, each is considered a member of the ''animal'' category.

Skinner (1957) suggested that the verbal operants are initially functionally independent; therefore, a response under one form of stimulus control might not be expected to occur under other stimulus conditions. For example, a child might say ''pig'' when he sees a pig in a book (i.e., a tact) but not when asked to ''name some animals'' (i.e., an intraverbal). To overcome such functional independence, Braam and Poling (1983) demonstrated the utility of a stimulus control transfer procedure (i.e., tact to intraverbal) to teach individuals with intellectual disabilities to name a variety of items that are members of particular categories. In such a procedure, one presents to the learner an instruction (e.g., ''name some foods''), after which a photograph or object is immediately presented to evoke a tact response. The visual stimuli are then faded until the verbal instruction alone evokes the target verbal responses (e.g., ''apple, orange, green beans''), thus meeting Skinner's definition of an intraverbal relation.

Several studies have demonstrated the efficacy of tact-to-intraverbal and echoic-to-intraverbal transfer procedures for establishing intraverbal categorization responses (e.g., Goldsmith, LeBlanc, & Sautter, 2007; Luciano, 1986; Watkins, Pack-Teixeira, & Howard, 1989). These procedures have proven to be effective across individuals with intellectual disabilities (Braam & Poling, 1983; Luciano, 1986; Watkins et al., 1989) and autism (Goldsmith et al., 2007), as well as those of typical development (Miguel, Petursdottir, & Carr, 2005; Partington & Bailey, 1993). Procedures that are similar to those used by sophisticated speakers when generating responses not under direct control of a verbal discriminative stimulus might also be beneficial (e.g., organizing or grouping stimuli, observing the environment). Skinner's (1953) conceptualization of *problem solving* appears to be relevant to this goal.

Skinner (1953) defined a problem as a situation in which the individual has no response in his or her immediate repertoire that will allow him or her to avoid or escape deprivation or aversive stimulation. For example, if a child is asked, ''What are some animals?'' the child might not be able to engage in a correct intraverbal response that will result in reinforcement. In other words, the verbal discriminative stimulus ''animals'' might be insufficient to evoke the relevant responses of ''cow, pig, and dog.'' Palmer (1991) suggested that individuals often engage in problem-solving responses such as organizing and grouping stimuli, observing the environment, visual imagining, and covert intraverbal behavior to respond to questions successfully. Such responses also allow the individual to manipulate variables covertly and to ''prompt and probe his own behavior'' (Skinner, 1957, p. 442) to increase the probability of a solution. These problem-solving responses have a direct effect on the current behavior (solution) that produces the reinforcer. Problem solving then involves engaging in a series of precurrent behaviors until one response in the individual's repertoire becomes prepotent over other responses. To the extent that this response increases the probability of reinforcement, it is likely to recur under similar conditions. Skinner (1968) and Palmer agreed that it is necessary for precurrent behaviors to be taught before they can be used for problem solving, but when they are acquired they are maintained due to their effectiveness in evoking responses that are subsequently reinforced.

Teaching precurrent responses (e.g., grouping items, visual imagining, observing the environment) for answering simple questions

could also be extended to more complex behavior such as categorization. Sautter, LeBlanc, Jay, Goldsmith, and Carr (2011) conducted an investigation to determine if teaching a problem-solving strategy to typically developing children would facilitate the acquisition of intraverbal categorization responses. Three categories were targeted for training throughout the study (i.e., animals, vehicles, and kitchen items). Each category was divided into three subcategories or groups (e.g., the animals category was divided into ocean, farm, and zoo), and each subcategory was further divided into four individual items (e.g., the ocean subcategory was divided into fish, lobster, shark, and dolphin). Participants were initially exposed to intraverbal training in which they were taught not only to emit item responses (e.g., ''fish, lobster, shark, dolphin'') to subcategory instructions (e.g., ''Tell me some ocean animals'') but also to emit subcategory responses (e.g., ''ocean, farm, zoo'') to category questions (e.g., ''Tell me some groups of animals''). However, participants were never directly taught category–item intraverbal relations. Multiple-tact training (MTT) followed, in which participants were presented with pictures of the individual items and were trained (a) to say each item and its subcategory (e.g., ''It's a *dolphin* and it's an *ocean* animal'') and (b) to say the subcategory and category (e.g., ''It goes in the *ocean* and it's an *animal*''). Participants were then taught a problem-solving strategy that involved a mediating response of four rule statements (i.e., say the three groups, pick a group, pick a different group, say the last group) designed to serve as self-prompts to evoke responses of subcategory membership. The rule statements were first taught as a chain, after which the participants were taught to apply the rule statements to each category. After the participants mastered use of the rule statements, the experimenter modeled use of the strategy to answer an intraverbal categorization question.

The results of Sautter et al. (2011) indicated that category-subcategory and subcategory-item intraverbal training (IVT), MTT, and mediating-response training (MRT) produced limited effects on the ability to respond to intraverbal categorization statements (e.g., ''Tell me some animals''). However, all participants showed significant increases in correct responding after the investigator prompted them to use the problem-solving strategy (e.g., ''Use your rules,'' ''What is your next rule?''). The authors noted that the number of problem-solving prompts decreased during the prompting phase for all participants. Sautter et al. provided information on the order in which participants emitted correct responses. Interestingly, each participant emitted the correct intraverbal responses for each category in groups of four clustered by subcategory. For example, if the target category was vehicles, the participant responded with the four air vehicles, then with the four land vehicles, and finally with the four water vehicles. This response pattern was indicative of the use of the rule statements. Stating the rule evoked the subcategory name (as an intraverbal), which evoked the four items in the subcategory as intraverbal behavior. Overt rule statements emitted by the participants eventually decreased, but the response clustering by subcategory remained, suggesting that the participants were still using the rule statements, but that they had decreased in magnitude to the covert level. These findings correspond with Skinner's (1957) speculation that verbal behavior is likely to shift to the covert level when it is no longer reinforced in overt form because it is useful to the speaker in many ways. The covert rule statements might form part of a response chain that is maintained because its end result is the overt emission of correct intraverbal responses.

Sautter et al. (2011) provided evidence for the utility of teaching a problem-solving strategy for improving categorization skills. Another problem-solving strategy that might

be beneficial for teaching categorization responses is visual imagining. Skinner (1974) described visual imagining as ''seeing in the absence of the thing seen'' (p. 91) and surmised that this behavior develops through respondent or operant conditioning. According to Skinner's operant account, an individual's behavior of ''seeing'' something that is absent is controlled by a history of reinforcement and the current state of deprivation. Deprivation strengthens not only responses that have resulted in reinforcement in the past (i.e., responses directly controlled by the verbal discriminative stimulus) but also responses that accompanied reinforcement (e.g., seeing a stimulus); thus, visual imagining may be taught and reinforced by the verbal community for practical use (e.g., problem solving). For instance, when a child plays with toys, adults often prompt and reinforce verbal behavior related to toy play (e.g., tact the toys, answer questions about the toys). If the child is shopping with Grandma and she asks, ''What toys do you have at home?,'' a state of deprivation might occur, because the child does not have a response in his or her immediate repertoire (i.e., no response under direct control of the verbal discriminative stimulus). The current state of deprivation and history of reinforcement for responding to the toys in their presence strengthen the child's behavior of now ''seeing'' the toys in their absence.[1] In addition, Grandma might prompt visual imagining by telling the child to ''think'' about the toys he plays with in his room. When the child ''sees'' his toys, verbal responses are evoked and social reinforcement ensues. Consequently, the boy might be more likely to engage in visual imagining when presented with a similar problem in the future.

[1]It is important to note that visual imagining is a behavior and should not be interpreted as being separate from the thing ''seen.'' Conceptualizing the phenomenon in this manner—as a behavior (imagining) rather than a stimulus (the mental image)—is more consistent with an action-oriented behavioral analysis.

The purpose of the current investigation was to conduct a systematic replication of Sautter et al. (2011) and extend it by evaluating the effects of a problem-solving strategy that incorporated visual imagining on the acquisition of categorization responses. Specifically, this study incorporated tact training and the presentation of visual scenes. The participants were prompted to imagine visual scenes rather than use a series of verbal statements to evoke responses learned through a prior history of MTT and intraverbal subcategorization.

METHOD

Participants, Settings, and Materials

Four typically developing preschool children, Bryan (63 months old), Jeb (53 months old), Jonathan (66 months old), and Annette (56 months old) participated in this study. All sessions were conducted in the participants' preschool in a quiet, partitioned area of the lunchroom. Sessions were approximately 15 min and were conducted once or twice per day, 3 to 4 days per week, depending on participant availability. The training materials consisted of relevant category scenes printed in the center of sheets of paper (216 mm by 279 mm), laminated color pictures (8 cm by 8 cm to 12 cm by 12 cm) of individual category items, and a 13-slide PowerPoint presentation that included relevant category scenes, gray slides, and black slides. A small audio recorder was placed in the session area to record the participants' vocal behavior. Two large plastic bins with preferred toys, edible items, and activities were stored in the research area and were made available to the participants at session completion contingent on general compliance and participation.

