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THE ROLE OF PROBLEM SOLVING IN COMPLEX INTRAVERBAL REPERTOIRES

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We examined whether typically developing preschoolers could learn to use a problem-solving strategy that involved self-prompting with intraverbal chains to provide multiple responses to intraverbal categorization questions. Teaching the children to use the problem-solving strategy did not produce significant increases in target responses until problem solving was modeled and prompted. Following the model and prompts, all participants showed immediate significant increases in intraverbal categorization, and all prompts were quickly eliminated. Use of audible self-prompts was evident initially for all participants, but declined over time for 3 of the 4 children. Within-session response patterns remained consistent with use of the problem-solving strategy even when self-prompts were not audible. These findings suggest that teaching and prompting a problem-solving strategy can be an effective way to produce intraverbal categorization responses.

Key words: categorization, intraverbal, meditating response, multiple tact training, problem solving

In *Verbal Behavior,* Skinner (1957) described a conceptual system that entailed classification of language based on characteristic operant control. This classification system included several verbal operants (e.g., mand, tact, intraverbal, echoic), each of which has unique controlling variables. These operants are often functionally independent of each other in early learners, although certain experiences can render these repertoires interdependent rather than independent (see Sautter & LeBlanc, 2006, for a review). Of the basic verbal operants, the intraverbal is perhaps one of the most complex and interesting. Skinner defined the intraverbal as a verbal response for which there is no formal point-to-point correspondence with the evoking verbal stimulus. He described a range of behaviors as intraverbals including social responses under simple stimulus control (e.g., ''thank you'' … ''you're welcome''), responses occurring as part of a verbal chain (e.g., the alphabet, reciting a poem), simple word associations (i.e., ''bat'' … ''ball''), metaphors, and translation.

Skinner's (1957) discussion of the intraverbal spoke mostly to language with a history of temporal contiguity and reinforcement for specific responses; however, others have extended study of the intraverbal to include responses such as categorization. Braam and Poling (1983) extended Skinner's definition of the intraverbal to include answering questions about category membership (e.g., ''What are some animals?''). This type of skill is frequently sampled in intelligence testing and in group instructional procedures in elementary education (McCarthy, 1970). Braam and Poling used a transfer-of-stimulus-control procedure that involved picture-based tact prompts to teach individuals with mental retardation to name

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This study served as the dissertation for Rachael Sautter, who is now affiliated with the Y.A.L.E. School Southeast.

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several items belonging to a target category (i.e., ''tell me some fruit,'' ''apple, orange, banana''). Subsequent investigations have further demonstrated the utility of tact-transfer procedures (Goldsmith, LeBlanc, & Sautter, 2007) and echoic-transfer procedures (Watkins, Pack-Teixeira, & Howard, 1989) for teaching intraverbal categorization responses to children with disabilities.

Intraverbal categorization skills have also been studied in typically developing preschool children. These studies have primarily been aimed at examining the degree of functional independence between the intraverbal and other operants (or listener skills). For instance, Partington and Bailey (1993) taught preschool children to tact stimuli (i.e., see picture of item, say name or feature); however, the children subsequently failed to emit the same topographical responses as intraverbals (i.e., naming exemplars when asked for toys, fruit, furniture, or cleaning items). Following multiple tact training (e.g., see lemon, say ''lemon, and it's a fruit''), participants' intraverbal responses increased somewhat, but they still did not reliably produce a large number of responses when instructed to ''tell me some fruit'' with no pictures present. Subsequently, Partington and Bailey used a transfer-of-stimulus-control procedure to directly train the intraverbal responses. The transfer-of-control procedure involved using pictures as prompts (i.e., delivering the instruction ''tell me some fruit'' while showing the children pictures of fruits), and then fading the prompts until the responses occurred under the control of the verbal antecedent stimulus. Miguel, Petursdottir, and Carr (2005) replicated the finding that multiple tact training failed to produce intraverbal responses and further illustrated that teaching multiple receptive discriminations (i.e., ''find the hammer,'' ''find the tools'') also did not produce the desired intraverbal categorization responses to the antecedent verbal stimulus (e.g., ''tell me some tools''). Like Partington and Bailey, Miguel et al. found that transfer-of-control procedures were effective in teaching the intraverbal responses.

Recently, Petursdottir, Carr, Lechago, and Almason (2008) further demonstrated the functional independence of intraverbal and listener relations in preschool children. Children were initially taught to tact a number of unfamiliar stimuli (i.e., maps of African countries, foreign symbols and characters). Subsequently, the experimenters directly trained either an intraverbal categorization response (i.e., ''Mali, Rocco are north'') or a listener categorization response (i.e., selecting the correct stimuli from an array when asked ''Which one is west?'') while testing the other under extinction conditions. Listener training did not result in the emergence of an intraverbal repertoire, and intraverbal training did not result in the emergence of a listener repertoire.

Overall, these studies illustrate that researchers are able to establish small and somewhat restricted categorization repertoires by directly training the responses using stimulus control transfer procedures. However, some have suggested that the resulting responses may differ from how most verbally competent individuals answer categorization questions (D. Palmer, personal communication, September 12, 2006). For example, a competent speaker's response to the question ''name several animals with a tail'' would not be solely under intraverbal control (i.e., stimulus control due to prior reinforcement history). For a given speaker, only the first response or two might be under direct intraverbal control, but the speaker might then engage in more complex (and often covert) problem-solving responses to generate additional category members (Sundberg & Michael, 2001).

Skinner (1953) defined problem solving as ''any behavior which, through the manipulation of variables, makes the appearance of a solution more probable'' (p. 247). Through problem solving, the stumped speaker can generate

stimuli to supplement his or her own intraverbals and generate a response that is likely to be reinforced. Skinner referred to this as ''prompting and probing'' one's own behavior (p. 442). Several common problem-solving strategies include organizing and grouping stimuli, visual imagining, observing one's own environment, and engaging in covert intraverbal behavior (Palmer, 1991). The developmental literature on children's problem solving indicates that typically developing young children can learn problem-solving strategies, but they usually must experience a direct reinforcement history and prompts to use the strategies under different antecedent and consequence conditions (Hetherington & Parke, 1993; Keeney, Cannizzo, & Flavell, 1967). For example, Guevremont, Osnes, and Stokes (1988) showed that preschool children could learn to provide self-instructions on academic tasks as a mediating response but needed reminders and specific instructions to use the strategy in new environments.

Although transfer-of-stimulus-control procedures have been effective in establishing small categorization repertoires, incorporation of problem-solving strategies as mediating responses might produce repertoires that are akin to those of advanced speakers. Categorization repertoires that incorporate problem solving might be useful when responses that are directly evoked by verbal antecedent stimuli become inadequate, such as during group instruction when other students are quicker to respond to a teacher's question. The purpose of this study was to investigate whether typically developing preschool children could learn a problem-solving strategy that involved self-prompting with intraverbal chains, and whether use of the strategy would lead to an increase in the number of responses to intraverbal categorization questions.

METHOD

Participants, Setting, and Materials

Four typically developing preschool children, John (56 months old), Jessica (47 months old), Christopher (39 months old), and Alexa (59 months old) participated in this study. All sessions were conducted in the children's preschool and occurred in a quiet area behind a room divider. Sessions lasted approximately 15 min (inclusive of all assessment, training, and reinforcer delivery) and were conducted 3 to 5 days per week, once or twice per day. The training materials consisted of 36 laminated color photographs (8.9 cm by 8.9 cm) that portrayed items from three categories. Each card depicted the training item on a white background with no other distracting images in the picture. A bin containing a variety of small prizes (e.g., stickers, stamps, edible items, party favors) was available at the completion of each session. The participants were allowed to choose one prize from the bin contingent on general compliance but not accuracy of responding.

