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A Framework for Establishing and Testing Problem-Solving Skills in Young Children Diagnosed with ASD

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by

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Abstract

Children diagnosed with ASD may have difficulties responding to novel situations and with problem solving. Current problem solving literature does not address concerns related to generalization of repertoires to novel tasks and does not account for further training should a problem solving strategy result in failure. This study focused on developing problem solving repertoires to account for these limitations. Three children diagnosed with ASD were trained in multiple problem solving strategies (visual scanning, visual imagining, and manding for help) in a multiple probes design. After training, the participants were probed in conditions where the strategy trained failed to produce the necessary responses. The results indicated that two of the three participants were successful with using multiple trained strategies to meet the response requirement. None of the three participants were able to successfully use visual imagining. Future research is needed on developing pre-requisite skills for visual imagining and developing problem solving repertoires.

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It is to these colleagues I dedicate this thesis. Ashley and Jess, I am constantly inspired by the both of you and hope our dedicated partnership can continue many years into the future to help all children reach their fullest potential.

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Chapter I: Introduction and Literature Review

A challenge in defining ‘problem solving’ and its related words (e.g., solution) is that the common use of the term lacks a precise definition, potentially leading to multiple meanings. For example, a person may say that a solution is a response (i.e., behavior) or an outcome of a response (i.e., behavioral product). How the word is used in a sentence might clarify the particular meaning but independent of context the definition is perhaps too broad to be of use in scientific discourse. The problem of a locked door will serve as a case illustration. When presented with a locked door and a missing key, a person may say ‘solution’ to mean opening a drawer to find the key (response), or the outcome of the response; the physical key in the opened drawer (behavioral product). Additionally, a person might say the solution is to unlock the door (response) or even open it (the opened door as a behavioral product). The example refers to aspects of a larger series of related responses and events resulting in the elimination of a problem. Therefore, ‘problem solving’ (verb) or ‘problem-solving’ (noun) may be used to mean a response (or set of responses) or the whole process, respectively.

Behavioral Definition

In a behavioral interpretation, a problem occurs when access to the final outcome requires a change in the environment, or as Palmer (1991) defined it, the need for supplementary controlling variables. A problem exists if no strong response is available. A *strong response* is a term used by Skinner (1953) to indicate the response that arrives at the final outcome. In our locked door example, unlocking the door is the strong response. The solution, in a behavioral definition, refers to a response, and not an outcome. A solution refers to a change in the environment that permits the strong response needed to solve the problem. In the case of the missing key, the solution is opening the drawer (as that behavior provides access to the key, which once obtained eliminates the problem; i.e., permits the strong response). The response that arrives at the supplementary controlling variables that permits access to that outcome is problem solving and is “defined as any behavior which, through the manipulation of variables, makes the appearance of a solution more probable” (Skinner, 1953, p. 247).

With the terms in problem solving clarified, we can turn now to analyzing the sources of control for each of the responses. To segue to these analyses, we can look at Palmer (1991) as providing an outline of responses:

> “1) A target response (or set of responses) is part of the organism’s repertoire under one or more stimulus conditions. 2) Discriminative stimuli are present indicating that the response is scheduled for reinforcement. 3) The response is not under direct control of current discriminative stimuli.” (p. 271).

In essence, Palmer is saying that you can produce the response, the response would be reinforced if produced now, but you are either unable to produce that response at this time or that you do not know which response in your repertoire you should produce (for further reading, see also Donahue & Palmer, 2004). Let us look at each element in exemplar fashion.

To Palmer’s (1991) first response discussed, for a solvable problem the strong response is part of the organism’s repertoire. If a person never used a key, unlocking a door would not be immediately solvable. For Palmer’s second and third points, the details depend on the specific problem. For instance, it is possible that the discriminative stimulus that is present indicates the availability of reinforcement for more than one response class, but the current environment does not control a specific response class in the organism’s repertoire. For example, a locked door indicates that a previously successful response will not contact reinforcement. An unavailable response, although an imprecise term, indicates that the current environment does not directly occasion a response in the organism's repertoire that meets criteria for reinforcement. In other words, points 2 and 3 can be reinterpreted as "solving this problem would produce reinforcement, but I either don't know how to remove the problem or I am unable to produce the response that typically removes the problem."

Motivating Operations in Problem Solving

Skinner (1953) concluded that all problem solving is correlated with some deprivation or aversive stimulation. Later termed motivating operations (see, e.g., Laraway, Syncerski, Michael, & Poling, 2003), these stimuli or events increase (or decrease) the effectiveness of a particular consequence correlated with an aspect of removing a problem. There are at least three motivating operations (MOs) correlated with problem solving: 1) The final outcome is reinforcing due to either deprivation or aversive stimulation, 2) Access to the final outcome is unavailable, and 3) There are multiple competing responses that might alter the environment to produce the appropriate S^D.

The final outcome is reinforcing due to either deprivation or aversive stimulation. The potential examples of the first MO are numerous but are simply the motivation to problem solve in the first place—a person is want for an answer to a question, getting inside a house escapes aversive stimulation, etc. In this sense, the first MO is a reflexive conditioned motivating operation (i.e., CMO-R) that signals a worsening of conditions because the outcome is not achievable. Thus, it establishes any response that removes the CMO-R as being reinforcing.

Access to the final outcome is unavailable. In this second concern, the unavailability of the final outcome is a transitive conditioned motivating operation (i.e., CMO-T) as it establishes one or more available responses as being reinforcing. The responses (e.g., problem solving) are always available, but only when the outcome is unavailable (i.e., the response is blocked) do we produce them.

There are multiple competing responses that might alter the environment to produce the appropriate S^D. Up to now, the elements of problem solving listed are in line with Palmer's (1991) definition. With Palmer's example of a math problem, the response (giving an answer to the equation) is unknown. Palmer explains that the individual then engages in a series of problem solving responses until a response is deemed correct, and problem solving ceases. In his example, the solution is in the repertoire (the correct number), but the stimulus (the math problem) does not directly control the characteristic response. Instead, the math problem occasions precurrent behavior (e.g., using a mathematical formula) until the solution is produced, at which time problem solving concludes. Palmer's formulation is at odds with Skinner's, in that Skinner argued that when the stimulus (the math problem) directly controlled one problem solving strategy (one particular mathematical formula), that problem solving was not taking place. Specifically, a stimulus seems like a problem, but the precurrent behavior is guaranteed to produce the strong response. As Skinner (1975) said about mathematical problems, "It is not quite correct, then, to say that no effective response is available. A *solution* is not available, but if the problem is soluble, a response which will produce the solution is" (pp. 132-133).