Categories of Stimuli

We used four categories of stimuli: animals, furniture, kitchen items, and vehicles. We initially conducted preexperimental tact training and baseline sessions with the animals,

Table 1
Training Categories, Subcategories, and Items

	Animals	
Farm	Ocean	Zoo
cow	dolphin	giraffe
horse	fish	lion
pig	lobster	monkey
sheep	shark	tiger
	Furniture	
Bedroom	Living room	Office
bed	coffee table	bookshelf
dresser	couch	desk
mirror	foot stool	desk chair
nightstand	TV stand	lamp
	Kitchen items	
Appliances	Dishes	Utensils
dishwasher	bowl	fork
microwave	glass	knife
refrigerator	mug	spatula
stove	plate	spoon
	Vehicles	
Land	Water	Air
bus	canoe	airplane
car	jet ski	hang glider
motorcycle	kayak	helicopter
truck	ocean liner	hot air balloon

kitchen items, and vehicles. If the participant correctly stated more than six (50%) of the target responses for any of the three categories during baseline, that category was not included in further evaluations, and a fourth category (i.e., furniture) was assessed. Each category was divided into three subcategories, and each subcategory included four items. Thus, each of the three categories contained 12 individual target items (see Table 1 for a complete list of categories, subcategories, and individual target items). We presented four scenes including the four target stimuli within each subcategory to the participants throughout the study (see Figure 1 for two examples).

Dependent Variables and Data Collection

The primary dependent variable was the number of correct target intraverbal responses during probe sessions (e.g., the number of target responses to the question "What are some animals?"). Additional dependent variables consisted of the number of correct tacts and matching responses during preexperimental tact

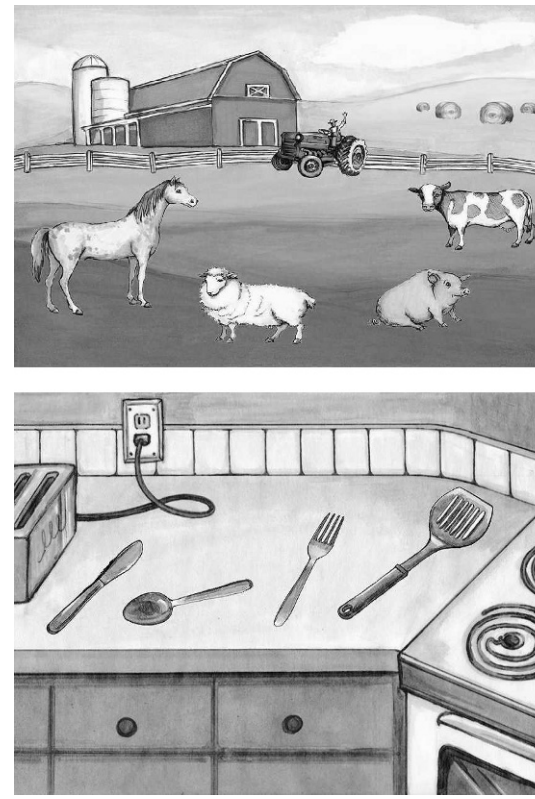

Figure 1. Depiction of the farm and utensil scenes.

training, the number of correct subcategory responses during subcategory intraverbal training, and the number of correct multiple-tact responses during MTT. The dependent variables were individually defined for each condition (see the description of each condition for definitions). In addition, data on problem-solving prompts provided by the experimenter and overt self-prompts emitted by the participants were collected during visual imagining prompting (VIP) and VIP plus rule sessions. Data collectors scored correct and incorrect responses using printed data sheets and wrote down the responses verbatim throughout all conditions. All sessions were also audiotaped.

Interobserver Agreement

A second observer independently scored at least 25% of all intraverbal probes, training sessions, and maintenance sessions for each

participant. An agreement was scored for each trial in which the experimenter and the observer both recorded the same correct or incorrect response. Point-by-point interobserver agreement was calculated for each session by dividing the number of agreements by the sum of agreements and disagreements and converting the resulting ratio to a percentage. Mean agreement for the primary dependent variable was 99% (range, 83% to 100%) for Bryan, 99.6% (range, 92% to 100%) for Jeb, 99% (range, 87% to 100%) for Jonathan, and 98% (range, 75% to 100%) for Annette. Mean agreement for secondary dependent variables was 99.9% (range, 67% to 100%) for Bryan, 99% (range, 92% to 100%) for Jeb, 99.9% (range, 83% to 100%) for Jonathan, and 99.6% (range, 67% to 100%) for Annette.

Design

A multiple baseline design across categories was used to assess the effects of subcategory IVT, MTT, visual imagining training (VIT), VIP, and VIP plus rule on categorization responses during probes. Training was implemented for two categories and a third category was assessed as a standard-series control.

Procedure

Preexperimental tact training. This condition was conducted to provide the participants with experience tacting the pictures and matching pictures of the target stimuli to specific locations in each category scene prior to experimental conditions. Tact training was conducted with pictures of the 36 items from the first three categories (animals, kitchen items, and vehicles). Additional tact training was conducted with Jonathan and Annette for the fourth category (furniture) because they emitted six or more responses for the animals category during baseline. Thus, preexperimental tact training was conducted with 48 items for these two participants. Tact training occurred in six (or eight) blocks of stimuli. Each block contained six items from each of the categories. The experimenter pointed to one of the pictures (e.g., lobster) and asked, ''What is it?'' If the participant emitted the correct response (i.e., ''lobster'') within 10 s of the instruction, praise was provided (e.g., ''That's right!''). Incorrect responses or no response within 10 s of the instruction resulted in an echoic prompt (e.g., ''It's a lobster. Say 'lobster.'''). Correct imitations were followed by praise, and incorrect responses or failure to respond resulted in additional echoic prompts until the participant responded correctly (there were no instances in which a participant required more than two echoic prompts). Following a correct tact (either prompted or unprompted), the experimenter presented a background scene from the relevant category and provided the instruction, ''Put it in the picture.'' The target items were absent from the background scenes, but item outlines were present as a prompt for correct placement. Correct placement within 10 s of the instruction resulted in praise. An incorrect placement or no response within 10 s of the instruction resulted in a model and verbal prompt. For example, the experimenter placed the item in the correct item outline and said, ''The lobster goes here. Can you put it here?'' Imitation of the experimenter's model resulted in praise. No imitation or placement of the item in an incorrect location resulted in another model prompt. This procedure continued for each block of stimuli until mastery, which was defined as independent correct tacting and matching of all six stimuli in each block across two sessions. Following mastery of each block, tact and matching maintenance sessions were conducted under extinction once per week for the duration of the study. Any incorrect responses during maintenance sessions were corrected in accordance with the training procedure.

Intraverbal probe sessions. During intraverbal probe sessions, the participant was asked, ''What are some [category]? Tell me as many as you can.'' Probes were conducted under

extinction, but general statements acknowledging the child's responses (correct or incorrect) were provided (e.g., "uh huh"). Only target responses were scored as correct, but data were also collected on nontarget responses. If the participant ceased responding for 5 s, the experimenter asked, "any more?" After responding for the selected category was complete or responding ceased for 5 s following the experimenter's question, the process was repeated for the two remaining categories. A probe session was complete after probes for each of the categories. The order in which categories were probed was randomly determined. Probes were conducted as a baseline assessment, following completion of each training phase (subcategory IVT, MTT, VIT), and throughout the VIP phases to evaluate the effects of the independent variables. Intraverbal probes that followed completion of a training phase were conducted in the next session. Some probe sessions occurred on the same day as training completion and some occurred on subsequent days, depending on participant availability. A category was considered mastered when the participant independently emitted 80% of the target responses during five consecutive probe sessions.

Subcategory IVT. This condition was conducted to determine if establishing a subcategory–item intraverbal relation would be sufficient for the production of numerous intraverbal categorization responses. A category was selected for subcategory IVT based on responding during baseline probes (i.e., the category with the fewest number of target responses). The experimenter asked the participant to say the three subcategories belonging to the target category (i.e., "What are some *places* where animals can go?"). In an effort to simplify the language for the participants, the word "places" was substituted for the word "subcategory" during training. A correct response was defined as the participant emitting the three target subcategories within 10 s of the question. If responding ceased for 5 s during the 10-s interval, the experimenter prompted further responding by saying, "any more?" If a participant started to list the target items and responding continued past 10 s, the responses were scored as correct as long as they did not cease responding for 5 s. In such an event, the experimenter continued with the next question. An incorrect response was defined as the participant saying an incomplete response (e.g., two of the three subcategories) or not responding within 10 s of the instruction. Correct responses produced descriptive praise (e.g., "That's right, those are places where animals can go!"), and incorrect responses were followed by an echoic prompt (e.g., "farm"). Each subcategory intraverbal was considered mastered when the participant independently emitted all three subcategory names (e.g., farm, ocean, and zoo) during two consecutive sessions. Following mastery of the subcategory intraverbals, maintenance sessions were conducted under extinction once per week for the duration of the study. Any incorrect responses during maintenance sessions were corrected in accordance with the training procedure.