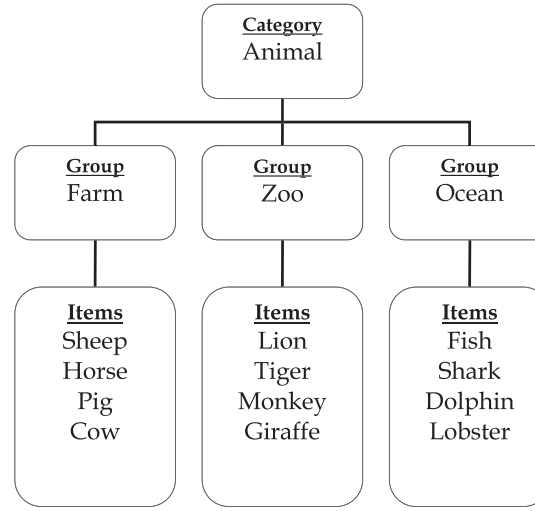

Figure 1. Items and groups of one target category.

Categories of Stimuli

We evaluated three categories of stimuli, further divided into three subcategories (referred to as groups from this point forward). Each group contained four items resulting in a total of 12 items per category (see Figure 1 for an example). The animals category included the farm group (cow, horse, pig, sheep), ocean

group (dolphin, fish, lobster, shark), and zoo group (giraffe, lion, monkey, tiger). The vehicles category included the land group (car, truck, bus, motorcycle), water group (ocean liner, canoe, kayak, jet ski), and air group (airplane, helicopter, hot air balloon, and hang glider). The kitchen items category included the appliances group (dishwasher, microwave, refrigerator, stove), dishes group (bowl, glass, mug, plate), and utensils group (fork, knife, spoon, spatula).

Dependent Variables and Data Collection

The primary dependent variable was the number of correct, target intraverbal responses to intraverbal probes of ''tell me some [category name].'' Observers scored a correct response when the child independently named one of the relevant targeted items (e.g., cow). Other related, nontargeted items were recorded verbatim but were not included as part of the primary dependent variable (data are available from the first author). Participants often emitted at least a few nontargeted items for animals but few to none for kitchen items and vehicles. Observers also scored independent correct responses during training, along with audible self-prompts. *Audible self-prompts* were defined as stating a group name aloud, immediately followed by naming any member (e.g., water; dolphin, fish, lobster), or stating ''use the rule'' or the rule itself (e.g., ''name some groups'') followed by naming any member. Finally, the observers scored experimenter prompts to use the mediating response (hereafter referred to as rule-use prompts), which were defined as reminders to use the problem-solving strategy (e.g., ''use your rules,'' ''What about the last rule?'').

Interobserver Agreement and Procedural Integrity

The experimenter collected primary data for all sessions, and a second observer independently scored a subset of sessions. Every response for a training trial or intraverbal probe had to be scored identically to be scored as an agreement. Agreements were divided by the sum of agreements plus disagreements and converted to a percentage. For John, mean interobserver agreement was 98% (range, 67% to 100%) across 56% of his sessions. For Jessica, mean interobserver agreement was 96% (range, 75% to 100%) across 58% of her sessions. For Christopher, mean interobserver agreement was 99.7% (range, 88% to 100%) across 44% of his sessions. For Alexa, mean interobserver agreement was 99% (range, 67% to 100%) across 47% of her sessions.

A trained observer scored the experimenter's behavior to assess accuracy of procedural implementation. For each trial or intraverbal probe, the observer scored several steps as ''yes,'' ''no,'' or ''n/a'' (not applicable) on a checklist. For example, during multiple-tact training (MTT), the observer scored whether the experimenter shuffled the cards prior to initial presentation, held up a card and presented the question (''What is it?''), allowed 5 s for a response, provided praise for any correct response, provided an echoic prompt for an incorrect or no response, placed the picture face down after completion, and immediately recorded data. All steps had to be scored yes or n/a (e.g., when the participant's response was correct, experimenter's response to incorrect would be scored n/a) for the trial to be considered correctly implemented. A second independent observer scored a subset of sessions for procedural integrity to determine interobserver agreement. An agreement was defined as a trial with all checklist items scored identically. Agreements were divided by the sum of agreements plus disagreements and converted to a percentage. John's procedures were implemented correctly for 99.6% of trials (fidelity data were collected for 26% of all sessions), and the agreement on the fidelity measures was 96% (range, 85% to 100%) (25% of sessions scored for fidelity were scored for interobserver agreement). Jessica's procedures were implemented accurately for 100% of trials (25% of sessions scored) and the agreement on the fidelity measure was 95%

(range, 80% to 100%) (31% of sessions scored). Christopher's procedures were implemented accurately on 100% of trials (25% of sessions scored), and the agreement on the fidelity measure was 97% (range, 88% to 100%) (26% of sessions scored). Alexa's procedures were implemented correctly for 99.8% of trials (31% of sessions scored), and agreement was 100% (27% of sessions scored).

Procedure

Baseline and intraverbal probes. The experimenter presented the three category requests "tell me some [category name]" in random order and allowed a 5-s latency to respond for each question. When responding ceased for 3 s to 5 s, the experimenter provided a single verbal prompt of "any more?" General statements of acknowledgment (e.g., "uh huh") were provided for all responses regardless of accuracy. No other systematic consequences were provided for responses during testing, but compliance was praised periodically (e.g., "You are really working hard") to increase participants' willingness to continue in the study. These intraverbal probe requests (i.e., "tell me some [category name]") were never directly presented in training sessions (see descriptions below). Training sessions (starting with prerequisite skills training [PST]) began after stable low responding was observed in the initial (baseline) intraverbal probes. Probes continued in this manner approximately every third session and at least once per week throughout all subsequent phases of the study to evaluate whether various training procedures increased the number of target intraverbals emitted under baseline conditions. Figure 2 provides an illustration of the temporal relation between intraverbal probes and training sessions, as well as information on the prompts and target responses for every phase and ongoing probes.

Prerequisite skills training: MTT. The problem-solving strategy that served as the mediating response required that the participants have several prerequisite skills that were directly targeted in early intervention phases. Figure 2 shows the progression of training phases and the specific discriminative stimuli and target responses for each phase. MTT was conducted in two stages to ensure that children could tact the target items, group, and overall category. In Stage 1, participants learned to name a picture of an item and the group it belonged to. For example, the experimenter presented a picture of a tiger and asked "What is it?"; the correct answer was "It's a tiger and a zoo animal." Echoic prompts were provided if 5 s elapsed with no response, or immediately after an incorrect response. This 5-s constant prompt delay was used in this phase and all subsequent training phases. We first trained each of the three groups of stimuli to mastery (defined as 100% independent correct responses in two consecutive 12-trial sessions). After the participant reached mastery with all the stimuli in turn, we presented the 12 pictures from all three groups in random order until the mastery criterion was met. In Stage 2, the participant learned to name the category and group. For example, the experimenter presented a picture of a pig and asked "What is it?"; the correct answer was "It lives on a farm and it's an animal." All 12 pictures were shuffled and presented in random order until the participant independently provided the correct answer for all 12 pictures twice consecutively.