When only the response to access the final outcome is unavailable (but the precurrent behavior is available), it might be more appropriate to define it as a temporary obstacle. For example, if the locked door occasions the person to look in a pocket, as s/he typically does for this door when locked, then it ceases to be a problem even before the key is retrieved. Even if responses are laborious or challenging, it is not problem solving. With the example of finding the square root of a large number, a person might complete several steps before finding the answer, but if the person recently completed the task or does so frequently, the precurrent behavior makes it so obtaining the strong response is essentially 100%, and therefore decreases the likelihood it is problem solving.

When speaking of problem solving, then, the unavailability of a response that appropriately changes the environment (precurrent behavior) is represented by a third MO; a CMO-R in which the lack of a single response is aversive and can be removed by engaging in problem-solving. Thus the unavailability of the outcome is a CMO-T that encourages a response that eliminates the problem, but the lack of a characteristic response produces a CMO-R which, once satisfied can eliminate both the CMO-R and the CMO-T. Said differently, the first CMO-R and the CMO-T are shared by both problems and non-problems, but it is the final CMO-R that distinguishes a problem from a non-problem.

Palmer (1991) listed some methods to alter the environment and generate supplementary variables: (a) one might directly manipulate the physical environment, (b) use an item that historically generates those variables (e.g., a map), or (c) alter her or his own behavior. The contexts of problems are so numerous, it would be an exhaustive task to categorize all precurrent behavior. Skinner (1968) provided categorization in problem solving by grouping types of problems. He stated that a problem includes when one is figuring out how to respond but also whether to respond or deciding between two actions. In the same text Skinner also reviews the distinction between contingency-based and verbally mediated responses and states the importance of verbally-mediated behavior in problem solving. The present review will look at three studies that do use verbally mediated behavior to generate supplementary variables but the details of studies will focus less that component and more on the controlling variables of precurrent behavior.

Behavior Analysis and Problem Solving

In behavior-analytic literature on problem solving, the focus tends to be on generating a solution for a problem. Sautter, LeBlanc, Jay, Goldsmith, and Carr (2011) conducted a study with typically developing preschoolers to target interverbal responding. The participants of the study were taught rules as self-prompts to promote responding. The target response was to name items in specific categories (e.g. animals, kitchen items). For instance, when presented with a picture of a tiger, the correct response would be, "It's a tiger and it's a zoo animal." A second response targeted was to name items in a specific category. For instance, the participant would be told to identify several zoo or ocean animals. The participant was asked to say the rules the researchers taught: 1. "Say three groups", 2. "Pick a group", 3. "Pick a different group", and 4. "Say the last group." A correct response included stating the rule, the name of the group, and the items in the group. A prompt of "What are your rules?" was given if the participant needed it.

All the participants were successful in using these rules to categorize items. However, the participants were not as successful when presented with a new category. If the solution works without fail for the particular problem, the organism doesn't have a problem and therefore does not need to problem solve. The organism is simply engaging in a response occasioned by a discriminative stimulus. Thus, one way to interpret Sautter et al. (2011) is to conceive of the study as one in which they taught a response to the prompt "What are your rules?" As the goal was for precurrent behavior guaranteeing the strong response, no problem, and thus no problem-solving, occurred. One way to alter this study would be to add a condition where the statement of the rules does not result in the correct response. For instance, a participant may be asked to name some insects. The participant is prompted to use their rules by naming the categories of animals they have been previously taught, such as ocean animals, zoo animals, and farm animals. These three categories do not provide an answer to the initial question of naming insects and the problem-solving strategy they have been taught results in failure.

In a replication of Sautter et al. (2011), Kissamore, Carr, and LeBlanc (2011) taught preschool children how to problem solve by using visual imagining. They targeted this visual imagining by presenting an image using projection of a scene in which one would find the items (e.g. a farm). The experimenter listed each item while they appeared on the screen for the participant. The participant imitated the response by looking at the scene, closing his/her eyes, and labeling each item in the scene. Following this training, the experimenter asked the participant to name items in a category. If the participant did not respond within 10 seconds, the experimenter would prompt "Remember you can imagine…" and stated a scene. Additionally, a condition was conducted in which the participant was told, "Can you tell me what you can do if someone asks you to name a bunch of different animals?" prior to asking them to name items in a category.

The study by Kissamore, Carr, and Leblanc (2011) presented limitations in generalization. When presented with a novel category the participants could not name objects from that category. Without knowing the scene or place a category of objects go, it is difficult to visually imagine that scene to aid in listing those objects. The researchers taught a specific precurrent response (visual imagining) for a specific strong response (naming items) that only produced success for the specific problem (the question to name some items in a category). Once this strategy was trained, the problem was no longer present and problem solving no longer occurred; in other words, responding became rote.

Kissamore et al. (2011) and Sautter et al. (2011) made worthwhile contributions to the literature on teaching children item categorization strategies but these strategies may be incorrectly called problem solving. Participants in both studies were nearly guaranteed success with the strategies they were taught for the categories they knew. The participants were not given the opportunity to try other methods when met with failure, and when they eventually did fail in the generalization phases of their respective studies, they no longer knew how to solve the problem. It may be necessary to teach a problem solving repertoire that accounts for these failures and ensures the solving of a problem.

In behavior analysis, teaching children with autism how to mand for information may fit into a behavioral interpretation of problem solving. In one study, authors Ingvarsson and Hollobaugh (2010) taught children with autism to mand for answers to questions. By learning how to mand for the relevant information to answer a target question, the children were able to answer novel questions in generalization probes. The authors of this study did not distinguish this strategy as problem solving. However, it may be that this method is in line with a behavior analytic interpretation of it. Manding for answers may be considered a precurrent response to the strong response of answering the question; manding may become more likely due to the establishing operation being that access to the answer is unavailable. In other words, the student does not know the answer (establishing operation) and asks the researcher for the answer (precurrent response) to give the correct answer to the target question (strong response) thus solving the problem. In these terms, Ingvarsson's and Hollobaugh's (2010) study may be an opportunity for further investigation into problem solving via asking questions.

The proposed study will attempt to address this issue by adding failure conditions after teaching problem solving strategies.

