JEIBI

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Where Education and Behavioral Science Meet

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As this year comes to a close, I want to take this opportunity to thank each and every one of our readers, authors and staff for their continued support.

All of us at JEIBI look forward to making JEIBI even bigger and better in the coming New Year.

And most of all, I want to wish you all a very safe and happy holiday season and a prosperous New Year!

Yours truly,

Joe Cautilli

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Where Education and Behavioral Science Meet

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Begin with the most important information, but don't waste space by repeating the title. Include in the abstract only the four or five most important concepts, findings, or implications.

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A Model for Problem Solving in Discrete Trial Training for Children with Autism

Suzannah Ferraioli
Carrie Hughes
Tristram Smith

Abstract

Discrete trial training (DTT) is a well-established intervention for teaching skills to children with autism; however, few published guidelines are available for determining whether a child's rate of learning a particular skill is satisfactory and, if not, what to do. We assert that progress within 8-10 teaching sessions usually is evidence of satisfactory skill acquisition, whereas absence of progress within this time frame indicates a need to consider modifying or stopping instruction of that skill. Absence of progress may involve (a) consistently low rates of correct responding, (b) variable performance across sessions, (c) increases in problem behavior (often in conjunction with low or variable rates of correct responding), or (d) limited generalization of the skill outside intervention. Likely reasons for each of these patterns are described, and decision flowcharts for identifying possible solutions are outlined. When implemented with supervision from a qualified professional, these flowcharts may facilitate systematic problem solving.
Key Words: autism, applied behavior analysis, discrete trial training, early intervention.

Practitioners often recognize or suspect that a child with autism is not making progress in an instructional program for teaching a specific skill. Without effective and timely troubleshooting, they risk compromising their intervention. If, for example, an unnecessary decision is made to stop a program, the child is deprived of a learning opportunity. If, on the other hand, an ineffective program is continued, the practitioner risks frustrating the child and wasting time.

Though treatment manuals present a wide range of instructional programs and standard procedures for implementing them (e.g., Janzen, 1996; Leaf & McEachin, 1999; Lovaas, 2003; Taylor & MacDonough, 1996), little information is available on systematic trouble-shooting strategies that practitioners may use when this concern arises.

In this manuscript, therefore, we propose a set of trouble-shooting strategies for one common teaching format, discrete trial training (DTT), and these trouble-shooting strategies also may be applicable to other instructional methods. DTT is a highly structured teaching format in which each learning trial has five parts (Smith, 2001):

1. *Cue* (technically called a discriminative stimulus or S^D): The teacher presents a brief, clear instruction or question such as "Do this" or "What is it?"
2. *Prompt*: At the same time as the cue, or immediately after it, the teacher assists the child in responding correctly to the cue. For example, the teacher may take the child's hand and guide him or her to perform the response, or the teacher may model the response. As the child progresses, the teacher gradually fades out and ultimately eliminates the prompt (e.g., guiding the student through less and less of the response) so that the child learns to respond to the cue alone.
3. *Response*: The child is allotted an intratrial response time for emitting the behavior cued by the teacher. The duration of this interval is typically 1-3 seconds but may be adjusted based on the child's learning style and the skill being taught. For example, it can be extended to 3-5 seconds for children who tend to respond slowly or for skills that involve carrying out a sequence of actions, and it can be shortened for skills that the child already has mastered.
4. *Consequence*: If the child has given a correct response, the teacher immediately reinforces the response with praise, hugs, small bites of food, access to toys, or other activities that the child enjoys.

If the child has given an incorrect response, the teacher says "no", looks away, removes teaching materials, models or guides the child to perform the correct response, or otherwise signals that the response was incorrect.

5. *Intertrial interval*: After giving the consequence, the teacher pauses briefly (1-5 seconds) before presenting the cue for the next trial.

Discrete trials are implemented as part of an instructional program that focuses on a specific teaching objective such as identifying body parts or tying shoes. The program includes a sequence of steps or phases for meeting the objective (e.g., teaching identification of an individual body part or working on a particular component of shoe tying). In addition, a program includes a clear definition of the target behavior(s) being taught, as well as procedures for administering cues, prompts, and consequences. Baseline data usually are collected to determine the child's level of mastery prior to instruction. A typical teaching session consists of 10 trials (Romanczyk, 1996), with 1-2 sessions per day for each instructional program in the child's current curriculum (Harris & Weiss, 1998; Weiss, 2001). However, the number of trials per session and sessions per day may vary. For example, children who are just beginning DTT or who quickly become frustrated or inattentive may receive fewer trials per session; more advanced children may have 20 trials per session or multiple sessions per day.

To implement the trouble-shooting strategies we propose, service providers must already be proficient in implementing DTT for children with autism. Thus, the strategies may be especially useful to supervisors, team leaders, case managers, and others who are responsible for overseeing a child's DTT program or training new staff. The strategies also may help hone the analytical skills of less experienced individuals such as parents who are new to DTT, paraprofessionals, instructors, or aides. However, these individuals should not attempt to trouble-shoot on their own. They should work together with the rest of the child's educational or therapy team, with consultation from a supervisor, to decide on appropriate strategies that all team members then implement.

Deciding Whether an Instructional Program Is Not Progressing

To determine if a child is not acquiring a skill in a DTT instructional program, the first step is to examine data collected on the child's rate of correct responding. If the child participates in 10-trial sessions of the program once or twice a day, and trial-by-trial data are collected each time, we suggest that the team review the data from the previous 8-10 times that the program was implemented (i.e., the previous 8-10 sessions with data collection, not necessarily the last 8-10 days). If data are collected less frequently, data from only 5-6 sessions may be examined in order to avoid spending too time on an ineffective program. However, the team should consider increasing the rate of data collection for that program to allow for closer monitoring of the child's progress. If sessions are 20 trials in length with trial-by-trial data collection, data may be inspected after 5 sessions (Greer, 2002).

There should be evidence of progress over the sessions that are reviewed (Harris & Weiss, 1998). The clearest evidence would be that the child's percentage of correct responding has increased over the course of those sessions. For example, even if the child is obtaining only 20-30% correct in the last sessions that were reviewed, this is an increasing trend that indicates improvement if the child was performing near 0% correct in previous sessions. Another sign of improvement would be a reduction in the amount of prompting. Because prompted responses are not usually counted as correct, data may show a low percentage of accurate responding, but successfully fading prompts is an indication that the child is beginning to acquire a skill. Other signs of progress may be quicker responses to instruction or fewer off-task behaviors such as gaze avoidance or self-stimulatory behaviors. If the child is displaying any of these signs of progress, it may be appropriate to continue the program in its current form. It is often helpful to visually inspect graphed data to evaluate progress, which refers to reaching a judgment about the reliability or consistency of intervention effects (Kazdin, 1982).

Evidence of improvement over 8-10 sessions that are 10 trials in length is only a rule of thumb for determining whether or not a program is progressing. Some children acquire skills more rapidly than others. Thus, knowing a child's learning history, a team might decide to extend the assessment over additional sessions. Also, progress may vary at different phases of an instructional program. For example, when a program for teaching imitation of nonverbal actions is first introduced, the child's progress in learning to imitate the first couple of actions that are taught may be slow but should accelerate when additional actions are taught. In addition, the rate of progress may vary across programs (e.g., occurring more quickly for visual-spatial skills than communication skills) or at different phases in the curriculum (e.g., increasing as the child advances).