Prerequisite skills training: Intraverbal training (IVT). The second phase of prerequisite skills training targeted intraverbals and was conducted in two stages. During Stage 1 of IVT, the participant was required to name all of the individual items belonging to a group after the request "tell me some [group name]." A complete response set included the four target items trained for the group (e.g., fish, shark, lobster, and dolphin for ocean animals). The order of training for groups was determined by random selection, and groups were trained successively to mastery (i.e., the participant said the complete response set for two consecutive

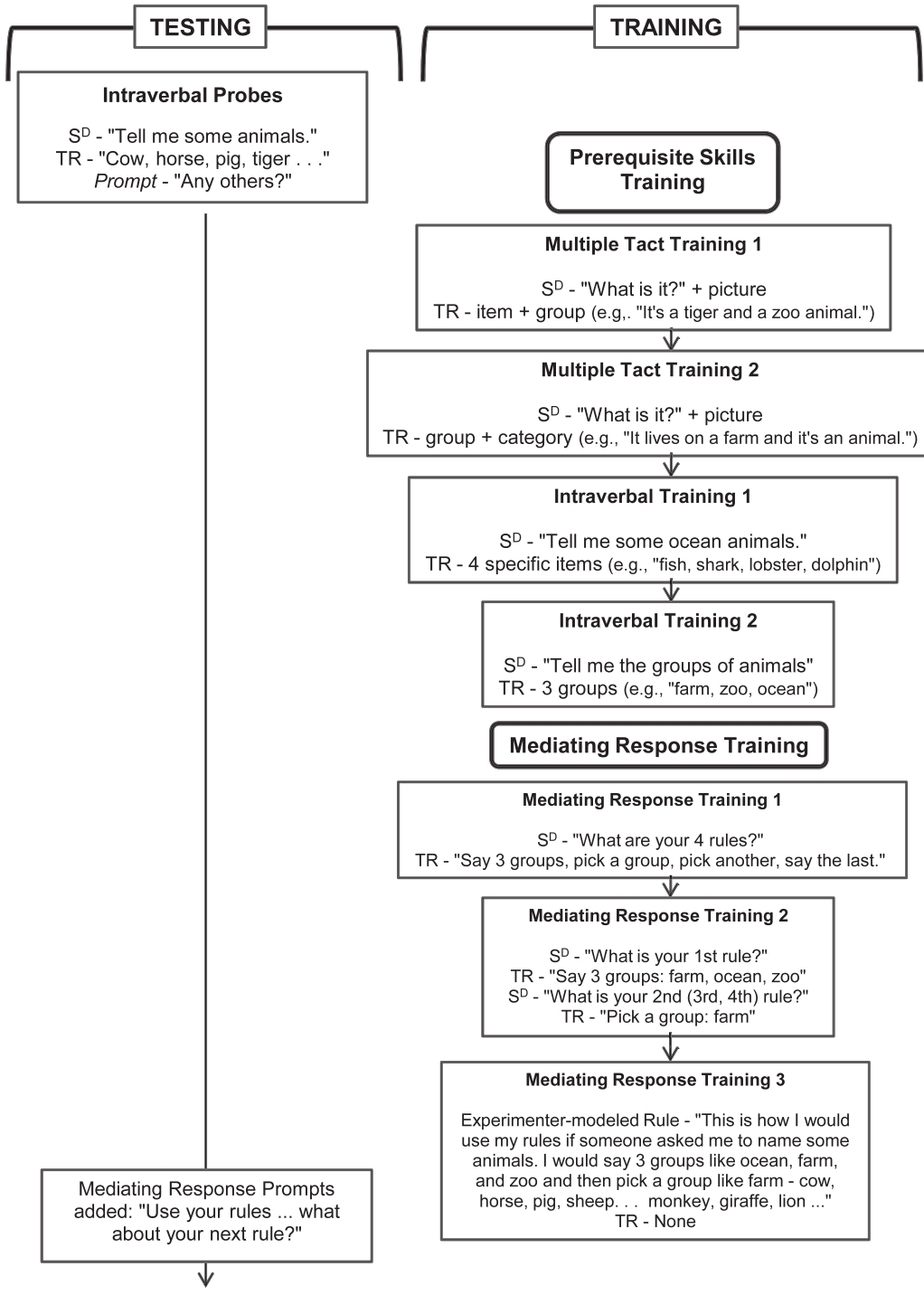

Figure 2. Temporal progression of intraverbal probes and training phrases with specification of discriminative stimuli and training targets for each training phase. S^D = discriminative stimulus; TR = target response.

trials). Stage 2 of IVT required the participant to name all of the subcategories for a category (but not the items belonging to the category) in response to "tell me the groups of [category name]." A correct response set included all three group names (e.g., farm, zoo, and ocean when asked about the groups for animals). The order of training was randomized by drawing numbers, and sets were trained successively to mastery (i.e., the participant said the complete response set for two consecutive trials).

Mediating-response training (MRT). The mediating response was a problem-solving strategy that consisted of a series of intraverbal self-prompts for group membership (i.e., farm, zoo, ocean) in response to the intraverbal probe request about the main categories ("tell me some animals"). That is, the children learned to use the group names to prompt previously trained intraverbal chains of items belonging to the target category. At the beginning of this phase, the experimenter explained that the participant would learn rules that could be used when asked a category question. This explanation was provided only once. In Stage 1 of MRT, the children learned to say four rule statements: "say the three groups," "pick a group," "pick a different group," and "say the last group" as a response chain in response to the question, "What are your four rules?" In Stage 2, the participants learned to apply each rule to the target category by stating the rule and then responding to their own statements. During this stage of training, the experimenter asked, "What is your first rule?" The target response consisted of first stating the rule ("say the three groups") and then listing the groups (e.g., "farm, ocean, zoo"). For the second, third, and fourth rules, correct responses had to include the rule statement (e.g., "pick a group"), the name of a group, and the names of the four relevant items. All four rules were trained in isolation until 100% correct independent responding occurred on two consecutive trials.

We implemented Stage 3 of MRT only if responding during the intraverbal probe after the first two phases of MRT (post-MRT on the figures) remained poor, which happened with every participant for every target. During this training stage, the experimenter modeled the entire correct response to the intraverbal probe question only once, with no response required of the participant. The experimenter stated, "This is how I would use my rules if someone said 'tell me some —,'" followed by a demonstration of the complete use of the strategy for the targeted category. The intraverbal probes continued periodically (i.e., about every third training session) throughout the entire MRT phase. If acquisition of the mediating response was rapid, there was only one intraverbal probe that occurred immediately following mastery of the first two stages of MRT. If training progressed more slowly, we conducted multiple probes including the probe that immediately followed the first two stages of MRT.

Mediating-response prompting (MRP). If the participant failed to provide a complete response set independently during intraverbal probes after all three phases of MRT, we used two types of prompts during the intraverbal probes to occasion correct responding (see Figure 2). Rule-use prompts were instructions to use the mediating response (e.g., "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 s, or if items from an entire group were neglected (e.g., farm and zoo but no ocean animals named). Tact prompts (i.e., pictures) were used when the participant provided many of the target responses from all three categories but omitted a few individual items (i.e., if the number of independent correct intraverbals was 11 of 12, the remaining response was prompted using a picture prompt). During this phase, sessions tended to be shorter (i.e., closer to 10 min rather than 15 min) because the

children responded to the three questions quickly and effectively, followed by selecting a prize from the bin.

Design

We used a concurrent multiple baseline design across categories to evaluate the effects of PST, MRT, and MRP on intraverbal categorization responses during intraverbal probe sessions. For the first three participants (John, Jessica, and Christopher), three categories were assessed and two were directly targeted while the third served as a constant series control. All three categories were targeted for Alexa.