Chapter II: Method

Participants and Setting

The study took place at a day treatment clinic for children diagnosed with autism. Participants were three children diagnosed with autism spectrum disorder (ASD). Participant one (P1) was a five-year-old boy who attended the clinic for more than two years. He was vocal-verbal and had worked previously on increasing his verbal repertoire while at the clinic. Participant two (P2) was a six-year-old boy who attended the clinic for a year and a half. Like P1, he was vocal-verbal and at the clinic worked on verbal milestones but had moderate delays in these areas. Participant three (P3) was a five-year-old girl who attended the clinic for two years. She was also vocal-verbal and had both a wide verbal repertoire and complex communication skills. Each participant attended the clinic full time for up to 40 hours per week.

Sessions were conducted one-on-one with one of five research assistants (RAs) in a 7’7’’ x 7’7’’ observation room. RAs were employees of the clinic for a minimum of one year.

Research Assistant Training

Research assistants were sequentially trained on room arrangements, procedures, and data collection. The graduate student provided procedure sheets for each research assistant. The graduate assistant were also shown visuals for room layout and role played each procedure for each research assistant. The graduate student answered questions and offered feedback throughout the training session.

Phase I: Room arrangements. Following training, each research assistant was instructed to do three room arrangements in line with the visual scanning procedures. Research assistants needed to complete the arrangements at 100% accuracy (i.e., every picture card in the correct place) before being tested on the next phase. Each arrangement was presented with the room arrangement procedures, and one arrangement was presented at a time. Failure to succeed at 100% in the first three attempts resulted in the research assistant being dismissed from the study. With success, the research assistant proceeded to procedural fidelity training. All RAs met requirements for mastery.

Phase II: Procedural fidelity and data collection. Each research assistant engaged in a role-play session with the graduate student. The research assistant asked a target question (i.e., What are 10 zoo animals?, What are 10 farm animals?, and What are 10 water animals?) and the graduate student responded by providing five correct and five incorrect answers for which the research assistant needed to correctly identify. Each research assistant needed to identify 100% of incorrect and correct answers, as evidenced by their data collection product. Failure to correctly determine correctness on 100% of trials in the first attempt resulted in the research assistant being dismissed from the study. All RAs met mastery requirements for this test with 100% accuracy and thus proceeded to conduct sessions with participants. Because all RA's met requirements in the first test they were not tested again.

Research Design and Data Collection

A multiple-probes design across participants was used for this study. The purpose of a multiple-probes design is to determine the effects of a training sequence on responding (Horner & Baer, 1978). Probes collected data on correct responses produced under test conditions, which sometimes included conditions not yet trained. Further, using the design across participants controls for possible history effects that might include center-wide teaching (e.g., teaching all clients about animals found in a zoo in a group activity).

Independent variables. The independent variables for this study was each procedure trained to each participant.

Dependent variables. The dependent variables consisted of the number of correct and incorrect responses under probe conditions, as well as what strategy was employed for each response. For visual scanning, a head-turn prior to answering indicates this strategy was used. For asking questions, the mand for information indicates this strategy was used. For visual imagining, any correct response that does not meet categorization for visual scanning or asking questions will be considered an instance of visual imagining; thus this last category was implied.

Response definitions. A correct response was any vocal response that befit the category of the target question. For instance, the answer of horse to the question "What are some farm animals?" was considered correct but an answer of tiger was considered incorrect.

Inter-observer agreement. Inter-observer agreement (IOA) was conducted on all sessions. IOA data was taken from video recordings and coded by the graduate student. IOA was determined by using exact agreement. Exact agreement was 100% for all recorded sessions.

Fidelity checks. The primary researcher was present to check fidelity for each session of the study. The primary researcher checked picture placement prior to the study's start for the visual scanning condition and the session began following this check. A video camera was set up in the corner of room for additional fidelity checks throughout the study. Fidelity was checked formatively by a researcher based on a fidelity checklist with percentage correct for each session reported. Additional training was considered if fidelity checks fell below 80%; continued performance (three or more consecutive sessions) below 80% resulted in the RA being dismissed from the study. Sessions for this study were conducted with a maximum 100% fidelity and a minimum of 90%. The primary researcher observed all sessions and was able to ensure integrity for each session conducted.

Materials

A list of sample stimuli and ten item picture cards was provided for each category. The ten cards were lettered from A to J on the back. For the visual imagining condition, ten picture cards with sequential numbers was provided. Data collection sheets were provided to each RA along with a pre-session checklist.

Procedure

Prior to the session, each RA received folders containing room set up diagrams for each condition, required materials, and data sheets for completing the session. There were three folders for each direct probe for each training strategy and three folders for the problem solving probes. Room diagrams were predetermined.

The RA conducted each session sitting side-by-side at the same table as the participant. Session rooms were devoid of any distractions including decorations and toys.

Pre-Assessment. Prior to baseline, each participant was assessed to determine the most known and least known item categories. The RA asked the participant to name items in each category from the category item list. When the participant ceased responding for 5 seconds, the trial concluded and the next category was probed. Each category was probed twice with one day separating each probe. Categories were ranked from least-known (fewest items nominated) to most-known (most items nominated).

Baseline. Each participant's six least-known category was retained; the three least known were used for problem solving probes and the next three least known were reserved for training across the three problem solving strategies. Assignment to starting condition order was randomly assigned such that each of the three conditions were put in a hat and drawn, with the first condition being assigned to the first participant and so on. Thus, P1 started with visual imagining, P2 started with manding for help, and P3 started with visual scanning.

Baseline assessments were conducted in line with probe conditions. Baseline for the first category ended when the direct probe was at 90% or greater across two probes.

Direct probes. RAs used the corresponding three direct probes folders for direct probe sessions. Participants were asked to name items from a category corresponding to each problem solving strategy. Data were recorded on number of correct responses under each strategy used. Success was defined as greater than 90% across two probe sessions. If the participant ceased responding for five seconds or greater, the probe session ended. Direct probes were conducted throughout the study for each participant before and after training a problem solving strategy. Direct probes done after training that were greater than 90% for two probe sessions resulted in a problem solving probe. After training, direct probes not at greater than 90% for two probes resulted in retraining of the strategy. Direct probes for a strategy that are failed after five consecutive days following a second training resulted in the participant moving on to the next strategy. The failed strategy was retargeted after the other strategies were done.