MTT. The purpose of this phase was to determine if establishing multiple tacts for each item would be sufficient for the production of numerous intraverbal categorization responses. MTT was conducted in two stages. Prior to beginning training for either stage, the experimenter explained to the participant that he or she should say the item name and place (Stage 1) or the place and category (Stage 2) when shown a picture. Stage 1 training consisted of teaching the participant to tact the relevant item and the subcategory (e.g., "It's a microwave and it's an appliance."). The first subcategory trained was randomly selected out of the three subcategories and was taught to mastery (defined as independently saying all four target responses during two consecutive sessions) before teaching began for the items in the next subcategory. Training involved the experiment-

er holding up one of the scenes, pointing to one of the stimuli, and providing an instruction (i.e., ''Tell me about this''). Correct responses were defined as the participant saying the target response within 10 s of the instruction. All correct responses produced descriptive praise. An incorrect response was defined as the participant providing an incomplete response (e.g., saying two of the three targets), saying the target response after 10 s, or if there was no response from the participant within 10 s. All incorrect or incomplete responses were corrected with an echoic prompt. Following mastery of all subcategories, each of the 12 stimuli (from the three categories) was randomly selected and again presented to the participant with the instruction, ''Tell me about this.'' Correct responses resulted in descriptive praise, and incorrect or incomplete responses were corrected with echoic prompts. After the mastery criterion was met for all 12 stimuli (i.e., independently emitting all 12 target responses during two consecutive sessions), Stage 2 training began. Stage 2 training consisted of teaching the participant to tact the relevant subcategory and the category when presented with a picture of the target stimulus (e.g., ''It's an appliance and it's a kitchen item.''). Stage 2 training was identical to Stage 1 with the exception of the instruction (i.e., ''What is it?''). Following mastery at each stage of MTT, maintenance sessions were conducted under extinction once per week for the duration of the study. Both Stage 1 and Stage 2 responses were targeted during maintenance sessions. Prior to maintenance sessions, the experimenter indicated whether the participant should respond with the item name and subcategory or the subcategory and category. Any incorrect responses during maintenance sessions were corrected in accordance with the training procedure.

VIT. The purpose of this phase was to provide a model of visual imagining. VIT was conducted in three fading stages for each subcategory. The training consisted of the experimenter modeling for the participant, with the aid of a PowerPoint presentation, how she would use visual imagining as a problem-solving strategy to provide answers to the intraverbal probe questions. The PowerPoint presentation provided a visual example of an image that might be ''seen'' when imagining a particular subcategory. After the experimenter modeled the behavior, the participant was asked to imagine and name the items he or she saw.

Modeling during Stage 1 involved the presentation of a subcategory background scene and the prompt to look at ''the picture of the place.'' The scene was presented for 10 s. The experimenter then stated that she was going to close her eyes, and subsequently closed her eyes as a gray screen was presented for 5 s. The gray screen was provided to approximate what is seen when an individual closes his or her eyes, and the experimenter stated this to the participant (''This is kind of what it looks like when I close my eyes.''). The gray screen disappeared after 5 s, and a subcategory background scene was presented. The experimenter then stated that she saw an item, and simultaneously a corresponding item appeared in the PowerPoint presentation. For example, when the experimenter said she could see a car, the car became visible in the presentation. An item was then presented every 5 s, and the experimenter kept her eyes closed until all items that belonged in the subcategory had been presented. The full scene was visible for 5 s after presentation of all four subcategory items. Next, the experimenter instructed the participant to ''Look at the picture of the place, close your eyes, imagine the place, and tell me what you see.'' A correct response was defined as the participant closing his or her eyes and saying the four items in the subcategory within 10 s of the instruction. If a participant started to list the target items and responding continued past 10 s the responses were scored as correct, as long as responding did not cease for 5 s. If responding ceased for 5 s and the 10-s criterion had been met, the

experimenter continued with the next question. An incorrect response was defined as the participant not closing his or her eyes, saying only some of the items, or not responding within 10 s. If the participant correctly stated the four items in the subcategory, the experimenter instructed the participant to do it again. If the participant did not state all four items, the experimenter modeled the procedure a second time.

Subsequent modeling stages involved fading use of the full scene. Modeling during Stage 2 was identical to Stage 1 with the exception that the presentation started with the gray screen instead of the background scene. Modeling during Stage 3 started with a black screen (to completely remove the PowerPoint presentation as a prompt), but was otherwise identical to previous stages. Each stage was considered mastered when the participant independently said the four target responses while his or her eyes were closed, within 10 s of the instruction, for each subcategory during two consecutive sessions. VIT maintenance probes were not conducted, because the skills involved in visual imagining were targeted in the subsequent visual imagining prompting phase.

VIP. The VIP probes were identical to the intraverbal probes with the addition of either problem solving or tact prompts. The problem-solving prompt consisted of a verbal instruction intended to set the occasion for visual imagining. The verbal instruction was the same across presentations and categories (i.e., ''Remember you can imagine a place where [vehicles] go and tell me what you see.''). A problem-solving prompt was provided if the participant did not emit any responses within 10 s of the experimenter's initial instruction delivered at the start of the intraverbal probe. A problem-solving prompt was also provided if responding ceased for more than 5 s, or if the participant provided several target items from two categories (at least three from each) but no items from the third. A VIP phase with a 0-s prompt delay was implemented with one participant (Annette) because a downward trend was evident in her responding with the original 10-s prompt delay. The experimenter allowed 10 s for additional responses after each problem-solving prompt, regardless if the delay was 0 s or 10 s.

The tact prompts were provided only when the participant correctly named most of the individual items from the three categories (e.g., nine) but not all of them. For example, if the participant named three of the air vehicles, four of the ocean vehicles, and three of the land vehicles, the experimenter provided pictures of the omitted air and land vehicles to evoke the responses. Responses that followed tact prompts were not considered correct. Mastery for this condition was defined as independent (i.e., without tact prompts) emission of 80% of the target responses during five consecutive sessions.

VIP plus rule. This condition was conducted to decrease the number of problem-solving prompts. The experimenter prompted the participants to emit a rule statement before the beginning of the phase. Otherwise, this phase was identical to the VIP condition. The experimenter first asked, ''Can you tell me what you can do if someone asks you to name a bunch of different animals?'' If the participant responded that he or she would imagine the places and say what was seen, the experimenter initiated the VIP plus rule phase. If the participant did not respond with a similar statement, the experimenter said, ''You can imagine all the places where animals can go and tell me what you see. What can you do?'' If the participant echoed the rule (or stated an approximation of the rule), the rule phase was conducted. If the participant did not echo the rule (or emit an approximation), echoic prompts were provided until the participant correctly echoed the rule. Following correct emission of the rule statement, the intraverbal probes began. Mastery for this condition was independent emission of 80% of the target responses during five consecutive intraverbal probes.

Procedural Integrity

A trained observer independently scored at least 25% of the sessions to assess procedural integrity during training, maintenance, and intraverbal probe procedures. Each trial was evaluated according to a checklist of experimenter behaviors that were required for proper implementation. The behaviors on the checklist were (a) providing the correct discriminative stimulus (defined for each condition), (b) providing praise for correct responses during training sessions and providing no differential reinforcement for responses during maintenance or intraverbal probe sessions, and (c) providing correct prompts (individually defined for each condition). Mean integrity scores for training and intraverbal probe procedures were 99.8% (range, 67% to 100%) for Bryan, 99.8% (range, 83% to 100%) for Jeb, 99.9% (range, 83% to 100%) for Jonathan, and 99.9% (range, 83% to 100%) for Annette.

A second trained observer independently collected data on procedural integrity for at least 25% of the sessions to calculate interobserver agreement on procedural integrity measures. An agreement was defined as the two observers scoring the same experimenter behaviors for each trial. Mean point-by-point agreement was 97% (range, 67% to 100%) for Bryan, 99.9% (range, 83% to 100%) for Jeb, 99.7% (range, 83% to 100%) for Jonathan, and 99% (range, 75% to 100%) for Annette.

RESULTS

Target Responses during Intraverbal Probes

Figure 2 depicts Bryan's responses during intraverbal probes across all phases. Bryan was first exposed to training for vehicles (top). He did not emit any of the target responses for vehicles during baseline or following IVT. A small increase in target responses was observed following MTT and VIT. When VIP was initiated, Bryan's responding increased to five target responses for two probes and quickly increased to 12 target responses on subsequent probes. He met the mastery criterion for the VIP phase in seven probes and maintained mastery-level responding ($M = 10.4$), with the exception of two probes toward the end of the phase. The number of visual imagining prompts necessary to facilitate Bryan's responding remained fairly constant across probes ($M = 2.8$). The prompts were faded during the VIP plus rule phase ($M = 0.3$). Responding during baseline and IVT probes for animals (middle) was low ($M = 3.1$). When VIP was initiated, responding immediately increased to mastery level, and the mastery criterion was met in five probes. Responding remained high and above mastery level throughout the phase ($M = 11.8$). The number of visual imagining prompts was variable and averaged 1.1. The prompts were faded during the VIP plus rule phase ($M = 0.2$). He was not exposed to training for kitchen items (bottom), and his responding did not reach mastery level.