For each targeted category, PST, MRT, and MRP phases were conducted successively. The general rule was to proceed from one phase to the next when all training for the current phase had been completed, and less than 50% (six of 12) of the target intraverbal responses occurred during the subsequent intraverbal probe. However, an exception occurred (in error) at the end of John's PST phase, when the MRT phase was initiated despite nine of the 12 intraverbal responses occurring in the second intraverbal probe. We followed the phase-change rule in all other instances.

RESULTS

Primary Dependent Variable: Intraverbal Probes

Figures 3 through 9 depict data from intraverbal probes only; training data are not depicted but are summarized in the text and are available from the second author. Figure 3 depicts John's independent correct responses to the intraverbal probes for vehicles (top), kitchen items (middle), and the constant series control category, animals (bottom). John provided no target intraverbal responses for vehicles during baseline probes, but began to name a few items during PST. His performance was variable during MRT, with a range of one to seven correct responses. An intraverbal probe immediately followed Stage 3 MRT and appears as the first data point in the next phase (the same is true for all other participants). After the experimenter modeled use of the mediating response and prompted John to "use the rules," his performance increased substantially and remained high ($M = 10.7$). As many as three rule-use prompts for the mediating response were required for initial probes but not for later probes. Few tact prompts were required during the MRP phase. The frequency of tact prompts is not shown in the graph but can be derived by subtracting the number of correct responses from 12 for any probe.

A similar pattern was observed for John's second category (kitchen items; Figure 3, middle) with low and stable ($M = 1.6$) baseline responding and variable responding during PST that deteriorated during MRT (Intraverbal Probes 17 and 18). Modeling and rule-use prompts resulted in an immediate increase in correct responding ($M = 10.9$) with a systematic decrease in the number of prompts for the mediating response. Responding in the control category remained lower than for the targeted categories (Figure 3, bottom). Nevertheless, a slight upward trend occurred, but responding never reached the level of the trained categories.

Figure 4 depicts Jessica's performance during the intraverbal probes for kitchen items (top), vehicles (middle), and the constant series control category, animals (bottom panel). She emitted very few correct responses during baseline with little or no increases during PST and MRT. After the experimenter modeled use of the problem-solving strategy and prompted, "use the rules," immediate mastery was attained (kitchen, $M = 11.8$; vehicles, $M = 11.9$). Periodic rule-use prompts were provided, although none were required for either category by the end of intervention. Responding in the control category was low and variable and never occurred at a level commensurate with the trained categories.

Figure 5 depicts Christopher's responses during the intraverbal probes for animals (top), vehicles (middle) and the constant series control, kitchen items (bottom). Baseline re-

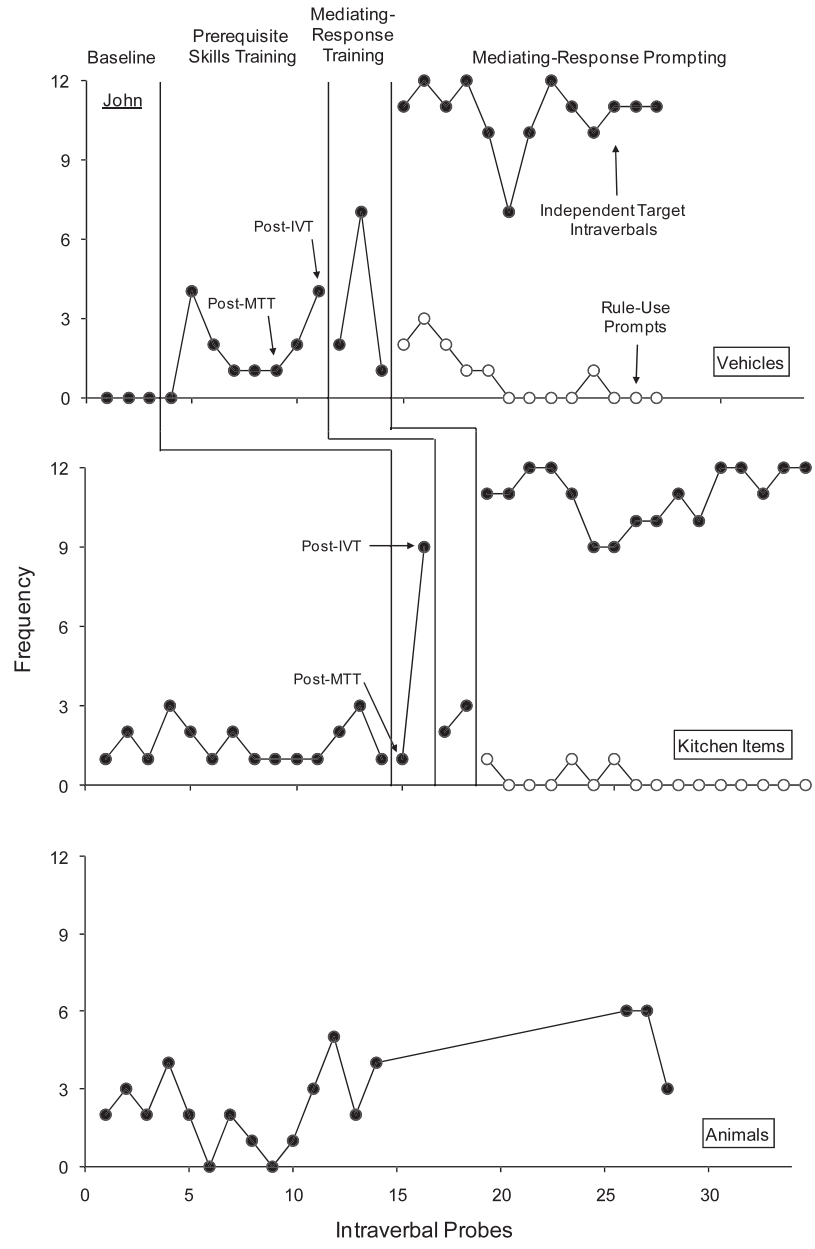

Figure 3. Correct target responses (filled circles) and number of experimenter prompts to use the rules (open circles) during intraverbal probes across categories for John. MTT = multiple-tact training; IVT = intraverbal training; MRT = mediating-response training.

sponding was low and stable (animals, M = 0.6; vehicles, M = 1.9) and remained low during PST and MRT. After the experimenter modeled the mediating response and prompted its use, correct responding immediately increased (animals, M = 11; vehicles, M = 10.8). Few rule-use prompts to use the mediating response were required for either category. Responding in the control category remained consistently low and stable throughout.