While the number of sessions that are reviewed may be individualized for a child or instructional program, there are limits. At minimum, an instructional program should be continued for 5 10-trial sessions unless the child has an extremely negative reaction (e.g., a large increase in tantrums or aggression). This period of time gives the child an opportunity to work with different instructors on separate days at varying times. At the other extreme, a month may be the maximum amount of time to continue an instructional program without signs of progress. There are very few examples in the research literature of a child mastering a program after such a long interval in which no progress was evident, and there is no reason to expect that simply repeating a program over and over again will suddenly yield a breakthrough (Odom et al., 2003). If progress has not occurred, it is best to consider modifying the program or components of the instructional format, as discussed in later sections of this article.

In sum, data from 8-10 sessions should give an indication of whether or not progress is occurring. However, in some cases data from a one-week period (e.g., 5 sessions) or from a period of up to one month may be reviewed.

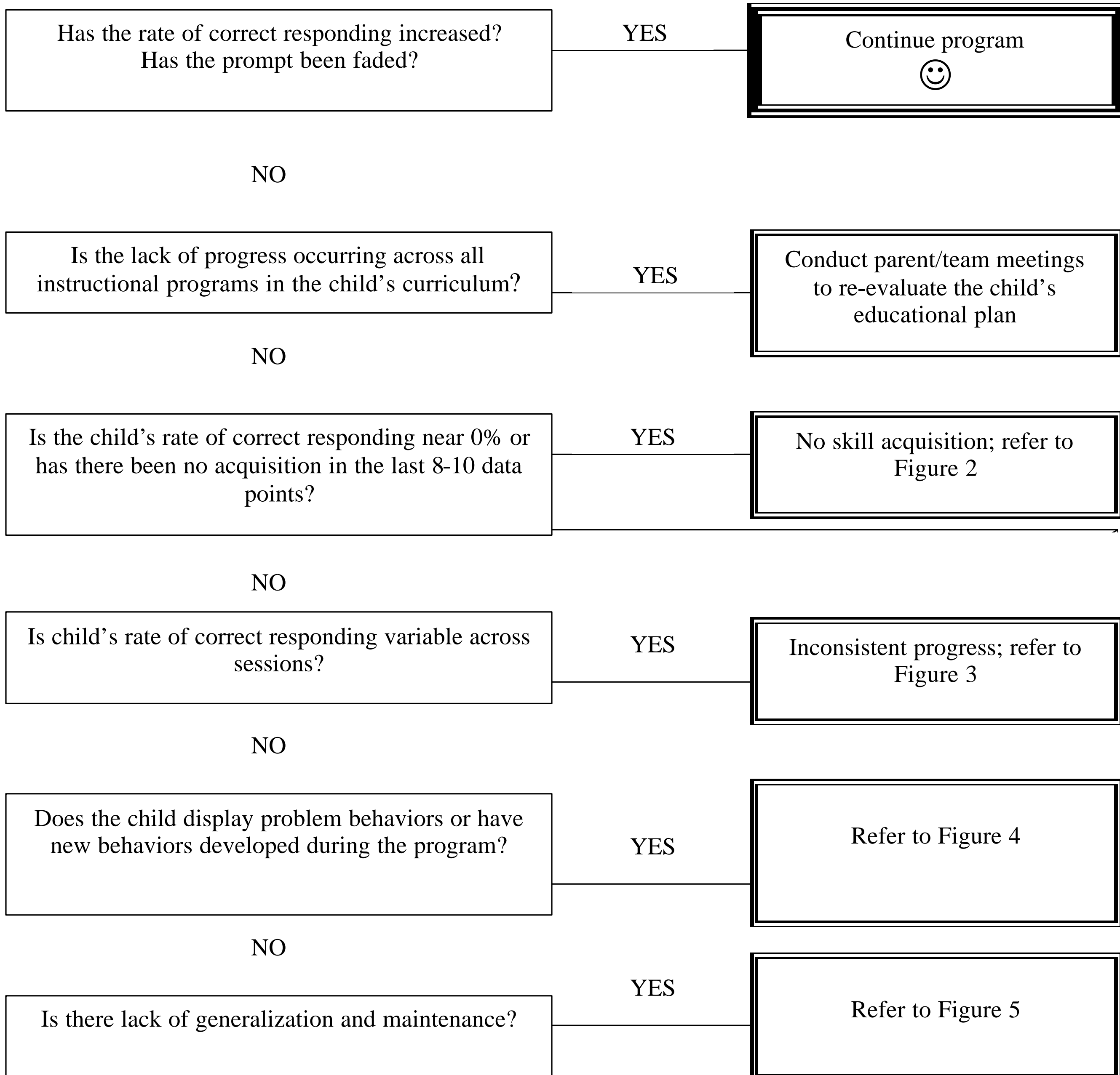


Figure 1. Questions to consider: an organizational schema for troubleshooting common programming problems encountered during early intervention.