Problem solving probes. Problem solving probes (PSP) tested responding or a different category in one of the participant's three least known categories. RAs used the folder marked problem solving probe to conduct these sessions. Participants were asked to name items from this new category with no additional prompts. In contrast to the direct probes, problem solving strategies only produced 30% of correct responses (e.g., three pictures present in the room for visual scanning, three responses by the RA for question asking). Data were collected on the number of correct responses under each problem solving strategy with the total number of responses used to determine overall percentage correct. It was also noted on each data sheet whether the participant used the problem solving strategy listed (e.g., asked for help, looked around the room). The phase ended if the participant gave less than 30% correct responses for two consecutive probes. The participant was then cross-trained with a different problem solving strategy.

It is important to note that a different category was presented for each PSP for the participant. This was to account for possible practice effects were the participant to demonstrate any learned skills outside of the session. It was also possible for a participant to skip a target if he/she demonstrated any of the untrained problem solving strategies. This occurred for P3 only.

Visual scanning condition. Prior to the session, the session room was baited with unobscured picture cards relating to the participant's assigned category. The pictures were placed on all sides of the participant requiring the participant to physically move their head or body around to look, though without getting up from the chair. Picture cards were placed above, at, or below the participant's sightline for this same reason.

At the start of the session, the participant was instructed to sit in the chair and face the desk. The researcher sat beside the participant. The researcher gave the instruction to name items in the participant's assigned category followed immediately with the prompt, "You can look around to find some." Following this prompt, the researcher guided the participant to attend to each picture around the room by pointing to each picture and instructing the participant to tact it. If the participant did not orient to the picture within three seconds, the researcher gave a vocal prompt to look at the picture. The participant was given five seconds to respond to each tact request. If the participant did not respond after these five seconds the researcher vocally modelled the correct answer and represented the prompt requiring the participant to tact the item, and continued this cycle until the participant independently tacted the item. The researcher then moved on to the next picture card. Training concluded when all picture cards were named. Direct probe sessions followed training sessions as earlier described.

Visual imagining training condition. The procedures for this condition replicated (with variations) the procedures for the visual imagining training detailed in Kisamore et al. (2011). The RA and the participant sat side-by-side in the session room at the table with the picture of the scene (card number one). The RA guided the participant's attention to look at the scene and provided the prompt "Tell me what place this is." The participant was given five seconds to respond. If he/she gave the correct answer, the researcher provided praise and moved on to the next segment of the training. If the participant gave an incorrect response or did not respond, the RA prompted the correct response and represented the prompt "Tell me what place this is" until the participant independently provided the correct answer.

Incorporating the visual imagining component of the training involved the experimenter modeling for the participant. The RA stated they were going to close their eyes. Without opening their eyes, the RA stated "An [item] goes in a [place]." A picture card with the item in the scene was placed in front of the participant. The RA modelled for the participant to name the item in the scene. If the participant answered correctly, the exercise will continue for all ten items in the category. If the participant responded incorrectly the picture card was removed and the exercise was repeated for the item. All ten items were present individually in each scene card, deviating from Kisamore et al.'s (2011) study. The reason for this was to control for possible memorization were all 10 pictures present in the final scene. See Appendix A for visuals of materials used.

Asking questions condition. The session began by instructing the participant to sit side-by-side with the researcher. The researcher asked the target question, “Name ten [items].” Immediately following this question, the researcher provided the prompt, “You can ask me to help you name some.” The participant was given five seconds to either name ten items or ask the researcher to tell him/her the items. If the participant did not respond or stopped responding after five seconds and the ten item requirement had not been met, the researcher further prompted, “You can ask me, ‘Can you help me name some [items]?’” When the participant asked the researcher for help the researcher told the participant the ten items. The researcher paused for five seconds after naming the item to allow the participant to say it back to the researcher. After naming all ten items, the researcher provided praise and ended the training.

Any assigned training occurred for the participant until he/she achieved ≥90% in a direct probe for that strategy or until the strategy had been trained with failure (less than 90%) for five days.

Cross-training condition. This condition was present for participants that did not use additional problem solving strategies in the PSPs. Training sessions were identical to the procedures explained above.

Post-training probes. To better evaluate the visual imagining strategy, all three participants were tested briefly on prerequisite skills for imagining. The first test involved object discrimination. Participants were shown a white board with 30 pictures on it. 10 of the pictures were items found in the participant’s visual imagining category. The remaining 20 images were from different categories. For example, Participant 2 had a board with 10 farm animals (target category), 10 ocean animals, and 10 zoo animals. After attending to the board, the participant was instructed “Find all the [items]” pertaining to their target category. The participant needed to correctly identify 90% (9 out of 10 items) of the target items. Additionally, each participant could not identify more than four incorrect answer from any of the other two categories shown. Each participant was probed three times for this test.

A second test was conducted to determine each participants' imagining repertoire. The participants were asked to imagine three locations: bedroom, amusement park, and toy store. After the RA prompted "Imagine a [place]" the participant was given 10 seconds to imagine it. Then, the RA prompted "Tell me what you see." Each scene was probed three times for each participant.

Chapter III: Results

Figure 1 depicts the results of preliminary assessments ranking each participants least to most known item categories. P1's least known categories were kitchen items, bugs, and zoo animals and were selected for the PSP conditions. The fruit, things that float, and school supplies categories were used for P1's training conditions. P2's least known categories used for PSPs were school supplies, things that float, and kitchen items. P2's training condition categories were clothing, farm animals, and fruit. P3's least known categories used for PSPs were things that float, things that fly, and fruit. P3's training condition categories were farm animals, school supplies, and kitchen items. For any least-known categories with equal numbers of responses (e.g., P1 yielding an average of zero responses for more than six categories), the six categories for training and PSPs were randomly selected.

Figure 3 shows the overall results of the study for each participant. P1 did not independently name any items in the first two direct probes following visual imagining training and improved slightly when he was retrained. These results remained consistent for P2 and P3 when trained in visual imagining. None of the participants met mastery criteria following training and thus never received a PSP following this condition. Because P1 passed five days without reaching greater than 90%, he was trained in visual scanning for the fruit category. P3 was initially trained in visual scanning and met criteria for mastery in the first two direct probes. P2 received training in visual scanning last and did not meet mastery criteria for any of the direct probes. However, in a final training session, P2 met mastery criteria. P1 and P3 were consistent in using the visual scanning method in the PSPs but only P3 used an additional strategy of asking for help independently. While P2 did not initially achieve mastery in any of the training strategies, he used all three strategies in final PSPs. P2 did not achieve mastery for asking for help but P1 achieved mastery following training. P3 did not initially receive training in manding for help having used the strategy in a PSP. She was later formally trained the strategy but did not use it in any of her final PSPs.