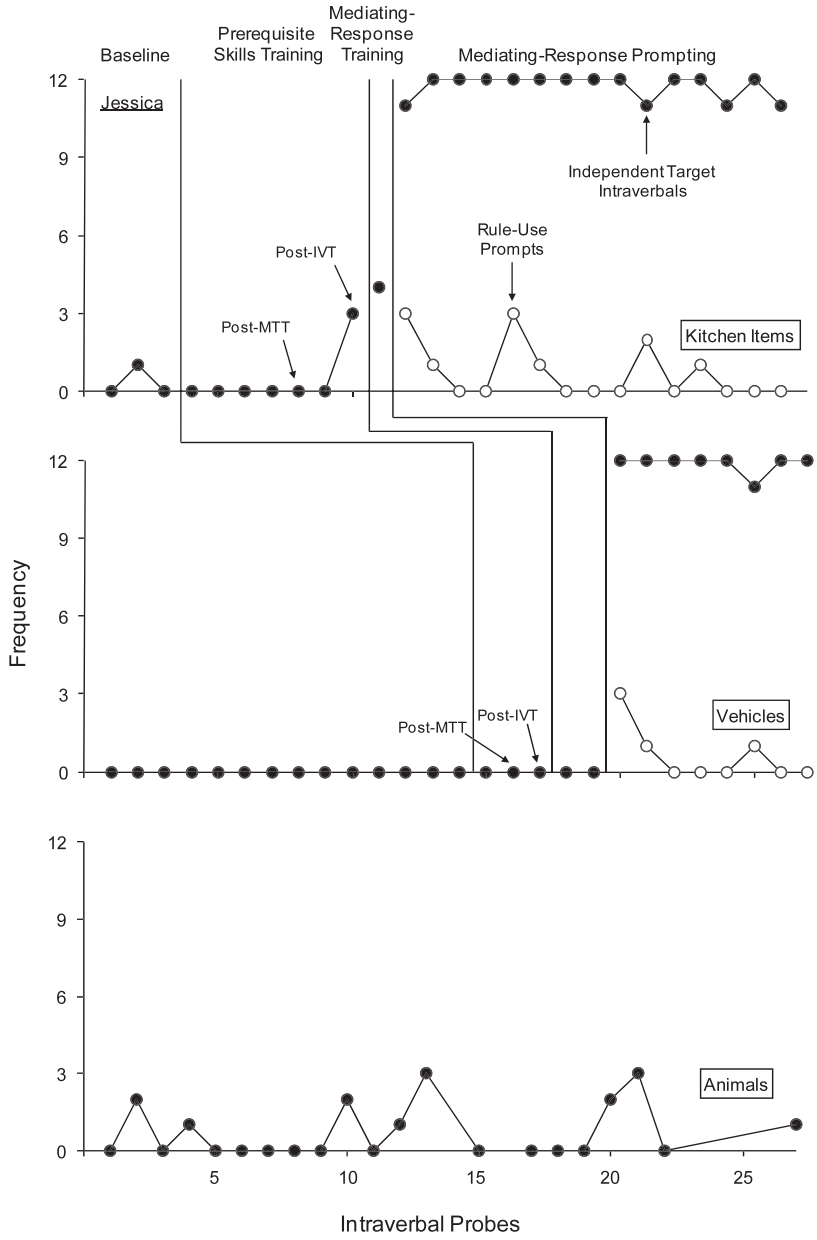

Figure 4. Correct target responses (filled circles) and number of experimenter prompts to use the rules (open circles) during intraverbal probes across categories for Jessica. See Figure 3 for definitions.

Figure 6 depicts Alexa's performance on the intraverbal probes for vehicles (top), animals (middle), and kitchen items (bottom), all of which were directly targeted during intervention. Alexa did not provide any of the target responses for vehicles during baseline, PST, or MRT, but immediately provided all target responses after the model with minimal prompting required. Her responses were low and stable during baseline for animals (M = 1.3) and kitchen (M = 1.1), with little to no increase following PST or MRT for either

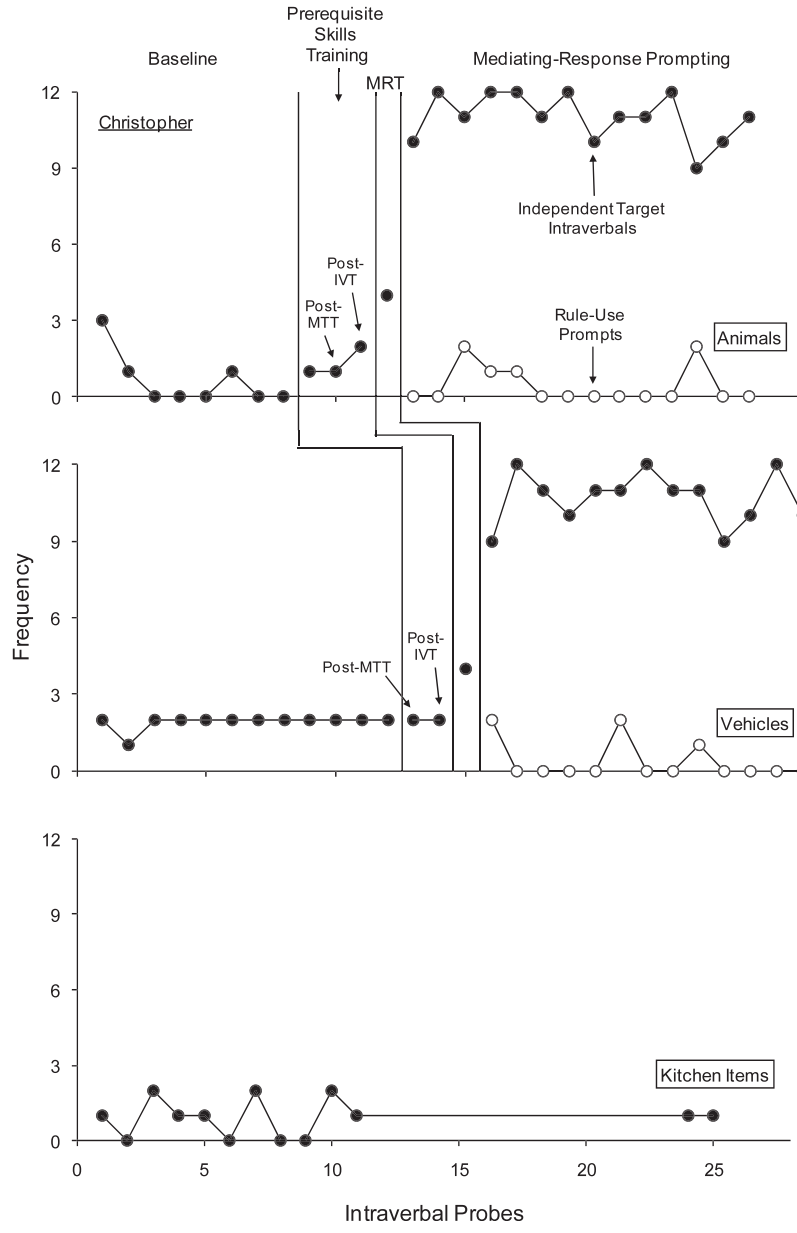

Figure 5. Correct target responses (filled circles) and number of experimenter prompts to use the rules (open circles) during intraverbal probes across categories for Christopher. See Figure 3 for definitions.

category. For the animals category, the model and a single prompt resulted in high and consistent responding (M = 11.8). For the third category (kitchen items), Phases 1 and 2 of MRT were not conducted to determine if Phase 3 (i.e., model the mediating response once) in isolation would produce effective responding after a history of successful full MRT training with the prior two categories. If the Phase 3 MRT had not been successful, full MRT would have been implemented. Stage 3 MRT training and rule-use prompts during early probes produced high and stable rates (M = 11.7) of the target intraverbals without the first two phases of MRT.