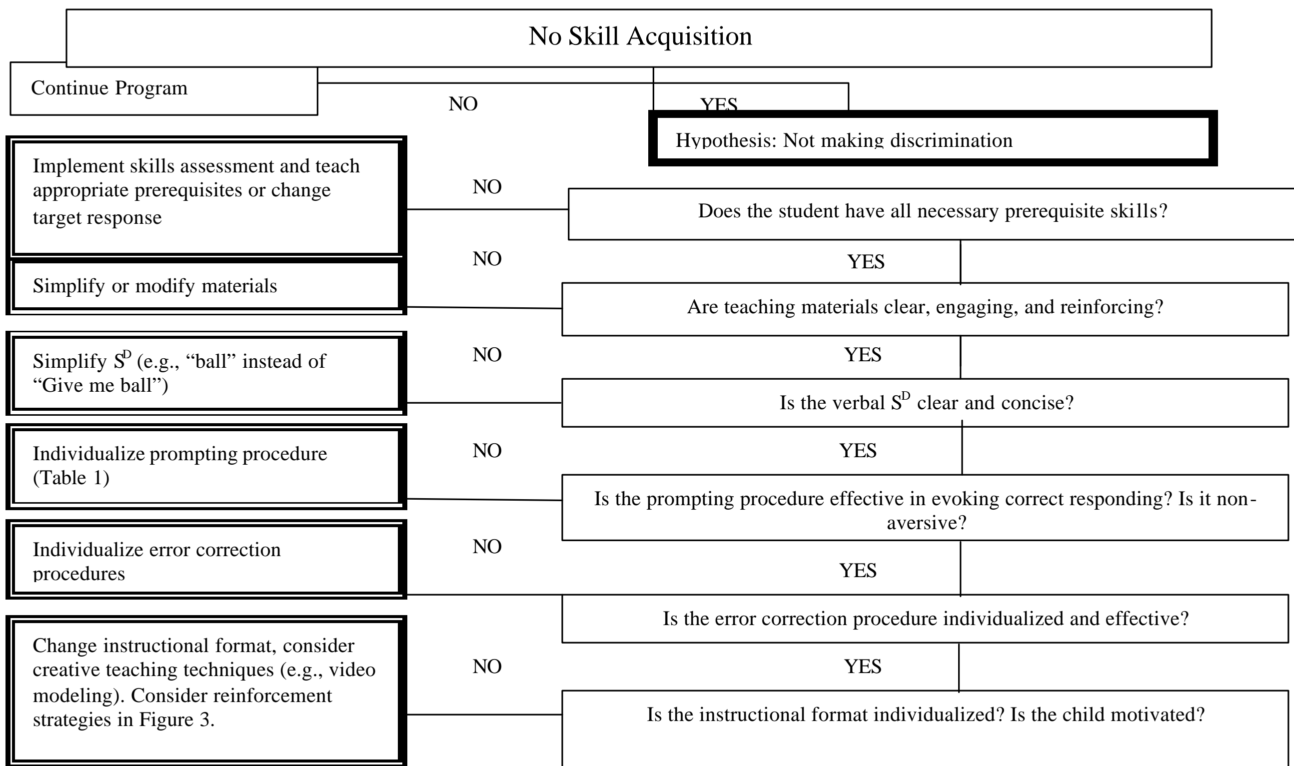


Figure 2. Troubleshooting for no skill acquisition

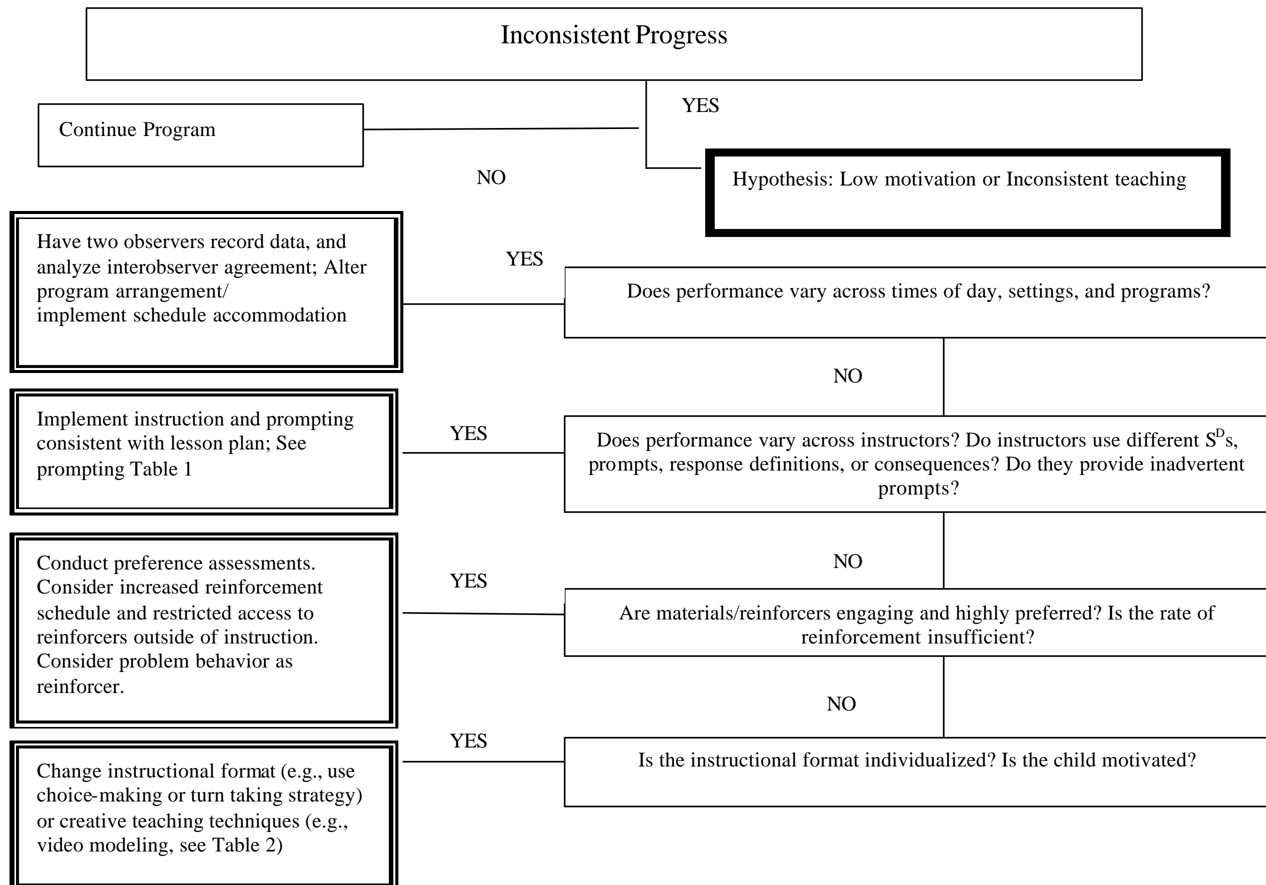


Figure 3. Troubleshooting for inconsistent progress.

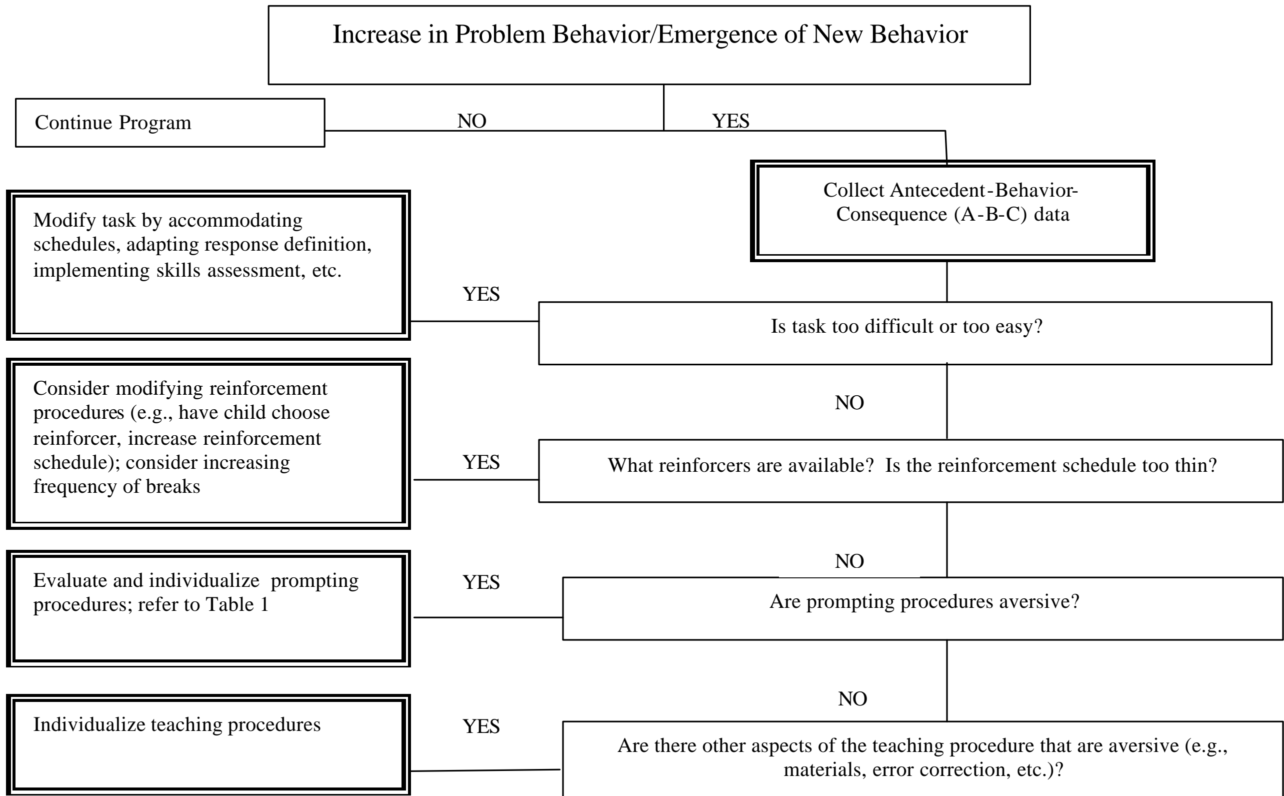


Figure 4. Troubleshooting for increase in problem behavior/emergence of new behavior.