Figure 3 depicts Jeb's responses during intraverbal probes across all phases. Jeb was first exposed to training for kitchen items (top). He emitted a few target responses during baseline and following the training phases, but responding did not reach mastery level ($M = 2.3$). His target responses increased immediately when VIP was initiated, and by the third probe his responding was at mastery level. Responding met the mastery criterion in 12 probes and was maintained at mastery level, with an average of 11.5 target responses emitted throughout the phase. The number of visual imagining prompts remained fairly constant throughout ($M = 2.4$). The prompts were faded during the VIP plus rule phase ($M = 0.6$). Responding during baseline and after all training phases for animals was low ($M = 2.8$). When VIP was introduced, an immediate increase in target responding was observed. Responding met the mastery criterion in five probes and remained at mastery level throughout the phase ($M = 11.7$). The number of visual imagining prompts decreased toward the end of the phase ($M = 1.6$), and they were

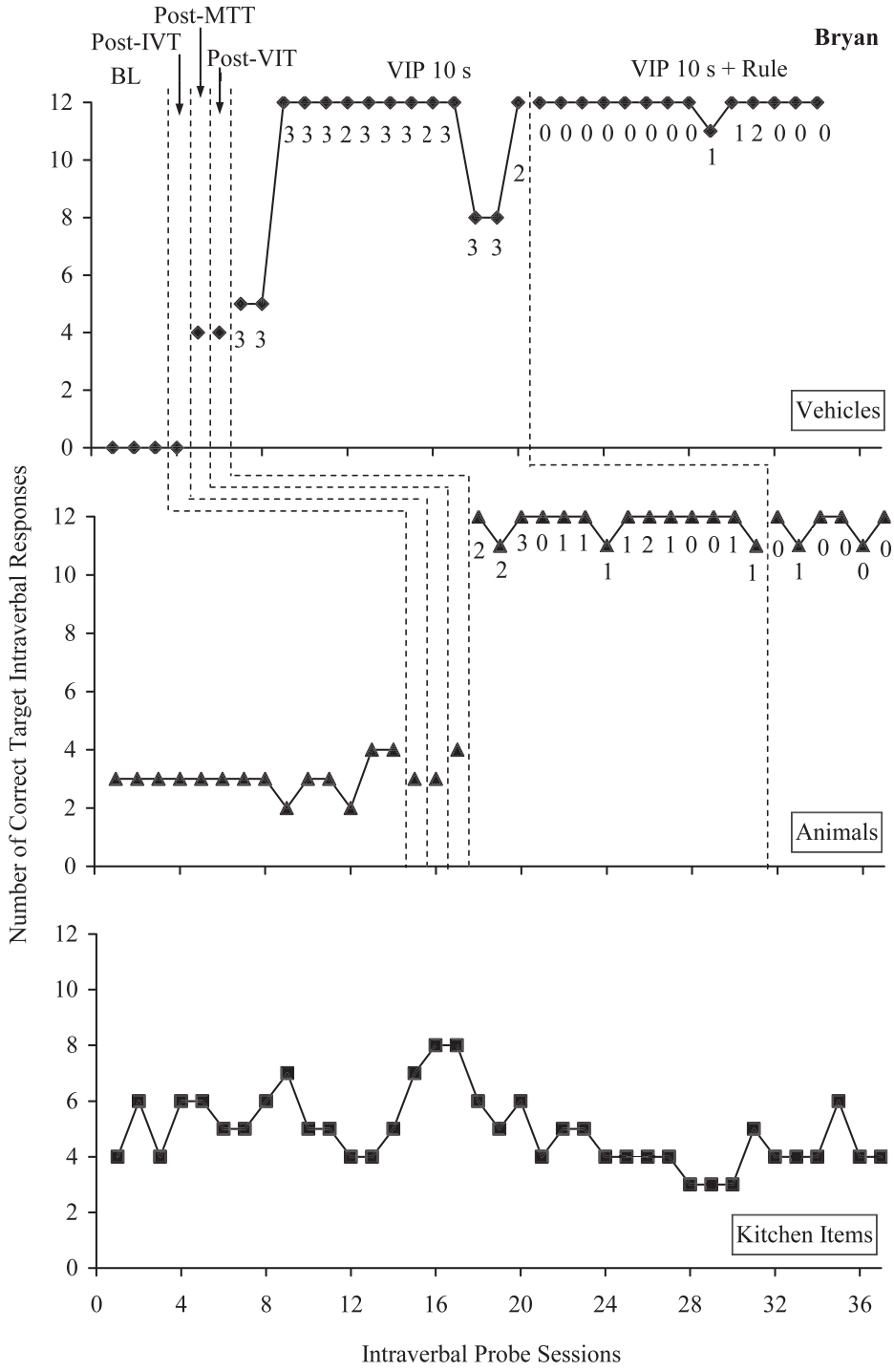

Figure 2. Number of correct independent target responses across training phases and stimulus categories for Bryan. Numbers = number of visual imagining prompts, BL = baseline, IVT = intraverbal training, MTT = multiple-tact training, VIT = visual imagining training, VIP = visual imagining prompting.

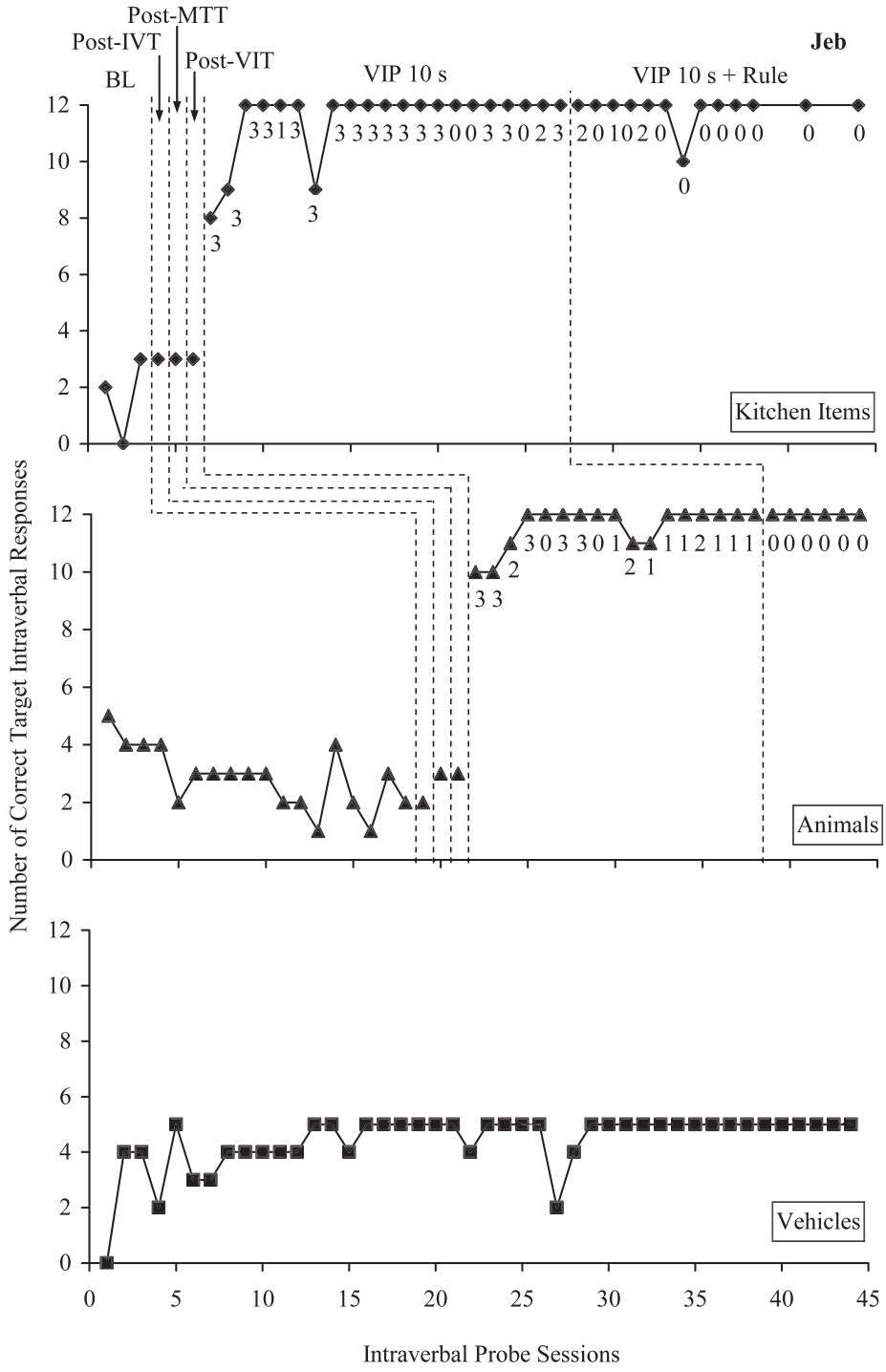

Figure 3. Number of correct independent target intraverbal responses across training phases and stimulus categories for Jeb. See Figure 2 for definitions.

eliminated during the VIP plus rule phase. Jeb was not exposed to training for vehicles (bottom), and his responding did not reach mastery level.

Figure 4 depicts Jonathan's responses during intraverbal probes across all phases. Jonathan was first exposed to training for furniture (top). His target responses during baseline and following the training phases were not at mastery level after training ($M = 1.2$). His target responses increased immediately when VIP was initiated, and responding for the first probe was at mastery level. Responding met the mastery criterion in eight probes and was maintained at mastery level throughout the phase ($M = 11.2$). The number of visual imagining prompts necessary to facilitate responding during the VIP phase was variable throughout ($M = 2.5$). The prompts were faded ($M = 0.4$) in the VIP plus rule phase. Jonathan was the only participant to emit overt self-prompts. He emitted one self-prompt at the beginning of the VIP (plus rule) phase (Probe 33: "bedroom, office, and living room"). Responding during baseline and probes for kitchen items was low ($M = 2.7$). When VIP was introduced, an immediate increase in target responses was observed. Responding met the mastery criterion in five probes and remained at mastery level throughout the phase ($M = 11.8$). The number of visual imagining prompts was variable throughout and averaged 1.6. Jonathan emitted two overt self-prompts towards the end of the VIP phase (Probe 32: "They go in the dishes, utensils, and appliances"; Probe 38: "I think of the places, imagine them, and tell you what I see"). The number of prompts immediately decreased to zero when the VIP plus rule phase was implemented and remained at zero throughout the phase. He was not exposed to training for the vehicles category (bottom), and his responding did not reach mastery level.