Figure 3 depicts results for the post-training tests. P1 was unable to meet 90% criteria while also staying under four incorrect answers. P2 was similar and at most discriminated two items from the target category. P3 achieved 90% criteria for all three probes.

Anecdotal data were collected for imagining tasks. A transcript of the results for each participant is listed in Appendix B. Results of the imagining probes show that only P3 was successful in naming items that she saw in each scene. The only scene she could not imagine items for was the amusement park scene. P2 attempted to name some items but began repeating items after naming one or two. P1 refused to imagine any scene.

Chapter IV: Discussion

In general, the participants of this study were successful in using multiple trained strategies to problem solve. P1 initially used the first strategy he was taught and was then able to use the additional strategies taught to increase the number of responses. P2 also used visual scanning and manding for help to increase responding in PSPs. P3 initially was able to use multiple strategies in early phases but only used one strategy trained in final PSPs. All three participants were unable to demonstrate the visual imagining strategy.

None of the three participants were successfully taught problem solving. This is not so much a limitation of the study but a limitation of current methodologies claiming to be problem solving. Each participant needed to be trained an additional strategy to successfully problem solve. A single strategy was not enough to produce the required responses in a novel situation. For example, P1 was trained in visual scanning and used that strategy effectively until it resulted in failure in the PSPs. When he was taught the additional strategy of asking for help, he was able to problem solve during his final PSPs where he used the multiple strategies. When visual scanning was not enough to achieve the necessary number of responses, he used visual scanning to supplement. This indicates that each strategy on its own cannot truly be called a problem solving strategy. Problem solving did not occur until the participant used an alternate strategy. Some generalization of skills may have occurred for initially trained strategies but was not consistent for all participants. Anecdotally, P1 did show generalization of visual scanning with his usual intraverbal programming following the study's conclusion. He was observed during clinic sessions looking around a classroom for toys and animals to respond to various intraverbal categorization tasks. He was also able to use this strategy following behavior technicians prompting him "Remember to look around the room before you answer." Similarly, behavior technicians working with P2 outside of the study reported P2 asking for help in novel situations more than usual. While there are not data for these reports, it can indicate that some problem solving strategies generalized to novel situations for two participants. Further observation is needed to conclude if this is true for P3.

A third limitation is that none of the participants were successful with the visual imagining training. P3 was closest to meeting 90% criteria and might be inferred to have used the strategy successfully. This matches on to P3's success in the post-training object discrimination and scene imagining tests. She showed the most potential to meet criteria for the visual imagining strategy and it could be hypothesized she would have mastered it given more time. P1 and P2 were not observed to have demonstrated visual imagining effectively. In post-training tests for object discrimination, P1 and P2 showed a skill deficit. P2 was generally unsuccessful in imagining any scene in the scene imagining tests. It is difficult to tell if P1 had a skill deficit in scene imagining due to his refusal to complete the test. Given these indications, the P1 and P2 failing to meet criteria for the visual imagining strategy is more indicative of a limitation in visual imagining methodology. P1 and P2 may not have demonstrated this skill effectively because they lacked prerequisite skills. It could be that expecting P1 and P2 to visually imagine without first being able to discriminate objects in categories or imagine scenes was setting them up to fail. Prerequisite skills may need to be trained before training visual imagining as described in this study.

The current study fills gaps in current problem solving literature and further research can be derived. Future studies may look into developing more generalizable repertoires to meet problem solving criteria. Future research also may address limitations with visual imagining by targeting prerequisite skills necessary. In general, future studies should continue to develop repertoires for true problem solving as Skinner defines and continue to refine methodologies.

Chapter V: References

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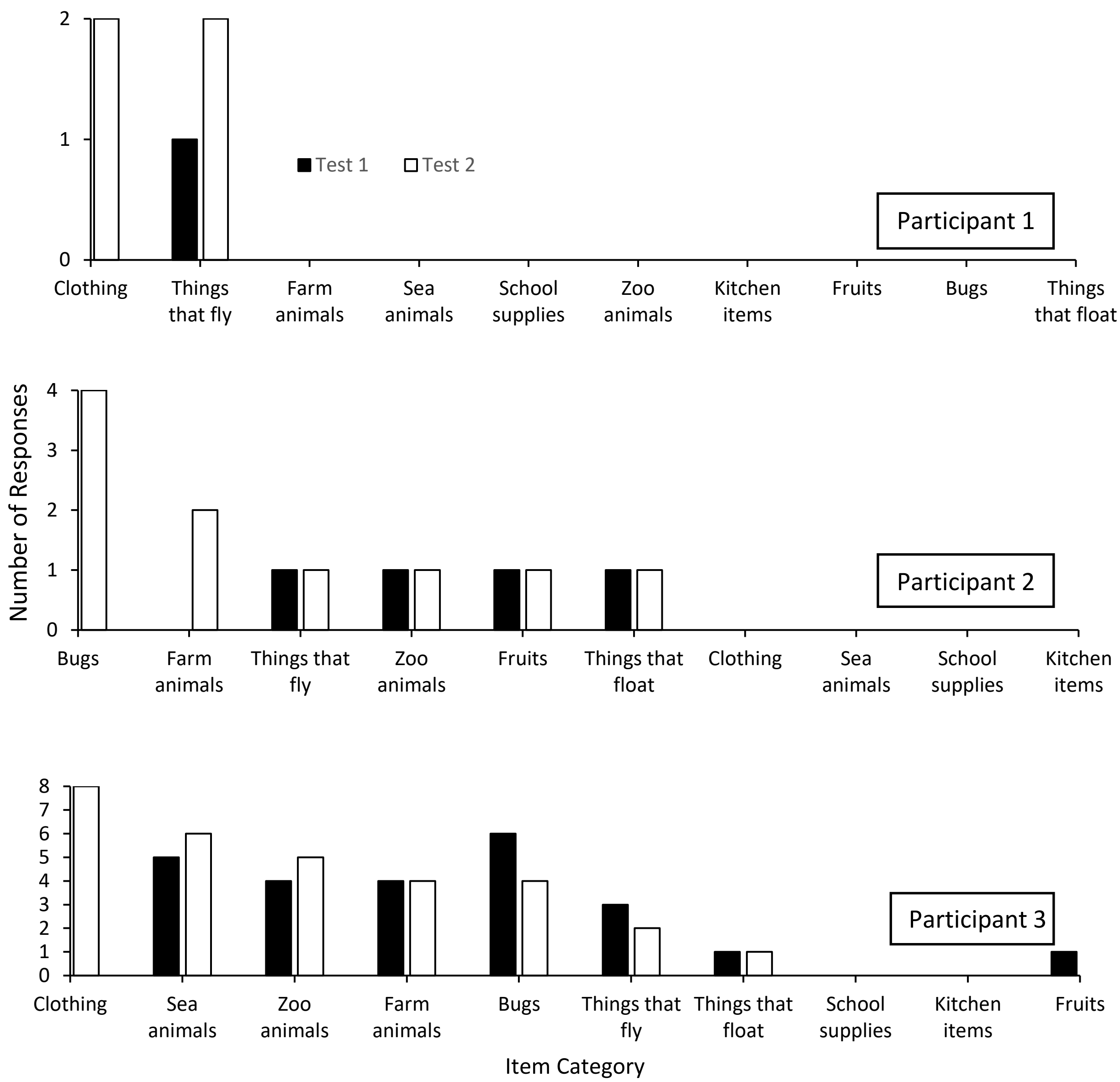
Appendices