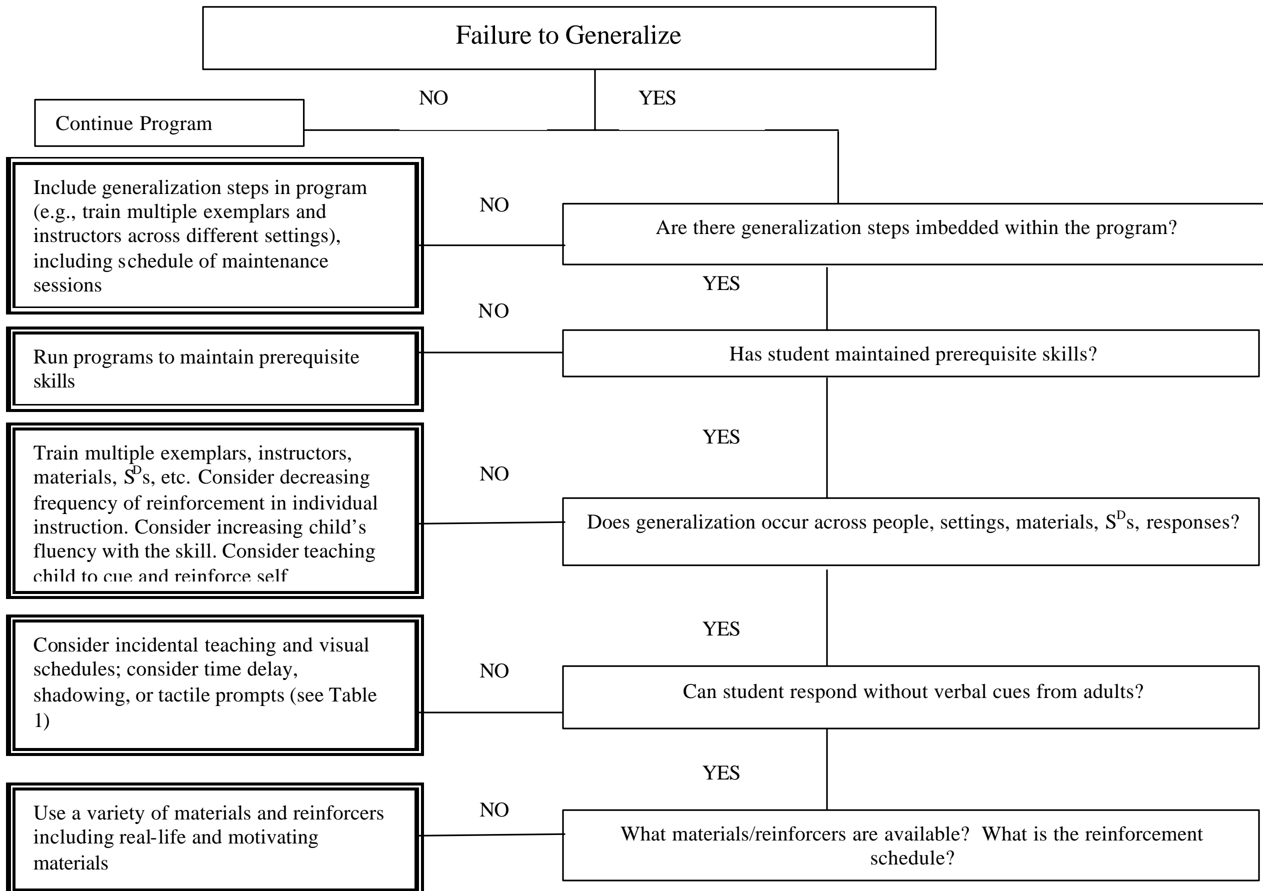
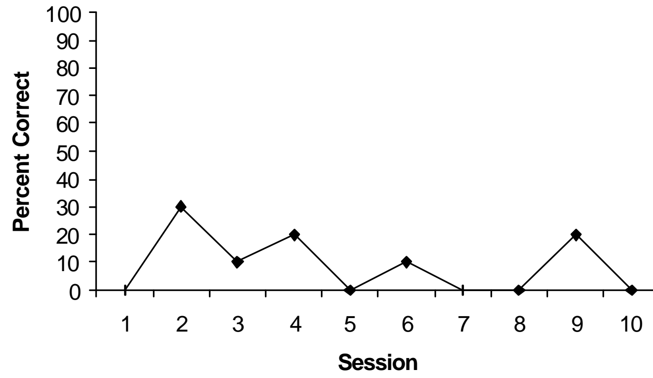
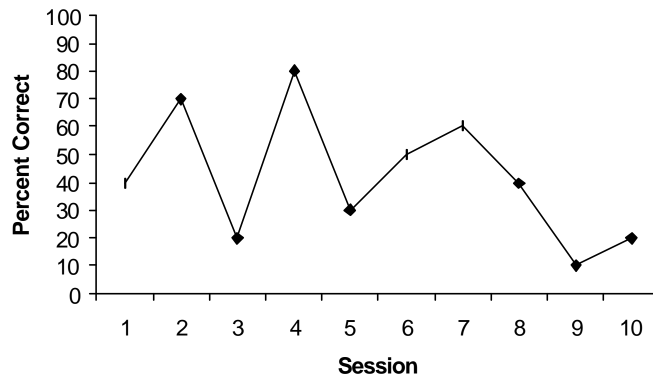


Figure 5. Troubleshooting for lack of generalization





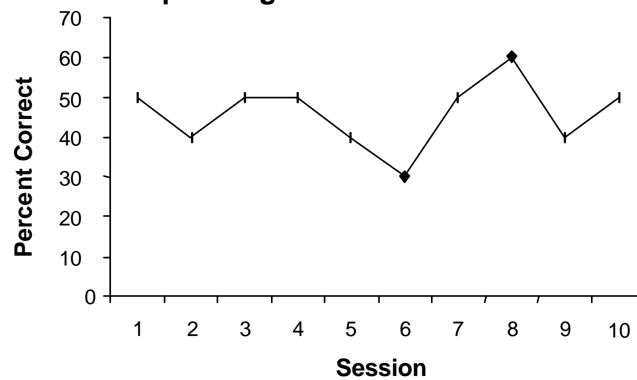


Figure 6. Examples of no skill acquisition (top panel), inconsistent progress (middle panel), and no skill acquisition or chance responding (bottom panel).