Figure 5 depicts Annette's responses to the probes across all phases. Annette was first exposed to training for vehicles (top). She did not emit any of the target responses during baseline or after the training phases for vehicles. It was not until VIP was initiated that an immediate increase in target responses was observed. Annette emitted an average of eight target responses out of a possible 12 during the VIP phase. Responding was on a downward trend when the prompt delay was decreased from 10 to 0 s. Annette emitted approximately six of the 12 target responses ($M = 5.7$) during the VIP 0-s delay phase. Her responding was variable, and on a few probes no responses were emitted. Following implementation of the rule statement, responding decreased to zero and remained at zero for a second probe. Responding for vehicles did not reach the mastery criterion. A similar pattern was observed with kitchen items (middle). She emitted a low number of target responses in baseline ($M = 0.3$). A slight increase in target responding was observed in the probes following MTT and VIT. Another slight increase in target responses ($M = 3.9$) was observed when VIP was initiated, but that increase was not maintained across probes, and responding eventually decreased to zero. Responding during probes for kitchen items was similar to the previous category and never met the mastery criterion. Annette's responding during probes for furniture (bottom) remained low throughout the study.

Within-Session Analysis

Figures 6 through 9 depict the number of correct target intraverbal responses that occurred in subcategory clusters during the prompting phases. Responses were considered to be clustered if the participant emitted at least three subcategory items in a row. The three subcategory responses did not have to occur in any particular order to be considered a cluster of responses. All participants responded in a clustered pattern to some extent. During the VIP phases for vehicles, Bryan (Figure 6) responded in clusters for 93% of the sessions for air vehicles, 75% of the sessions for land

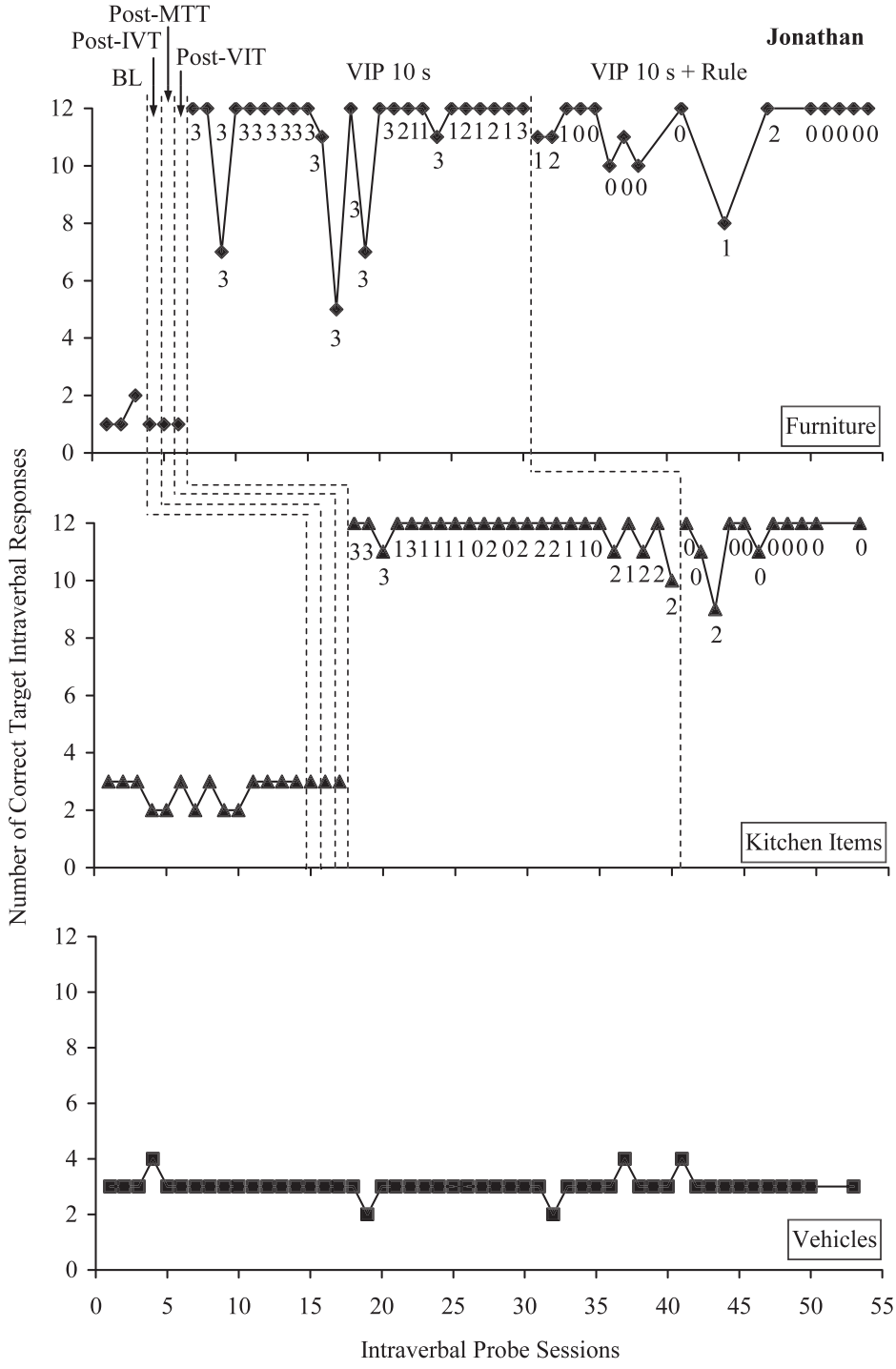

Figure 4. Number of correct target independent intraverbal responses across training phases and stimulus categories for Jonathan. See Figure 2 for definitions.

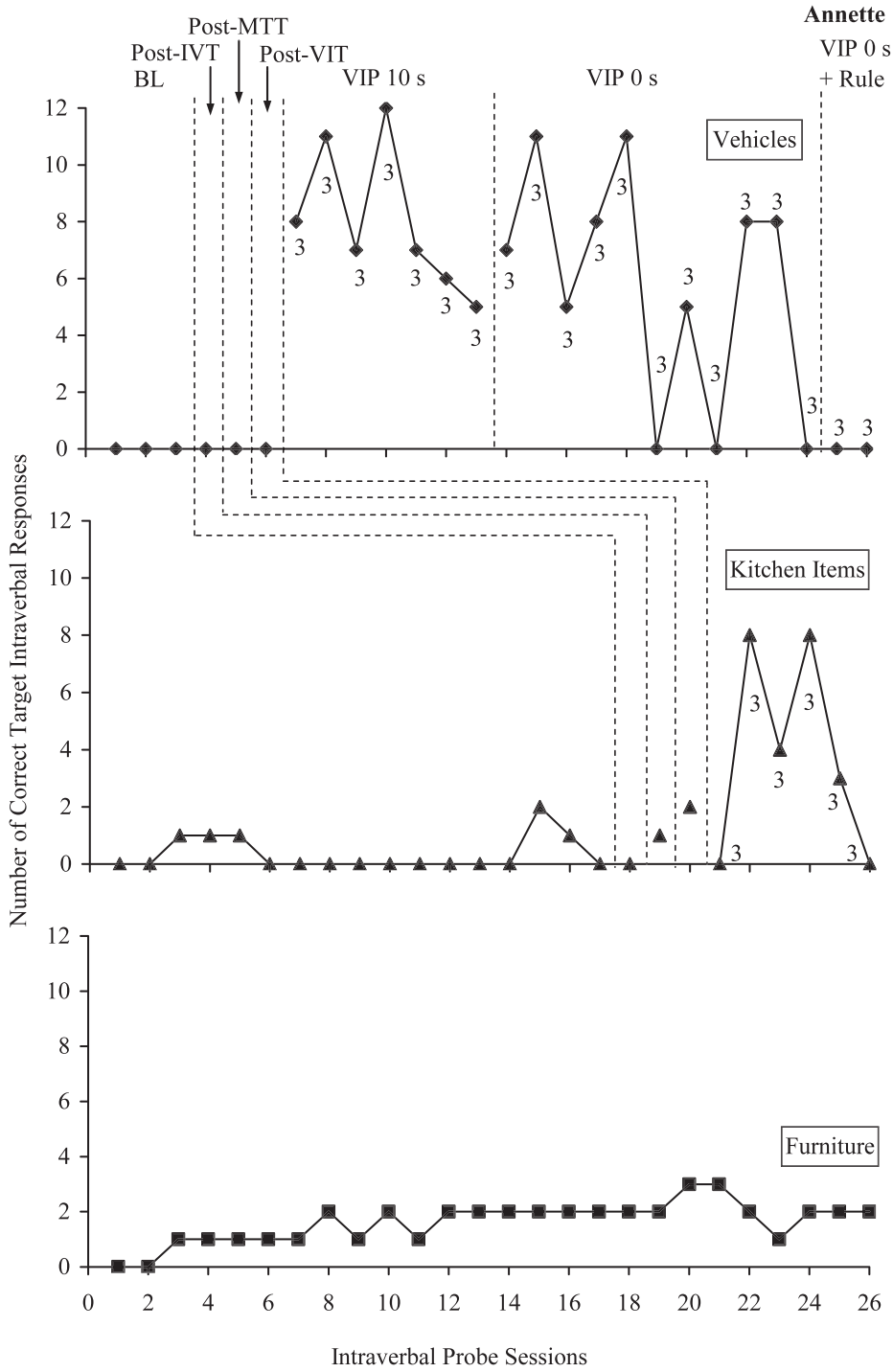

Figure 5. Number of correct target independent intraverbal responses across training phases and stimulus categories for Annette. See Figure 2 for definitions.