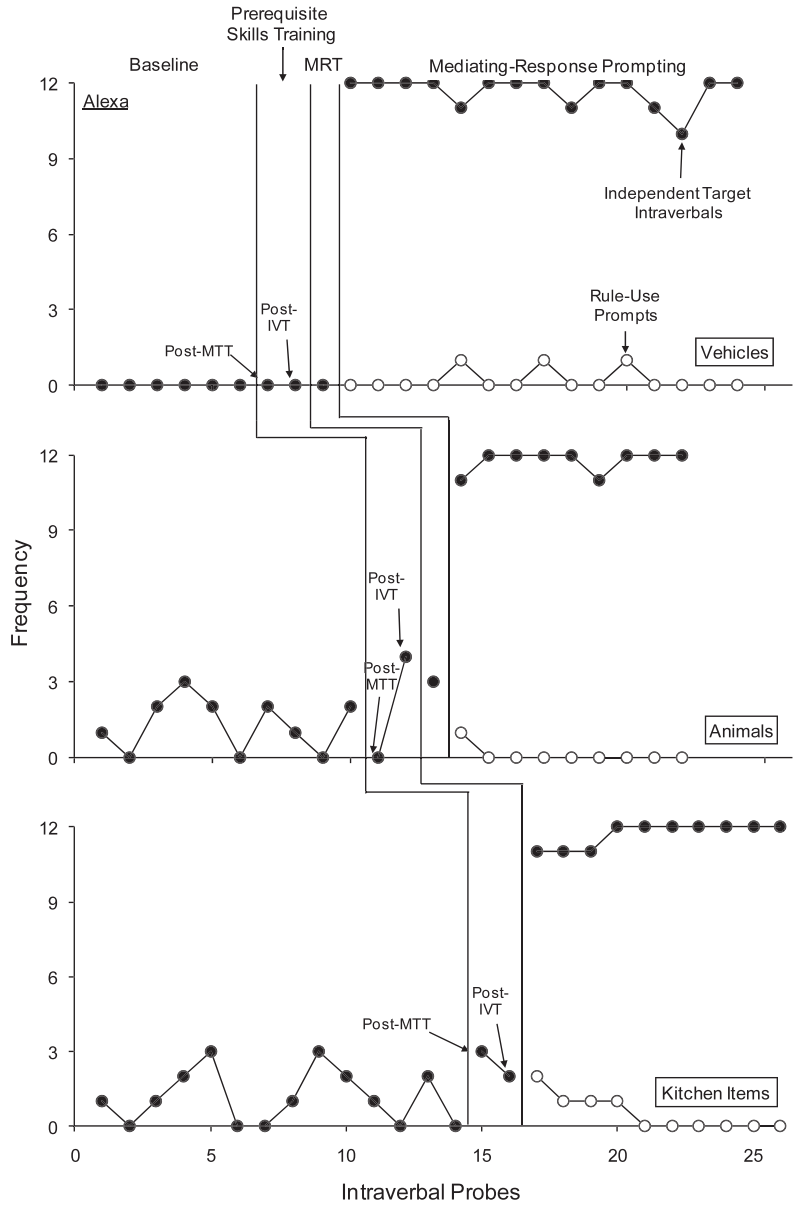

Figure 6. Correct target responses (filled circles) and number of experimenter prompts to use the rules (open circles) during intraverbal probes across categories for Alexa. See Figure 3 for definitions.

Alexa required the fewest rule-use prompts of any participant across all categories.

Secondary Dependent Variables: Self-Prompts and Within-Session Response Patterns

Figures 7, 8, and 9 depict the results for the secondary dependent variables during the final phase (i.e., MRP) for each trained category for each participant. Figure 7 shows the number of times each child emitted a self-prompt consistent with the mediating response (e.g., "air: airplane, balloon," "pick a group") for each intraverbal probe. Self-prompts for the mediating response were audible at some point for every participant.

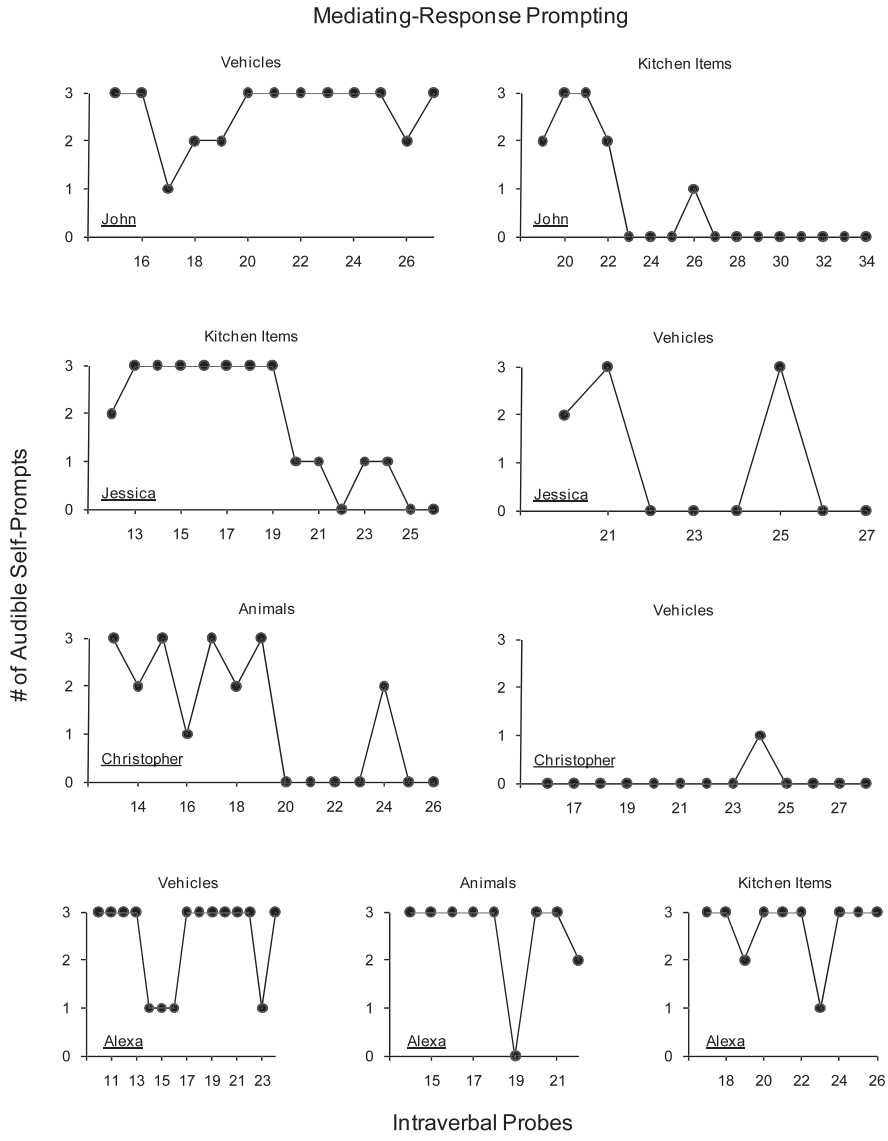

Figure 7. Number of audible self-prompts during MRP phases for each target category across participants.

Audible self-prompts occurred for almost every probe during the first category for each participant and decreased during the second category for three of the four participants. Alexa continued to self-prompt overtly throughout all three categories. As audible self-prompts decreased for three participants, the frequency of correct intraverbals (Figures 3 through 6) remained high, suggesting that the meditating response was still being used covertly rather than overtly.