Analyzing an Instructional Program That Is Not Progressing

Figure 1 outlines questions to consider when a program is not progressing. The top of the figure indicates that, if the data show any progress in 8-10 sessions, the program should be continued, but, if the data show no progress, there are a series of questions that the team may ask in order to pinpoint the problem. The first consideration is whether the lack of progress is unique to a specific program or program step, or whether it is observed across the student's whole curriculum. If the latter, the team should conduct a general review of the appropriateness of the child's education plan and quality of implementation. Romanczyk (1996) offers a useful model for conducting this review and evaluation. If the trouble mainly affects one program, the next question is whether or not it is important for the child to continue that program. For example, a team may have introduced a program simply because it comes next in a curriculum; however, if the child is not progressing, it is appropriate to re-evaluate the developmental, academic, or functional appropriateness of the program for the child at that time. For example, there is usually no urgent need for the child to master skills such as language concepts (e.g., opposite pairs such as big/little, prepositions, and pronouns) and academics (e.g., reading and mathematics). Other skills, however, may have immediate relevance for the child's functional independence (e.g., requesting desired items, toileting). Additional skills such as imitation and matching may serve as a critical foundation for later instruction. Thus, if a child is not progressing with programs for these skills, extensive efforts at trouble-shooting may be warranted. A further issue to consider is whether the child made progress in the initial steps of a program and then stopped making progress in later steps, or whether the child has had difficulty with the program from the beginning. The former situation may justify greater efforts to continue the program than the latter. Close collaboration between the team and family, with the involvement of a behavioral consultant, is necessary to determine whether to put a program on hold, discontinue a step or condition, or trouble-shoot ways to continue it. An important part of this collaboration is to have periodic parent/team meetings to review the scope and sequence of the child's educational plan and develop priorities for individual programs to implement within that plan.

Figure 1 shows that the next question is whether the program is being run frequently, consistently, and with accurate data collection. In most research on Early Intensive Behavioral Intervention (EIBI) for children with autism, each instructional program is implemented with a child at least 3-4 times per week (Harris & Weiss, 1998). If it is being run less often, the team should increase the frequency and then re-evaluate the child's progress after another 8-10 sessions. It is also important that all team members use the same instructional materials, S^D, prompting methods, and procedures for reinforcing correct responses and correcting errors. Demonstrating an instructional program or reviewing videotaped sessions in a team meeting as well as having the supervisor or another team member observe instruction are ways to ensure consistency. Regarding data collection, some teams may collect data only once or twice a week or may simply estimate the child's performance following a session. However, when there are concerns about a child's progress in a program, it is necessary to enter data immediately after each learning trial in all sessions to ensure the validity of the data.

If the program is being implemented consistently with accurate data collection, yet the child is not making progress, Figure 1 identifies four scenarios that one may see in the data. Figures 2-5, discussed later in the manuscript, discuss problem-solving steps in each scenario:

1. No skill acquisition

a. The child's percentage of correct responding is near 0%. For example, as shown in Figure 6a, a child may have had an instructional program for teaching imitation of nonverbal actions for three weeks, without any clear increase in correct responding (0% in the first session, then 20%, 10%, 30%, 20%, etc.).

b. The child's percentage of correct responding is near chance. For example, if two objects are placed on the table, and the child is asked to select one, a child who is guessing randomly would average 50% correct, as shown in Figure 6c. This situation may arise when the child is not differentiating between objects or S^{D}'s. For example, it may occur when one object is requested repeatedly across trials, but the position of the two objects varies. It also may be observed when the child has mastered selecting one object when it is repeatedly

requested, then mastered the second object when it was repeatedly requested, and now has to select one of the objects when requests for the objects are randomly alternated.

2. Inconsistent performance

a. The child's performance is highly variable across sessions. For example, in an instructional program for matching identical objects to each other, the last five data points may be 40%, 70%, 20%, 80%, and 30% (Figure 6b). The criterion for mastery of the program is 80% across two consecutive sessions.

b. The child often responds correctly but does not reach the criterion for mastery. For example, a child may have an instructional program for identifying body parts in which she often performs above chance level but has not met mastery criterion across two consecutive sessions (e.g., 70%, 80%, 60%, 80%, 60%).

c. The child was approaching the criterion for mastery, but his percentage of correct responding has begun to decrease (e.g., 60%, 80%, 70%, 40%, 30%).

3. Failure to generalize

For example, a child successfully labels pictures of household objects such as a refrigerator, towel, or bed with the pictures that are used at school. However, her mother reports that she does not label these items at home, even when verbally prompted.

Once the problem is identified, the team may form a hypothesis about why it is occurring and ask further questions to identify solutions, as discussed below. This process involves examining the components of the discrete trial (e.g., the S^D, prompts, and consequences). In some instances, more than one problem may be identified. For example, a child may show both an absence of skill acquisition and an increase in problem behaviors during the program. Solutions for each problem may then need to be considered. However, teams should make only one or two changes at a time so that they can assess the impact of each change. If the change does not produce an increased rate of skill acquisition, it may be necessary to repeat the problem-solving process, incorporating data on the child's performance after the most recent change.

No Skill Acquisition

When there is little or no skill acquisition, the most likely explanations are found through analyses of the antecedent components of the discrete trial: discriminative stimuli, prompts, or instructional materials. For example, the child may not be differentiating between the discriminative stimuli used in the program, or the prompts may be ineffective in setting the occasion for the behavior. Consequent events (i.e., error correction and reinforcement procedures) also may be a factor and should be considered as well.

Figure 2 shows that the first step is to verify that the child has the necessary prerequisite skills. If not, the team may have to postpone a program until these skills are a solid part of his repertoire. For example, if the program requires the child to give a verbal response (e.g., saying a word or phrase), the child must be able to articulate the word intelligibly. If the program involves imitating an oral-motor movement such as smacking his or her lips, the child should already be proficient at imitating gross motor movements such as clapping hands and tapping legs. If the program involves teaching an abstract language concept (e.g., an opposite pair such as big/little), research on typical language development (Fenson et al., 1993) suggests that the child should have mastered at least 50 words for names of objects (ball, doll, cookie, etc.). Referring to a published EIBI curriculum (e.g., Janzen, 1996; Leaf & McEachin, 1999; Lovaas, 2003; Taylor & MacDonough, 1996) or consulting with a supervisor may be necessary to determine whether the child has prerequisite skills.

Figure 2 indicates that, if the child has the prerequisite skills, the next questions focus on antecedents (instructional materials, S^D, and prompt). When materials such as objects or pictures are being used, teams may consider whether to substitute new ones. For example, a line drawing or picture with a plain background may be easier for a child to identify than a picture with a busy background. In a program for teaching a child to differentiate between *big* and *little*, it may be best to start by presenting a big and little version of the same object (e.g., a big car and a much smaller car), rather than two different objects. The S^D may also be simplified.

For example, instead of saying, "Give me car", the instructor may simply say "Car." Instead of saying, "Put the block on top of the table" the instructor may say only, "On top." Also, it may be appropriate to change prompting procedures. For example, physical prompts (i.e., providing hand-over-hand guidance) may be aversive to some children (MacDuff, Krantz, & McClannahan, 2001). Table 1 lists other prompts that can be considered such as modeling the correct response, using positional cues (placing the correct object or picture closer to the child than the other items), and gesturing. Also of note is that research has found that within-stimulus prompts (prompts that are incorporated into the materials or S^D) are more readily faded than extra-stimulus prompts (prompts that are separate from the materials or S^D) (Schreibman, 1975). For example, when teaching a child to select a picture for a preferred item instead of pictures for non-preferred items, the picture for the preferred item may be in color while the other pictures are in black and white (Frost & Bondy, 1994). As another example, when teaching a child to differentiate between the letters *b* and *d*, the loops on each letter can be exaggerated.