Appendix A: Pre-Assessment Results

Figure 1

Pre-Assessment Results

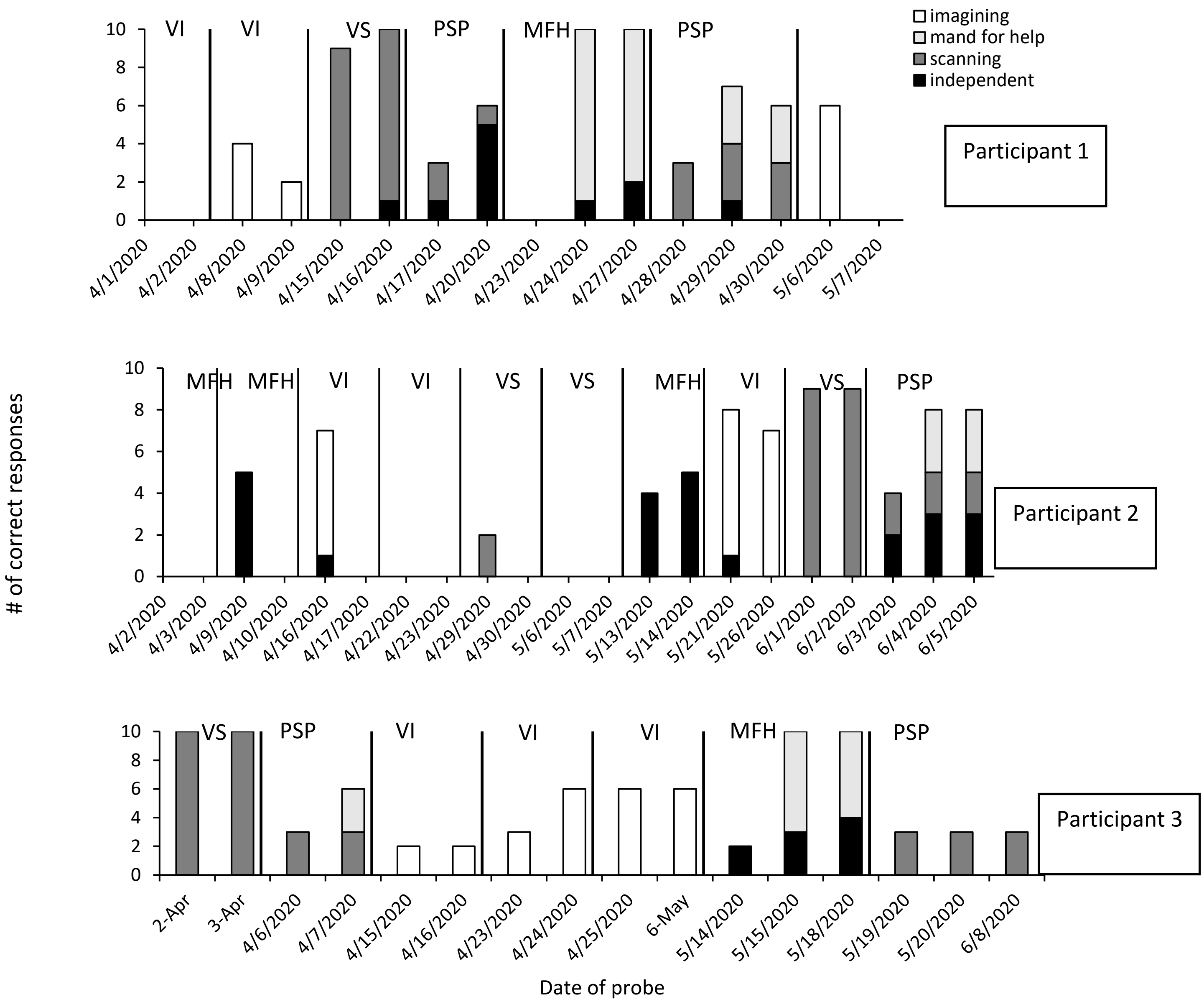


Note. Bars indicate results for two tests for each category. Results are in most known to least known order.