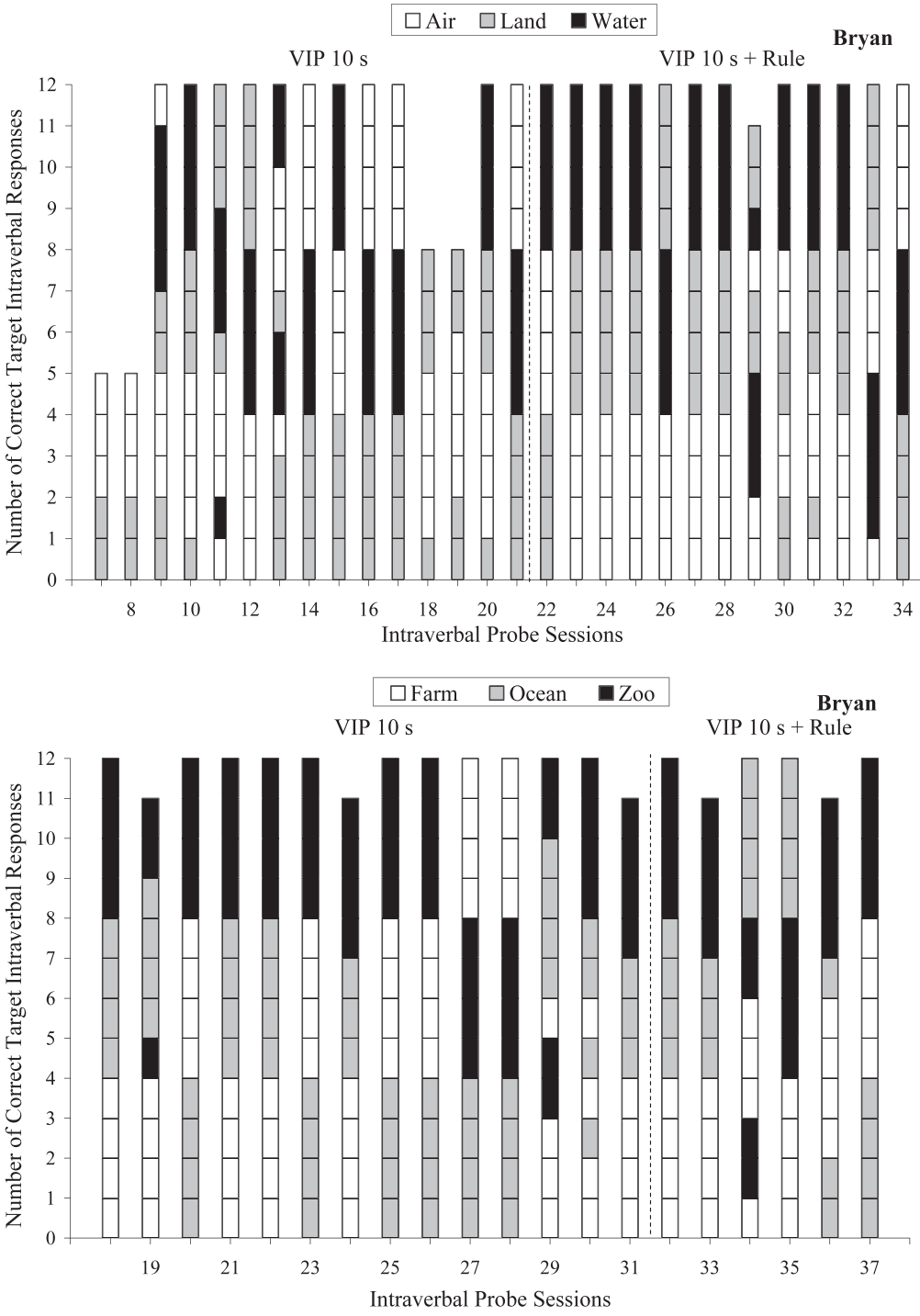

Figure 6. Number of correct target independent intraverbal probe responses in clusters during the prompting phases for Bryan. The data for vehicles are in the top panel, and the data for animals are in the bottom panel. See Figure 2 for definitions.

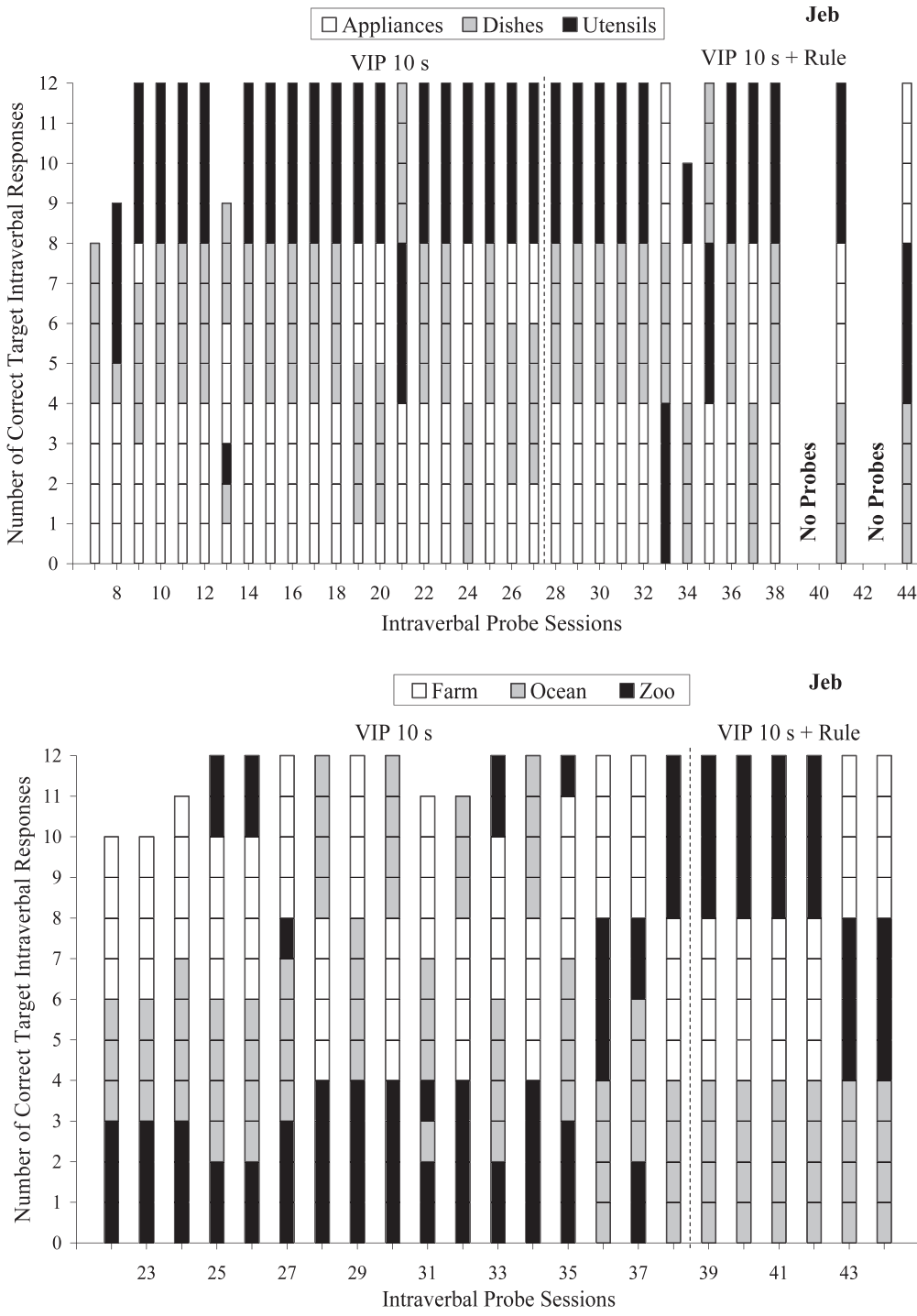

Figure 7. Number of correct target independent intraverbal probe responses in clusters during the prompting phases for Jeb. The data for kitchen items are in the top panel, and the data for animals are in the bottom panel. See Figure 2 for definitions.