Table 1

Prompting Procedures

Type of Prompt*	Definition	Example	Advantages/ Disadvantages
Gestural	Using a visual gesture, such as a point, to indicate the correct response	In a program for identifying objects, pointing to the correct object while giving the S^D, "Give me [object]"	Easy to implement and fade out
Verbal	Providing part or all of a response audibly	Immediately after asking "What is it?" while holding up a cookie, saying the word or providing the first sound ("c")	Easy to implement but can be the most difficult to fade
Modeling	Showing the correct response, or part of a response	While giving the S^D "Clap hands", the instructor performs the action	Easy to implement and fade out but requires that student has well-developed imitation skills
Positional	Modifying the placement of materials	In a program for matching words to corresponding pictures, placing the correct picture closer than other pictures to the student	Easy to implement and fade out
Physical	Placing one's hand on the child's hand, wrist, elbow, etc., to guide the student to complete a response or perform a task	When teaching a child follow the instruction "Stand up", placing hands on the back of child's shoulders and lightly nudging the shoulders; when shadowing the child during a group activity, sitting behind the child and providing hand-over-hand guidance as needed to complete tasks	Often useful for motor activities and for activities in which it is advantageous for the child to complete tasks without orienting to instructor (e.g., self-help activities or group lessons). May be aversive to some

			children
Pictorial	Pictures used to represent objects, actions, and tasks	When teaching a long response chain such as making microwave popcorn, using a picture to represent each individual step	Helpful for children who have good visual skills. Useful for cueing child to perform activities without relying on verbal prompts from adults
Textual	A written cue such as a checklist, label, written instruction or script	Placing a written instruction next to a picture depicting a game for a child to read when asking a caregiver or peer to play the game	Useful for cueing child to perform activities without relying on verbal prompts from adults. Requires the child to have reading skills.
Time Delay	Providing a prompt after a designated period of time following the instruction (S^D); the time can be increased as child progresses	When starting to teach a new expressive label, saying the word immediately after presenting the S^D, "What is it?" As the child progresses, the time between the S^D and prompt (saying the word) is gradually increased	Beneficial in promoting initiation of communication without verbal cues from adults. However, student may simply wait for prompt unless S^D is already effective
Tactile	A devise such as a vibrating pager ("Gentle Reminder") that is activated remotely at designated time intervals to cue the child to engage in a specific behavior	When a classroom teacher asks a question during Circle Time, pager is activated to prompt the child to raise his or her hand	Useful for encouraging child to respond without an adult nearby
Within Stimulus	Using the physical properties of a target response as a relevant stimulus to help increase the likelihood of a correct response	When teaching a child to identify the word blue, teaching the color "blue" having the word surrounded by a blue border, and gradually decreasing the size of the border as the child progresses	Within stimulus prompts are often the easiest of all prompts to fade out. However, it may be time-consuming to prepare materials.

**Note: A combination of prompts may be used*

Prompt Hierarchy

- Most-to-Least Prompting: starting with a very salient prompt and gradually using less salient prompts as the child progresses; usually used for teaching new skills. Examples:
    - Graduated guidance: progressively reducing physical guidance (e.g., when teaching a writing task, starting by placing one's hand on the child's hand, then fading by placing the hand on the wrist, then on the arm, the shoulder, etc.)

  - Progressive Time Delay: systematically increasing the length of time between the S^D and prompt as the child acquires a skill (e.g., starting with a 0 second delay, then increasing to 2 seconds, 5 seconds, etc.)
  - Combination procedures such as starting with a full physical prompt (hand-over-hand guidance), then using a lesser physical prompt, then using modeling or gestures, and then using no prompts
- Least-to-Most Prompting: Initially using no prompt but providing increasingly greater levels of prompting until the child successfully completes the response, usually used for skills that the child has previously mastered.
  - Physical prompts: providing manual guidance as needed
  - Time delay-verbal-modeling: waiting expectantly, then, if no response, giving a verbal prompt (e.g., asking, "What do you want?"), then, if still no response, demonstrating the response (e.g., say, "I want puzzle")

If the child's difficulties persist despite modifications of the antecedent stimuli, consideration should be given to changing the target response. For example, if a child is not requesting desired items using spoken language, the child may be successful with using alternative communication strategies such as the Picture Exchange Communication System (PECS; Frost & Bondy, 1994). It is unclear whether acquiring skills through augmentative communication will help the child learn spoken language (Yoder & Layton, 1988); however, it will not impede learning (Charlop-Christy, Carpenter, Le, LeBlanc, & Kelley, 2002), and it may in itself be a very useful communication strategy. As another example, if a child is not acquiring a receptive language skill (e.g., selecting an object when requested to do so), he might be successful when it is first taught expressively (e.g., presenting an object and asking the child to state the name of the object; Wynn & Smith, 2003).

Another possible strategy is to modify the error correction procedure. In some educational settings, instructors are trained to respond to errors with verbal statements such as saying "no" or "try again." The aim of this procedure is to help the student distinguish between consequences given for a correct response and an incorrect response. In other settings, instructors may use nonverbal feedback such as physical guidance or modeling (Holmes, 1998), sometimes requiring the student to give the correct response before going on to the next learning trial (Greer & McDonough, 1999). This procedure is designed to draw attention to the correct response. Another procedure, which is sometimes colloquially called "errorless learning," involves providing guidance before the student completes an incorrect response (Holmes, 1998), then delaying the start of the next learning trial, and giving no other feedback at all. Research on the relative efficacy of these procedures is limited but suggests that no one procedure is always best. For example, some children with autism appear to do better with statements such as "no" or "try again" while others do better with modeling or guidance (Smith, Mruzek, Wheat, & Hughes, 2005). Thus, when a child is not acquiring a skill, it may be helpful to change the error correction procedure (e.g., using modeling instead of saying "no" or vice versa). Familiarity with the student's learning style may assist in determining which error correction strategy will be effective.

An additional strategy is to increase reinforcement. A variety of approaches for doing so are available and they summarized in the next section and in Figure 3.

If the child continues to show poor acquisition, another possibility is to switch from DTT to another instructional format (see Figure 2). For example, video modeling is a well established procedure through which a child learns a new skill by imitating another person who performs the skill on videotape. Studies indicate that video modeling can be effective in teaching a variety of skills such as conversation, pretend play, use of schedules to guide activities, activities of daily living (e.g., bathing), and community skills (e.g., purchasing) (see Corbett, & Abdullah, 2005). This technique has also been shown to generalize well (Charlop & Milstein, 1989; LeBlanc et al., 2003). Table 2- gives guidelines for developing a video model and using it to teach children with autism.

Table 2

Guidelines for Video Modeling

Creating a Video

1. Actors wear neutral clothing and stand against a neutral background
2. Actors face the camera, rather than each other. This may look awkward for some activities such as conversations, but it facilitates learning by allowing the child to see every element of the target social skill including gestures, facial expressions, and general affect.
3. Actors slow down and exaggerate words, actions, gestures and facial expressions in order to facilitate accurate modeling.
4. Actors use materials that interest the child (e.g., favorite toys or puzzles for a video of turn-taking, colored soap or bubbles for hand-washing, costumes of favorite characters for role-play)
5. Scripts are kept short.

Sample Script 1:

A: Let's talk about your family.
B: I have a sister.