Appendix B: Direct Probes and Problem Solving Probes

Figure 2

Direct Probes and Problem Solving Probes

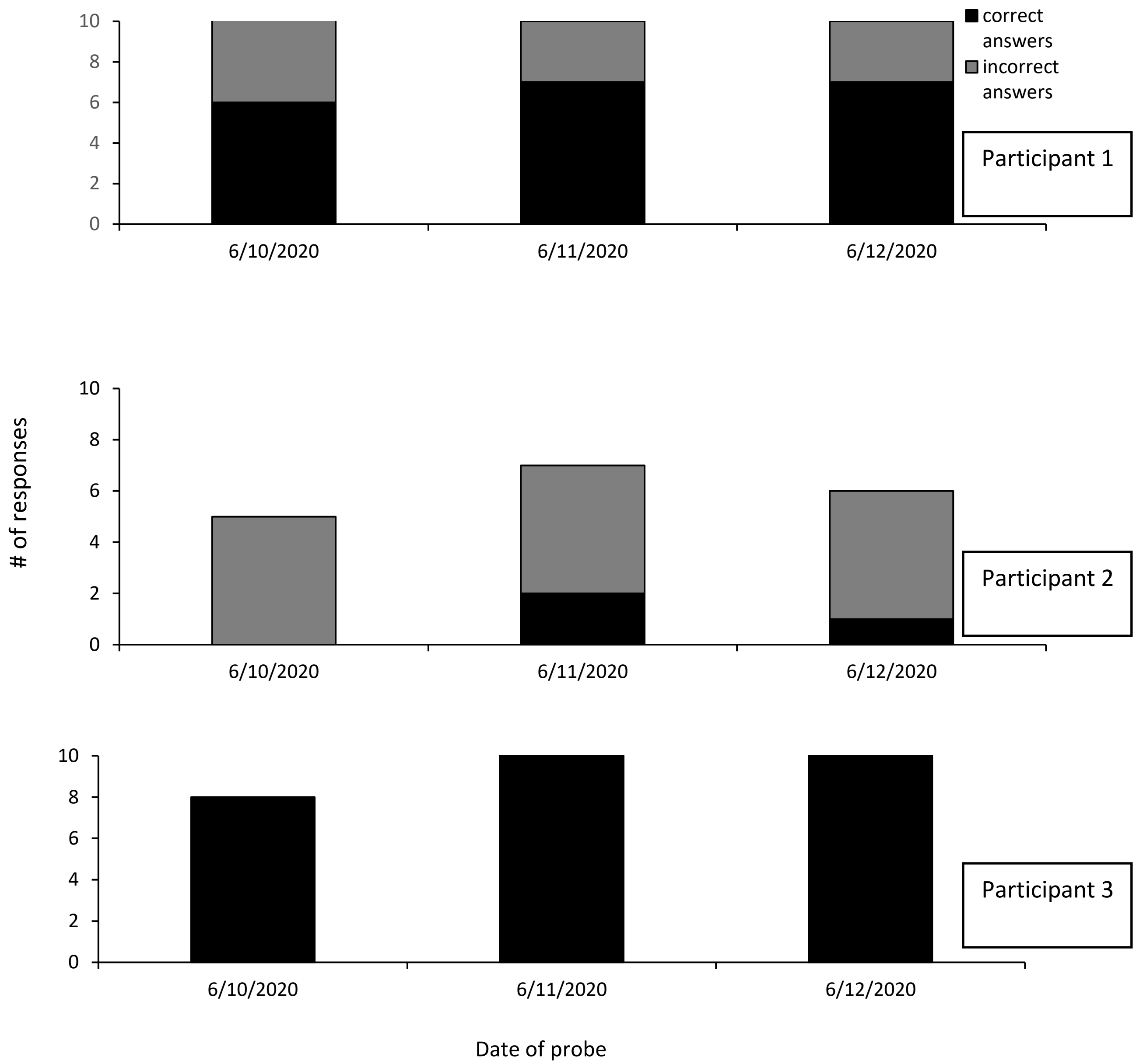


Note. Number of responses across each direct probe and problem solving probe. Phase titles are indicated by VI (visual imagining), VS (visual scanning), MFH (mand for help), and PSP (problem solving probe).