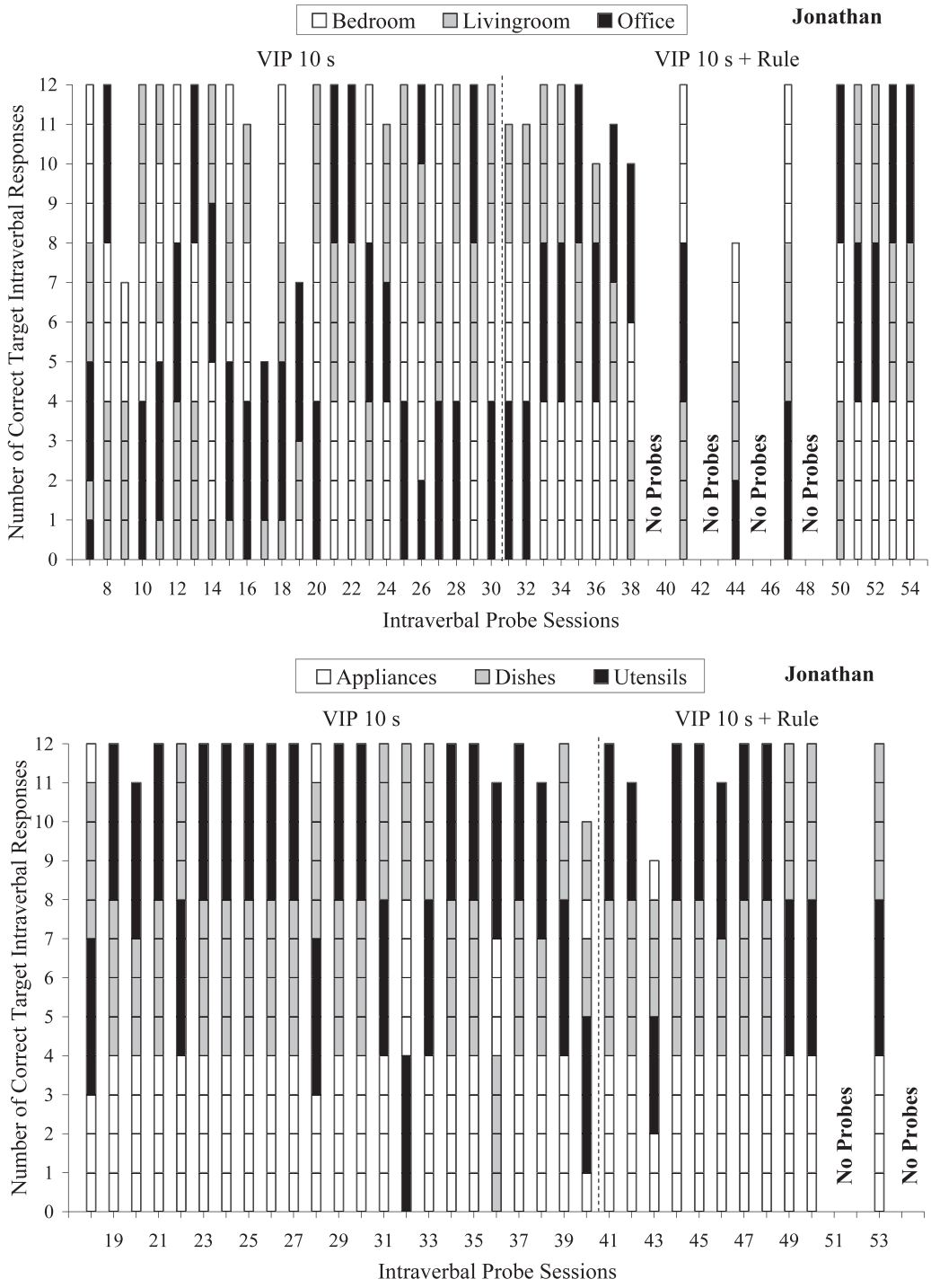

Figure 8. Number of correct target independent intraverbal probe responses in clusters during the prompting phases for Jonathan. The data for furniture are in the top panel, and the data for kitchen items are in the bottom panel. See Figure 2 for definitions.

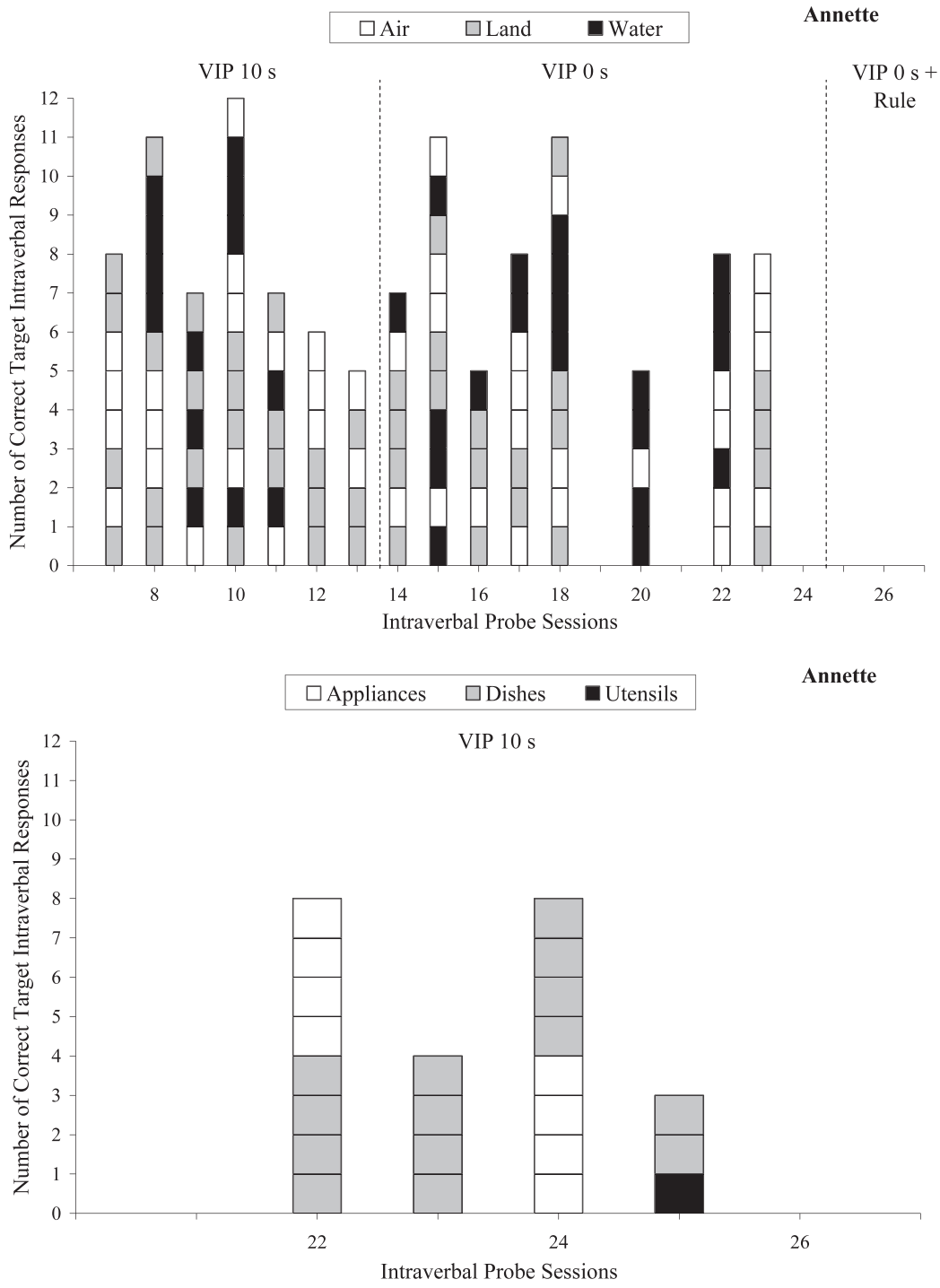

Figure 9. Number of correct target independent intraverbal probe responses in clusters during the prompting phases for Annette. The data for vehicles are in the top panel, and the data for kitchen items are in the bottom panel. See Figure 2 for definitions.

vehicles, and 82% of the sessions for water vehicles. His responses during the VIP phases for animals were clustered for 95% of the sessions for farm animals, 90% of the sessions for ocean animals, and 85% of the sessions for zoo animals. Jeb's responses (Figure 7) during the kitchen items VIP phases were clustered for 94% of the sessions for appliances, 94% of the sessions for dishes, and 91% of the sessions for utensils. His responses during the VIP phases for animals were clustered for 100% of the sessions for farm animals, 100% of the sessions for ocean animals, and 78% of the sessions for zoo animals. Jonathan's responses (Figure 8) during the VIP phases for furniture were clustered for 95% of the sessions for bedroom furniture, 90% of the sessions for living room furniture, and 92% of the sessions for office furniture. His responses during the VIP phases for kitchen items were clustered for 94% of the sessions for appliances, 97% of the sessions for dishes, and 100% of the sessions for utensils. During the VIP phases for vehicles, Annette's responses (Figure 9) for vehicles were clustered for 33% of the sessions for air vehicles, 27% of the sessions for land vehicles, and 27% of the sessions for water vehicles. Her responses during the VIP phases for kitchen items were clustered for 50% of the sessions for appliances, 75% of the sessions for dishes, and 0% of the sessions for utensils. It should be noted that these data are based only on the sessions in which Annette responded.

DISCUSSION

The purpose of this investigation was to systematically replicate the study by Sautter et al. (2011) and extend it by evaluating the effects of training children to use a visual imagining strategy on correct responses to categorization questions. Results indicate that typically developing children between the ages of 4 and 5 years were unable to emit a large number of responses to categorical intraverbals following subcategory IVT, MTT, or VIT. It was not until the visual imagining strategy was taught and modeled, and its use was prompted, that the children began emitting a large number of categorization responses. These results provide further evidence that methods other than stimulus control transfer procedures can be used to teach skills that are often termed *intraverbal categorization.*

Sautter et al. (2011) showed that prompts were necessary to facilitate use of a problem-solving strategy that involved rule statements. Similarly, none of the participants in the present study emitted a sufficient number of target responses until they were prompted to use visual imagining. It was not until they were prompted to generate a rule about using the visual imagining strategy that the number of prompts decreased.