A: What's your sister's name?
B: Mariellen. Do you have a sister?

A: Yes, I have a sister.
B: What's her name?

Sample Script 2:

A: Let's talk about Game Boy.
B: I like Game Boy.

A: What's your favorite game?
B: My favorite is Kirby.

A: What does Kirby do?
B: Kirby runs to the castle.

Implementing a Video Modeling Program

1. When introducing a new video, have the child view it three consecutive times. Prompt and reinforce for "good sitting", "good looking", etc., as needed.
2. After presenting the video, say, "Now you do it, like on TV" (or similar statement)
3. Reinforce for approximations and correct imitations.
4. If necessary, have the child watch the video again and present an opportunity for imitation after each subsequent viewing.

If necessary, prompt by saying, "Say, ___[sentence from the video]" or "Do [action from the video]" or by presenting a textual cue (e.g., words or picture symbols for what the child is to say or do).

Variations of modeling procedures also exist and may be useful. For example, modeling can be done *in vivo* (having a skill demonstrated by a peer or adult who is physically present). Also, rather than demonstrating a skill, a script can be presented in writing, in pictures, or verbally from an audiotape or Language Master (EIKI International, Inc.). A Language Master is a machine that reads words recorded on magnetic cards (McClannahan & Krantz, 1999) that can be used to cue completion of tasks, such as in an activity schedule, or teach conversational skills, for example.

Incidental teaching is another example of an alternate teaching strategy that has substantial research support (Delprato, 2001). It is used to encourage skills such as communication by setting up situations in the natural environment that encourage the child to initiate communication and then respond in ways that require additional language from that person (Hart & Risley, 1982). For example, an instructor might arrange toys in sight but out of reach of a child. When the child reaches for a toy, an opportunity arises to teach requesting or to require increasingly complex requests or elaborate on other learned skills (e.g., attributes). To prompt the child, the instructor may just wait expectantly (a procedure called time delay) or ask a question (e.g., "What do you want?"). If the child correctly makes the request, he or she receives the desired toy. Also, an instructor may hide a favorite object from a child, so that the child must ask, "What is it?" or "Where is it?" to gain access to the object. A person or action figure can be hidden so that the child is encouraged to ask, "Who is it?" Koegel and Koegel (1995) and Fenske, Krantz, and McClannahan (2001) describe incidental teaching procedures for children with autism in greater detail. They emphasize that although incidental teaching may initially focus on encouraging a child to request objects or activities, it can be used to teach a variety of other language skills such as seeking help, using syntax such as prepositions, and asking for missing items that are needed to complete a task or activity.

For skills that involve completing a chain of behaviors, such as a self-help task or a sequence of play activities, activity schedules that are presented in a series of photographs, picture cues, or words are another well-established intervention (MacDuff, Krantz, & McClannahan, 1993; McClannahan & Krantz, 1999). These visual cues are sometimes arranged in a vertical or horizontal line or in a flip book with one activity per page. The child is usually given a general instruction (e.g., "See what's next"), and physical guidance is used as needed to prompt the child to refer to the schedule and carry out activities. McClannahan and Krantz (1999) provide an excellent discussion of procedures for using schedules.

The preceding discussion demonstrates that, when a child is showing no skill acquisition, there are many possible ways to modify the antecedents, target behavior, reinforcement, and error correction procedures, and there are often instructional formats other than discrete trial training that merit consideration.

Inconsistent Progress

As shown in Figure 3, when variable (up-and-down) performance occurs it is likely that teaching procedures are inconsistent or that the child has low motivation during instructional sessions. Inconsistent teaching may take a variety of forms. For example, differences in performance may be observed across settings, indicating that components of the environment may interfere with efficient learning. Distractors in the room may be responsible, or the student may be uncomfortable in unfamiliar surroundings. To remedy this problem, the same setting should be used for all teaching sessions, especially when working on a new or difficult skill. Later, after the child has mastered the skill, teaching sessions can be carried out in different settings to promote generalization. Temporal factors may also contribute to inconsistent progress. A student may be more successful during the morning hours, relative to afternoon or evening hours. In this case, new or especially difficult programs should be administered early in the day. Graphing data on a scatterplot can help identify patterns of responding and isolate behavior that may be highly correlated with a time of day, setting, absence or presence of certain people, reinforcement contingencies, etc. (Touchette, MacDonald, & Langer, 1985).

Variation in performance also may be caused by inconsistencies across instructors; analysis of instructor uniformity should take place whenever an instructional program is not progressing. Having two different observers record data and analyze interobserver agreement (IOA) may be especially important (Figure 3). IOA data may reveal that instructors have different criteria for what constitutes a correct response. For example, one instructor may accept a response in which the child initially gives an incorrect answer but quickly changes to the correct answer, whereas other instructors may count this response as incorrect. One instructor may consider a verbal approximation of a word or phrase to be acceptable, while others may require accurate pronunciation. An instructor might also be giving subtle, inadvertent prompts such as glancing or moving slightly in the direction of the correct response, changing facial expression when the child begins to make an incorrect response, or presenting S^Ds in a predictable order (Lovaas, 1977; Charlop-Christy & Kelso, 1997). Alternately, effective use of reinforcement by certain instructors may contribute to enhanced performance in their teaching sessions. In this case, communication between instructors can facilitate the consistent implementation of effective teaching strategies.

Lack of motivation, the second part of the hypothesis presented in Figure 3, is a common problem when teaching children with autism. In addition to the kind of erratic performance illustrated in Figure 6b, the child may display other behavioral signs of low motivation such as responding slowly or not at all to S^Ds, glancing only briefly at instructional materials, pushing back or fidgeting in the chair, verbally protesting, or engaging in repetitive behaviors. There are several ways to respond to low motivation, but the most straightforward solution is to examine reinforcement procedures. As shown in Figure 3, an important consideration is to identify preferred reinforcers.

Preference assessments are an example of a widely used tool to encourage the student to choose his own reinforcers (Cannella, O'Reilly, & Lancioni, 2005). While some preference assessment procedures are quite lengthy and may require training from a professional behavior analyst (Fisher et al, 1992), others are more straightforward. A common procedure is to present an array of choices. For children who communicate in either spoken words, gestures such as pointing, or visual systems such as PECS, the instructor can hold up a choice board with pictures or drawings and ask, "What do you want to work for?" It may be necessary to prompt by asking, "Do you want _____?" For less verbal children, the instructor can hold up two or three objects simultaneously, ask, "What do you want to work for?", and determine which object the child reaches for or looks at (Mason, McGee, Farmer-Dougan, & Risley, 1989). Often, these procedures are used to identify a single reinforcer that is repeatedly presented to a child during task sessions. However, it is usually more effective to have the child choose a reinforcer often (e.g., at the beginning of each instructional program) in order to prevent satiation and allow for changes in preference. It is important to have a limit on access to the reinforcer (e.g., setting a timer for access to toys or giving only a small amount of food while keeping the rest away) so that the reinforcer maintains its effectiveness and the child is soon ready to resume instruction.