The observers recorded correct intraverbals verbatim, allowing an analysis of the temporal order of responses and their group membership for each intraverbal probe. In Figures 8 and 9, each bar represents correct intraverbal responses emitted in intraverbal probes during the MRP phase. The order of correct answers is depicted vertically, such that the earliest correct response in a given intraverbal probe constitutes the bottom box of each bar, and the last correct

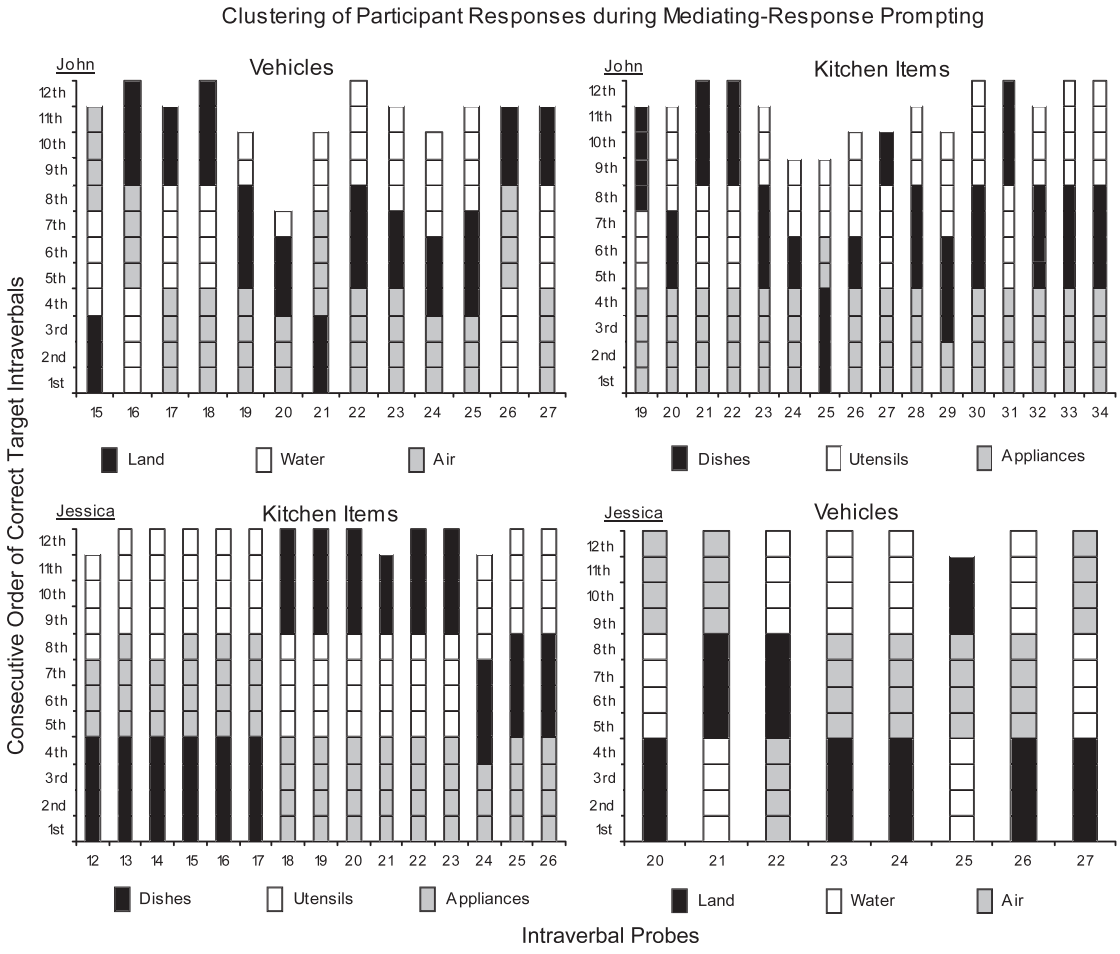

Figure 8. Within-session response patterns depicting the order (from first to 12th) and group membership of correct target intraverbals during MRP phases for each target category for John (top) and Jessica (bottom).

response in each intraverbal probe constitutes the top box of each bar. Each box is shaded in accordance with the group to which the item belonged. Responding consistent with use of the mediating response (i.e., "pick a group and say the items," "pick another group") appears as a series of responses from the same group followed by a series from another group (i.e., clustered responding).

John's data (Figure 8, top) indicate clustered responding consistent with use of the mediating response for both targeted categories. For example, during the 15th intraverbal probe for the first category (vehicles), the first three responses were land vehicles, the next four responses were water vehicles, and the final four responses were air vehicles. Such clustering occurred in every intraverbal probe for both target categories. For the first category, each group occurred as the initial cluster of responses at least once. That is, responding was orderly and consistent with use of the mediating response but was flexible with respect to order of the groupings across intraverbal probes (e.g., Probe 15: land, water, air; Probe 16: water, air, land; Probe 17: air, water, land). For the second category (right panel), appliances was typically the first group emitted but was sometimes followed by dishes and other times by utensils. The responses for Jessica (Figure 8, bottom),

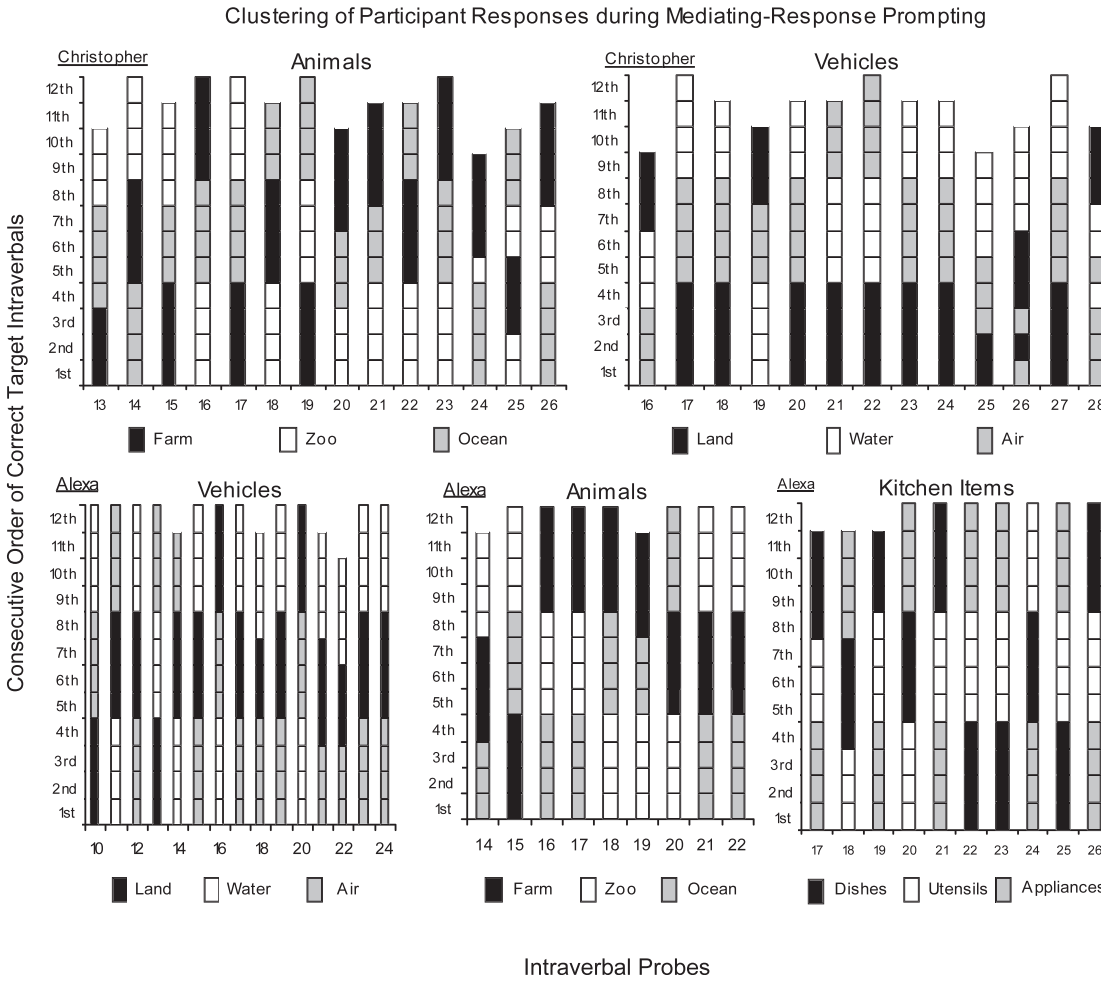

Figure 9. Within-session response patterns depicting the order (from first to 12th) and group membership of correct target intraverbals during MRP phases for each target category for Christopher (top) and Alexa (bottom).