These outcomes suggest that training was effective for providing the participants with a set of precurrent behaviors (Palmer, 1991; Skinner, 1953) that were used as a means for prompting and probing their own behavior to emit responses to the categorization questions (e.g., "What are some animals?"). During preexperimental tact training, the participants learned to tact each stimulus. The background scenes were present during item placement; thus, a history of reinforcement was also established for responding in the presence of the scenes. The participants then learned to name the subcategories for each particular category during IVT. This training might have established the tendency to name the subcategories (as intraverbals) when given the category name, as a potential first step in the problem-solving process. During MTT, the participants were taught to tact the stimuli in multiple ways (i.e., item name and subcategory, subcategory and category). This phase established a history of reinforcement for responding to the stimuli in multiple ways (i.e., saying the item names, subcategory names, and category names). The VIT phase gave the participants the opportunity to watch as the experimenter modeled how to use the skills taught in the previous phases. The

PowerPoint presentation, which followed the experimenter's report of what she was seeing, also allowed the participants to see a model of what it might look like if one were to imagine each scene visually.

According to Skinner's analysis of operant seeing (1953), the history of reinforcement that was established in the presence of the scenes during item placement in preexperimental tact training and MTT might have been sufficient to produce the ability to "see in the absence of the thing seen," or to imagine. When the participants were presented with a question for which they had no immediate response in their repertoires, they might have experienced a state of deprivation that brought all related responses to strength (e.g., saying the subcategory names, visually imagining). Each of the participants demonstrated mastery of the target skills during training, but they did not engage in the behaviors during intraverbal probes until prompted to do so. When prompted to use the visual imagining strategy (e.g., "Remember you can imagine a place where [category] goes and tell me what you see"), the participants readily emitted responses. The prompt might have served as a discriminative stimulus that evoked covert intraverbal behavior (i.e., naming the subcategories). If the participant was acting as both a speaker and a listener (Skinner, 1957), his or her covert behavior might have evoked visual imagining of the subcategory (i.e., the scene) that provided the necessary stimuli for the target responses to be evoked.

Another interpretation of the results is that the responses were simply learned intraverbals. The intraverbal responses were never directly trained, but it is possible that the participants engaged in covert intraverbal behavior when the full scenes were present during MTT and VIT. If the participants engaged in covert verbal behavior, they might have learned the responses for each subcategory. This seems to be a possible explanation for Annette's data. Annette demonstrated that she was capable of emitting a large number of categorization responses without explicit training when the animals category was probed during baseline. The animals category was removed from the set because her responding met the mastery criterion and further training was not warranted. The number of trials to mastery for each training condition was similar across participants; however, Annette required 10 more sessions of preexperimental tact training, compared to the average of the other participants (14 sessions). This might indicate that her tacting repertoire was not as developed as that of the other participants. During visual imagining training, she did not immediately respond to the prompt to close her eyes. The experimenter conducted a few shaping trials, and Annette soon complied with the prompt. She continued to engage in the behavior during the first few visual imagining prompting probes, but then her compliance ceased. In the following probes, there was a decrease in responding. Responding during the VIP phases for both categories never met the mastery criterion, but she occasionally emitted several target responses. After introduction of the VIP plus rule condition, responding decreased to zero and remained at zero for all subsequent probes. Thus, it seems likely that she did not consistently use the visual imagining strategy, and that at least some of the intraverbal categorization responses that occurred early in training might have been evoked by the verbal antecedent stimulus. Although the within-session data depicted in Figure 9 do not indicate that any of Annette's responses were chained, it is still possible that some subcategory-item intraverbal relations were intact in her repertoire.

The clustering of the participants' target responses by subcategory during the VIP phases is consistent with the hypothesis that the responses were the direct result of the use of the visual imagining strategy. This interpretation is strengthened by the fact that subcategory response clusters occurred in different orders

across sessions, which also suggests that participants were not simply engaging in intraverbal response chains. For example, in Session 35 of Bryan's animal evaluation, his responses were clustered in the following subcategories: farm → zoo → ocean. However, in Session 37, his responses were clustered in a different subcategory order: ocean → farm → zoo. An alternative interpretation of these data is that responses emitted in each subcategory were related intraverbally (e.g., through prior experience, saying "fish" evoked the subsequent response "lobster"). However, it is perhaps more parsimonious to appeal to the role of visual imagining during sessions because the participants emitted subcategory items in different orders across sessions and subcategory response clusters occurred in different orders across sessions.

Bryan, Jeb, and Jonathan each emitted vocal behavior that indicated that visual imagining occurred. Bryan made comments during VIP probes such as "I forget what's under the plane" and "Beside the horse is a sheep." Jeb named items that were present in the pictures but were not target responses. For example, on one VIP probe for kitchen items, he said "sink" before emitting the target responses for kitchen items, "utensils." During one VIP probe in which the probe for furniture followed kitchen items, Jonathan closed his eyes and said, "I can't. They're out of my head. All I can see are kitchen items. I'm trying, but I can't do it. It's out of my head. I'll try." He then commenced to emit all target responses for kitchen items. On another occasion he said, "a mug with coffee in it" during the kitchen items VIP probe. The mug in the training picture did have coffee in it. Collateral behavior was emitted by the three participants for whom the procedure appeared to be effective and provides further evidence that these three participants were engaging in visual imagining.

The results have two major applied implications. First, it might be possible to train typically developing 4- and 5-year-old children to use a visual imagining strategy as a way to emit responses that are not directly evoked by a verbal antecedent stimulus. This problem-solving strategy might be similar to those used by verbally sophisticated individuals. These preliminary findings suggest that problem-solving strategies can be effective for the acquisition of responses often referred to as *intraverbal categorization,* although the fact that responses were likely under multiple control (e.g., tact, echoic) suggests that these repertoires might need a different, more general, descriptive term. Second, learning to imagine visually requires mastery of other complex behaviors and might not be appropriate for children who are not readily able to engage in complex speaker and listener behavior. In addition, independent use of the visual imagining strategy did not occur until after the participants were given a rule. This indicates that the presence of rule governance is a necessity and that the procedure might not be effective if rule-governed behavior is not demonstrated.

Some limitations of the study are worth noting. First, visual imagining is a covert behavior, and it cannot be said with certainty that the participants were using the strategy to emit responses. The high rates of correct target responses and the clustering of responses by subcategories are the only tangible evidence that support this claim. Second, the number of times the experimenter asked "any more?" was not held constant across intraverbal probes. The question was always asked when responding ceased for 5 s, but the participants responded more during the VIP and VIP plus rule phases; thus, there were more opportunities for responding to cease and the prompt to be provided. Responding might have increased before VIP if the participants had been provided with more prompts to respond. Third, three of the four participants (Annette, Jeb, and Jonathan) had previously participated in another intraverbal study with the same experimenter

in which listener and intraverbal categorization responses to foreign symbols were taught. Annette's participation in the other study ended just 1 month prior to the present study. The previous participation might have contributed to the deterioration of her performance in the present study by affecting motivating operations (Michael, 1993). It is possible that spending time with the experimenter in the experimental environment was no longer reinforcing and that the prizes and activities no longer served as reinforcers for participation. If the available reinforcers in the experimental environment were no longer effective as reinforcers, Annette would not have responded to gain access to them. The previous participation did not seem to affect Jeb and Jonathan in the same manner. Jeb's participation ended 3 months before participation in the present study, and Jonathan's previous participation ended 5 months before the present study. Finally, the participants' ability to imagine visually was not evaluated before the study. It is unknown whether the procedure actually taught the participants how to imagine or if the procedure simply prompted them to use a skill they had already learned. Each of the participants engaged in behavior that might have indicated that an imagining repertoire was already in place. For example, Jonathan pointed to the grassy area behind the water vehicle's scene and said, ''Did you know the zoo is back there?''

The present study extends the literature on the utility of covert problem-solving strategies beyond rule mediation by suggesting the benefits for the use of visual imagining training to increase intraverbal categorization responses. However, the strategy does warrant further investigation. There are a number of questions to be answered about covert mediating strategies. First, each of the participants required numerous prompts to engage in visual imagining, and use of the strategy did not generalize to other categories. One explanation for this finding is that use of the strategy was never explicitly reinforced. The experimenter simply responded with vague statements of recognition (e.g., ''uh huh'') when the responses were emitted. Future researchers should examine whether providing direct reinforcement would facilitate generalization and decrease the number of prompts. Second, the utility of the other problem-solving strategies (e.g., grouping items and observing the environment) suggested by Palmer (1991) warrant investigation as possible methods for teaching categorization skills. Only two of the strategies have been evaluated at this time (i.e., self-rules and visual imagining). Third, it would be beneficial to know if all stages of training were necessary for ''seeing'' to occur. For example, the history of reinforcement established in the presence of the scenes during preexperimental tact training and item placement or during MTT alone might have been enough to bring the response of imagining to strength, making the other phases unnecessary. Fourth, the method used to train visual imagining might be improved (i.e., the PowerPoint presentation). It is possible that some scenes were not necessary or that another method would be more effective. Fifth, equating the number of ''any more?'' prompts across early training conditions might be beneficial for increasing the number of responses without further training. Sixth, the effects of the rule and the problem-solving prompts should be evaluated further. It would be beneficial to know if the rule would have effectively increased responding without prior exposure to the prompting condition. Seventh, participants might be prompted to describe what they are thinking when presented with categorization questions in an effort to evaluate verbal behavior that is indicative of visual imagining.

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