Appendix C: Object Discrimination Results

Figure 3

Object Discrimination Results

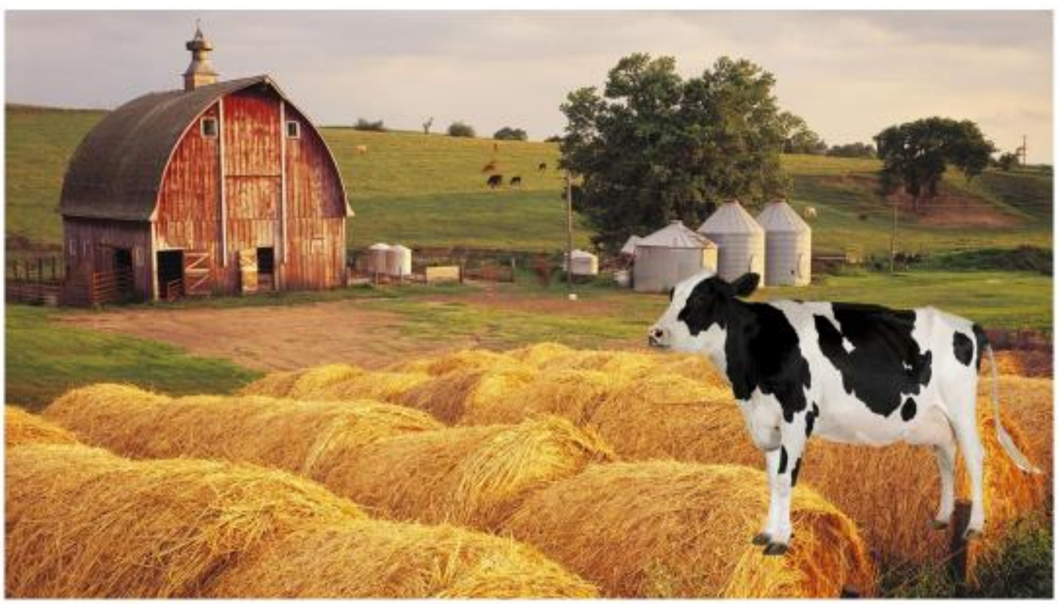


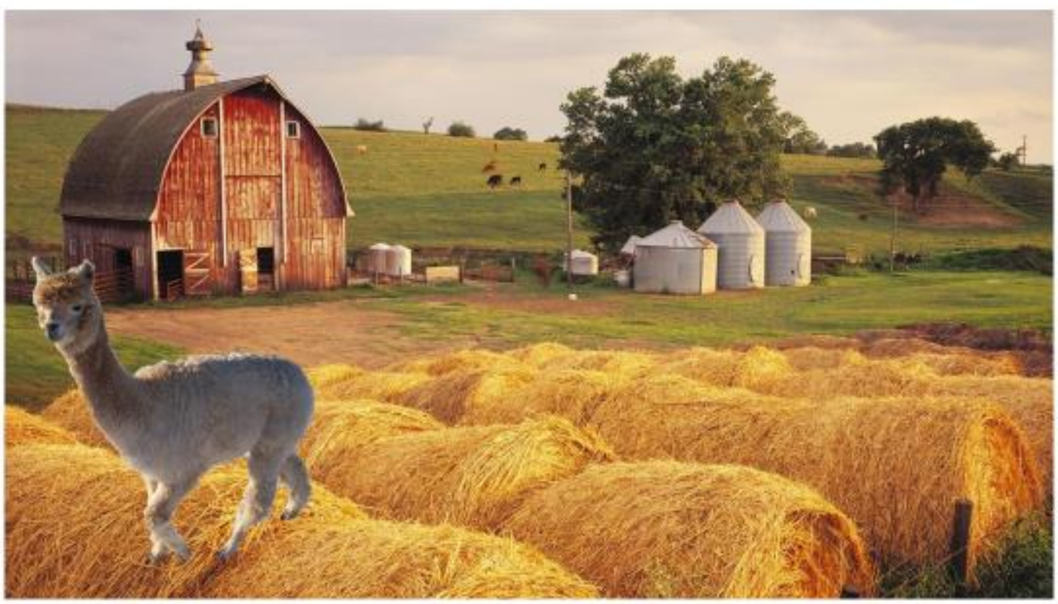
Note. Correct and incorrect objects identified in object discrimination tests.

Appendix D: Visual Imagining Materials

Participant 1:

Participant 2:





Participant 3:

Appendix E: Imagining Exercise Transcripts

Participant 2

6/16/2020

Bedroom:

RA: Let's imagine a super cool bedroom. (brief pause)

P2: Okay!

RA: Okay, so what do you see in your super cool bedroom?

P2: A pillow! A blanket! (pause) 2 blankets!

RA: Good what else can you see?

P2: A big pillow!

RA: Okay do you see anything else?

P2: Yes!

RA: What else do you see?

P2: A blanket, a pillow, a blanket, a pillow (repeats several times before RA moves on to next scene)

Amusement park:

RA: Let's imagine an awesome amusement park, like Disney world. (pause) What do you see? (repeats prompt to regain attention)

P2: Grass! Tree! Flowers, a slide! (RA redirects by reprompting to imagine an amusement park) Flowers!

RA: Like imagine a place like Disney World, what can you see there?

P2: Some animals? (RA moves on to next scene)

Toy store:

RA: Okay, let's imagine a super cool toy store. (pause) What do you see in your super cool toy store?

P2: A teddy bear. A t-rex.

RA: (provides the prompt again)

P2: A tyrannosaurus rex!

RA: Okay can you see anything else?

P2: (no response, end tests)

6/17/2020

Bedroom:

RA: Okay [name], let's imagine a super cool bedroom! (pause) Tell me what you see in your super cool bedroom.

P2: A blanket, a pillow. A (unclear) bed.

RA: Okay that's good, what else do you see in your cool bedroom?

P2: Ah, uh, uh, oh. Aha, I got it! A bed! (lays down on the table and pretends to fall asleep)

RA: (moves on to next scene)

Amusement park:

RA: Lets imagine a super cool theme park, do you like rides? It's a ride park. Imagine your own amusment park – ride park. (pause) What do you see in your theme park?

P2: 2 eggs.

RA: (reprompts)

P2: Duckies, a gree frog, a t-rex! A stegosaurus! A dog.

RA: Okay. (moves to next scene)

Toy store:

RA: Imagine a big, super cool toy store, it's your own toy store. (pause) What do you see in [name]'s toy store?

P2: A t-rex!

RA: Okay, what else do you see?

P2: I made it to the animals! I made a toy store, with a super robot doll!

RA: A super cool robot doll. What else do you see?

P2: (unclear, RA ends tests)

Participant 3

6/16/2020

Bedroom:

RA: Can you imagine the coolest bedroom? (pause) Can you tell me what you see in the coolest bedroom?

P3: Sparkles, pictures.

RA: Okay, what else do you see?

P3: Uh, ants. Probably a lot. A lot a lot.

RA: Do you see anything else?

P3: The walls are pink.

RA: Oh my gosh that is SUCH a cool bedroom.

P3: My roof isn't.

RA: What color is your roof? (started getting a little off track here)

P3: White. A very long time ago when I got home from my plane they painted it. It was a surprise from Mommy, they painted the walls pink, with sparkle pink.

RA: That's so cool, I love your cool room!

P3: Ants really like my bedroom, eating the sparkles. Black ants bite, Mommy is a scaredy cat of ants.

RA: (moves to next scene)

Amusement park:

RA: Okay, can you imagine a really cool amusement park? (pause) What do you see?

P3: I never been to one.

RA: What do you think – can you imagine something that could be in an amusement park?

P3: Poop.

RA: Okay, anything else?

P3: Ants. A picnic inside the park and the ants eat the food. I opened the door and they ate it all (unclear) and they break in half.

RA: (moves to next scene)

Toy store:

RA: We're gonna imagine the coolest, biggest toy store. (pause) What is in, if you could have anything, what do you see in your toy store?

P3: I see…a huge house. A giant, huge bee stinging everybody! The bees sting you and then they (unclear) heads grow big.

RA: (redirects and reprompts)

P3: I see a big bee stinging the door. A giant bee, a giant ant, a giant a lot of stuff, giant pirates. Huge ginormous tree and giant food!

RA: Okay, that's cool! (ends tests)

6/17/2020

Bedroom:

RA: Imagine the coolest bedroom you can think of. What's in your super cool bedroom?

P3: I see giant bees.

RA: Okay, what else?

P3: There's a huge queen bee and the bees are lifting a huge pencil. There's a huge apple. Mommy got stung by a bee.

RA: In your super cool bedroom?

P3: Yeah.

RA: Do you see anything else in your bedroom?

P3: (no further response)

Amusement park:

RA: Now I want you to imagine a cool theme park. Like a place with rides. What's in your theme park?

P3: A bunch of giant cats and a huge tooth.

RA: A huge tooth?

P3: And a huge toilet!

RA: Okay…what else do you see in your theme park?

P3: Um…I don’t know.

RA: That’s okay if you don’t know we can be done with this one.

Toy store:

RA: Let’s imagine a super awesome big toy store. With anything you want. What do you see?

P3: GIANT toys.

RA: Okay, that’s awesome, what else?

P3: A…nana wall. And a horse. A huge giant picture. And giant lips!

RA: Giant lips. IN your toy store?

P3: Yeah and there’s a huge dollie. A giant house.

RA: Lots of things are giant, huh? Do you see anything else?

P3: (shakes head, laughing. RA ends test)