Christopher (Figure 9, top), and Alexa (Figure 9, bottom) were also clustered for each targeted category, consistent with use of the mediating response. Each of these participants started with at least two of the groups across intraverbal probes for a category (e.g., Jessica, Probe 12: dishes, appliances, utensils; Probe 18: appliances, utensils, and dishes). In addition, each participant's response patterns were flexible with respect to the order of named items within the groups. For example, Christopher responded on Probe 13 for the zoo animals with "monkey, lion, tiger, giraffe" but on Probe 14 for the zoo animals with "tiger, lion, giraffe, monkey" (data for all intraverbal probes are available from the corresponding author).

DISCUSSION

This study provides an initial investigation of the role of problem solving in the acquisition of intraverbal categorization skills with typically developing preschool children. Previous studies have relied on direct transfer-of-stimulus-control procedures to establish categorical responses as intraverbal chains (Braam & Poling, 1983; Goldsmith et al., 2007; Luciano, 1986; Miguel et al., 2005; Partington & Bailey, 1993;

Watkins et al., 1989). As an alternative to these procedures, we successfully taught preschoolers to emit a large number of responses by using a problem-solving strategy to prompt and probe their own behavior. We never directly trained the target intraverbal relations (e.g., ''What are some animals?'' ''horse, pig, sheep'').

The rule-use prompts presented throughout the final phase (MRP) met Skinner's (1957) definition of thematic prompts because they did not directly prompt use of the strategy (e.g., ''name the groups'') nor did they directly prompt the intraverbal target responses (e.g., ''fork''). Rather, these thematic prompts effectively evoked participants' prompting and probing of their own behavior to emit correct and complete response sets based on their prior tact and intraverbal training. For example, the prompt ''use the rules'' often evoked the group names, ''land, water, and air,'' which then evoked the related target responses. The secondary analyses in Figures 8 and 9 indicate that the thematic rule-use prompts resulted in flexible yet orderly response patterns due to overt or covert application of the problem-solving strategy.

During the MRP phase, the participants did not emit rote intraverbal chains. Rather, response clusters (i.e., groups) occurred in varying order, and the order of responses within response clusters also varied. For three participants, the audible self-prompts occurred initially and later ceased, perhaps becoming covert. As audible self-prompts ceased, the number of correct responses remained high and the order of responses continued to cluster in a pattern indicative of use of the mediating response. As with any study of private events, we cannot be certain that participants emitted the mediating response covertly. However, the fact that correct responses remained high and response clusters remained consistent with rule use after audible self-prompts decreased suggests that participants may have been emitting the mediating response covertly.

Although all participants acquired the mediating response, none showed generalized use with other categories. Alexa once asked ''Can I use my rules?'' (the experimenter responded, ''if you like''), but she subsequently failed to use the strategy until the experimenter modeled its use. The other three participants never mentioned the rules and never used them without a model and at least a few rule-use prompts. The failure to develop a generalized problem-solving repertoire after only one targeted category may not be surprising with this population. However, Alexa was able to use the strategy with a third category (kitchen items) after a single model and without any prior practice for that category. This suggests that training of multiple exemplars (in this case, vehicles and animals) might have facilitated use of the problem-solving strategy. Future research should evaluate this possibility further. The absence of generalized responding across categories might also be attributable to the lack of reinforcement for correct responding during the intraverbal probes.

Skinner (1953) suggested that behavior that allows a person to solve a problem might potentially be maintained by automatic reinforcement. Although there was no direct reinforcement for strategy application or the resulting correct responses, all participants performed well during the MRP phase and required fewer rule-use prompts with each successive category that was targeted. The participant's success in responding to the prompts with the first category may have been automatically reinforcing because the strategy allowed him or her to solve the problems. Thus, the likelihood of using a beneficial strategy might have been increased for subsequent intraverbal probes. Anecdotal support for the reinforcing value of strategy use was evident in Alexa's statements that she liked using the rules to help her answer the questions.

The present findings have an important implication for language training. When de-

signing programs for teaching intraverbals (see Sundberg & Partington, 1998), the clinician should consider whether the learner's response should be solely under intraverbal stimulus control or require problem-solving responses as well. For example, the questions "What's your name?" or "Where do you live?" have a limited number of optimal responses that could all be targeted through direct intraverbal training. On the other hand, questions such as "Can you name some animals?" or "What did you do this weekend?" could and should result in a multitude of varied responses. Answering these questions flexibly and competently requires more than simple intraverbal stimulus control. Incorporating problem-solving strategies as part of instruction seems a viable option for these kinds of relations. However, our procedures involved complex rule statements and would be appropriate only for children who demonstrate rule-governed behavior and advanced speaker and listener repertoires. For children with severe delays, typical transfer-of-control procedures may still be the intervention of choice for teaching a small number of categorization responses (Goldsmith et al., 2007).

The categorization task described in this study appears to be a useful procedure for providing an initial behavioral analysis of complex and covert behavior such as problem solving. Problem solving is a topic ripe for future behavior-analytic research, not only because of the applied implications described above but also because it intersects with important areas of psychological investigation, such as remembering. Donahoe and Palmer (2004) described memory as problem solving, which takes the form of creating supplementary stimuli to augment the immediate context in a way that increases the probability of the target response. These supplementary stimuli might consist of visual imagining or intraverbal prompts as mnemonic procedures. For example, in a subsequent follow-up study, we taught visual imagining skills to young children (see Kisamore, Carr, & LeBlanc, 2011). Research is needed to determine the prerequisite repertoires for successful acquisition and use of these types of problem-solving strategies. Although it seems reasonable that rule-governed behavior and advanced speaker and listener repertoires are required for the intraverbal-based mediating response that we targeted, this suggestion should be experimentally evaluated.

Researchers should also investigate whether procedural changes could facilitate generalized use of the mediating response. The current procedure targeted the strategy of organization to accentuate relations among elements (e.g., grouping animals that live in the ocean), followed by presentation of a group name to facilitate responding (Donahoe & Palmer, 2004), but the organizational framework was provided by the experimenter (e.g., basing the organization on where animals live rather than topographical features such as tails, stripes, or ears). Alternatively, the participants themselves could be allowed to organize information into groups of their own creation (e.g., stuff that goes in a drawer; stuff you use to eat your food; yellow stuff in a kitchen) rather than providing the groups based on the teacher's organization and terminology (e.g., utensils). Our participants might not have been able to use the strategy for novel categories because they did not know how to group the information for the untrained categories. However, generating their own groupings based on personally salient and familiar features (e.g., "the ones in the refrigerator," "the ones I use to eat") might further facilitate acquisition and generalization. In addition, future research might examine whether simply increasing the number of prompts might be sufficient to increase responding. In the later phases of the current experiment, the experimenter prompted rule use (if needed) and also said "any more?" if the participant stopped responding without emitting all target responses. In earlier phases, the only prompt was "any more?" Thus, the number of experimenter

prompts varied across phases and might have accounted for increases in responding. Future studies might hold the number of prompts constant across phases. Finally, behavior analysts should begin to investigate the utility of other problem-solving strategies to establish various types of complex responding. Strategies such as visual imagining or observing the nearby environment for potential response options have been touted as potentially beneficial strategies (V. Carbone, personal communication, August 29, 2004; Palmer, 1991).

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