Another tactic for motivation enhancement is to increase the schedule of reinforcement. A child may be performing well during some tasks when receiving praise or access to a preferred activity after an average of three or four correct responses, but may benefit from reinforcement after every one or two correct responses for new or difficult tasks (Delmolino & Harris, 2004). Instructional programs for teaching new skills should initially have more regular and frequent reinforcement than programs for helping the child maintain previously mastered skills. Similarly a difficult instructional program may require more reinforcement than other programs, even if the student has worked on the program for several weeks. Reinforcement should not automatically be increased to giving one reinforcer for each correct response. Rather, the reinforcement schedule may be increased in increments until there is evidence that the child's performance has improved. In addition to altering the reinforcement schedule, enabling the child to anticipate when reinforcement will be given is helpful. A token economy system, in which the child earns a certain number of pennies or stickers and then exchanges them for reinforcers, may be an effective approach, particularly for children who can count.

Sometimes, none of the choices that are typically offered in preference assessments (e.g., toys, food, or gross motor activities) are effective reinforcers, even when given on a dense schedule. Figure 3 indicates that one possible solution is to restrict access to reinforcers outside of instructional program (Klatt, Sherman, & Sheldon, 2000). For example, while it is inappropriate to prevent a child from having regular meals and snacks, it is reasonable to reserve preferred snacks such as crackers or small bits of candy for instructional programs. This is likely to increase the potency of these foods as reinforcers (McAdam et. al., 2005). Similarly, some highly preferred toys can be used as reinforcers in instructional programs and stored out of sight of the child at other times. Access to preferred foods or toys may be restricted further by limiting their use to new or difficult instructional programs.

Another possibility, shown in Figure 3, is to use short, constrained episodes of problem behaviors (e.g., repetitive or perseverative activities) as reinforcers when other preferred activities or items cannot be identified. In some cases, particularly with young children and others who do not yet have a wide variety of reinforcers, opportunity to engage in problem behaviors is a more effective reinforcer than standard choices (Charlop, Kurtz, & Casey, 1990). This strategy may seem counterintuitive because the usual goal in an early intervention program is to minimize such behaviors. Of course, instructors cannot let a child perform dangerous actions such as self-injurious behavior (SIB), displays of aggression, and pica. Nevertheless, they can consider offering opportunities for repetitive motor activities such as hand-flapping, perseverative behaviors such as lining up toys or gazing at spinning objects, and delayed echolalia (e.g., repeating scripts from favorite movies). They can do so even when they are attempting to reduce such behaviors during other parts of the child's day. Indeed, depriving the child of access to these activities most of the time and then using them as reinforcers for correct responding in instructional programs may be an especially effective combination. Also, as with other reinforcers, it may be helpful to conduct frequent preference assessments, using the procedures described earlier, so that the child can choose the object or activity that he or she will earn. It is very important to stick to a standard method of reinforcer presentation (e.g., setting and enforcing a time limit) so that the student understands that these reinforcers are available only at the instructor's discretion. In addition, efforts should continue to identify other reinforcers and establish new ones (e.g., pairing praise for correct responses with the presentation of opportunities to engage in problem behavior).

In addition to modifying instructional procedures, Figure 3 depicts several other strategies for addressing low motivation. One is choice making, which has been demonstrated to increase task responding and decrease off-task behaviors (Moes, 1998). Having the child choose reinforcers has already been discussed. Children also may be given a choice of which instructional program to do next, or they may be given pictures or words for three or four programs and asked to arrange them in the order they would like to do them. Further, they may choose preferred materials (e.g., markers and paper for a drawing program).

Incorporating preferred materials into programs also may increase motivation (Klatt, Sherman, & Sheldon, 2000). For example if a child has a strong interest in trains, it may be more effective to teach prepositions by asking the child put the train on top of or under another object than to use a neutral object such as a block. It may be more effective to teach the pronouns *he/she* by using preferred action figures than using pictures of unfamiliar people.

Turn taking and task interspersal are two additional strategies that may increase motivation by introducing variety into instructional sessions. As an example of turn-taking, an instructor may ask the child to draw something, then the instructor will draw something him/herself, then ask the child to draw something again, and so on. Or, for children who can speak in sentences, an instructor could make a request of the child, then tell the child that it is his or her turn to make a request of the adult (e.g., "Your turn—ask me, 'What is it?'"), and so on. The child can be introduced to turn-taking during breaks between instructional sessions; when the child becomes familiar with this routine, it can then be included into sessions. Task interspersal involves incorporating previously learned skills into a new instructional program. For example, if a child is

learning a new language concept (e.g., an opposite pair such as *hot/cold*), requests to select a hot or cold object can be mixed with requests to imitate simple actions (e.g., identify body parts; Dunlap, 1984).

The alternate teaching formats described in the preceding section are important options to consider. Incidental teaching programs are specifically designed to capitalize on objects or activities that are of particular interest to the child (Fenske, Krantz, & McClannahan, 2001). With their reliance on visual materials, video modeling and activity schedules also may have appeal. For additional information on approaches for increasing motivation, Delmolino and Harris (2004) provide an excellent reference.

Increase in Problem Behavior

A child may display an increase in problem behaviors such as tantrums or aggression during instructional programs. These behaviors may occur in conjunction with a lack of skill acquisition or inconsistent progress, or they may arise independently. The key to analyzing the behavior and how it relates to instructional programs is to collect behavioral data. First and foremost, an operational definition of the problem behavior must be developed so that the data collection is accurate and reliable. An operational definition is a description of the target behavior that is both observable and measurable. For example, an operational definition of tantrums might be screaming, or making loud verbal protests for three or more seconds. Data are most commonly collected by recording the behavior as it occurs by writing a narrative of the antecedent, behavior, and consequence around each episode or event of the target behavior (A-B-C data). This type of data collection allows for a specific description of the environmental conditions under which the behaviors were emitted, which may be critical to problem solving, such as where and with whom was the program being run (Cooper, Heron, & Heward, 1987). It also gives information on the rate of occurrences of behavior so that change in frequency over time can be monitored.

A-B-C data may indicate whether the problem behavior is occurring during one particular program or is being exhibited across various contexts, whether the behavior is emitted at higher rates with one instructor than others or at similar rates across instructors, and whether it occurs with the presentation of the S^D, prompt, consequence, or other events. Problem behavior may be a sign that the task is too easy or too difficult and the child may engage in these behaviors in order to avoid or escape the task (Foxx, 2001). For example, when a target is too easy, a child may become bored and act out to terminate the task. To avoid reinforcing the problem behavior, it is important to continue the session until the child complies with a cue from the teacher. After the session ends, however, it may be beneficial to stop running the instructional program and shift the focus to applying the skill to everyday situations outside of instruction. If a task is too difficult, as often occurs when teaching a new target skill or with a child that is just beginning early intervention, problem behavior may enable the child to escape from the task. Again, the teacher should continue the session until the child complies with an instructional cue from the teacher. Subsequently, however, stopping or putting the program on hold, or using the troubleshooting strategies for lack of skill acquisition (Figure 2) should be considered. Before choosing one of these courses of action, the team also should be aware that some children often resist the introduction of new tasks, even when instructional fit and reinforcement have been adequately considered. Under these circumstances, continuing the program and using the strategies discussed below for reducing problem behavior may be the best decision.

Problem behavior also may emerge when there is insufficient reinforcement or opportunity to take breaks. Teams may consider reinforcement strategies and task interspersal, as reviewed in the preceding section and in Figure 3. In addition, they may shorten sessions. For example, they might conduct 5 trials per session instead of 10 or move away from having any standard number of trials, instead ending sessions after an especially good response from the child or after a short number of consecutive correct responses. A common strategy to increase communicative, spontaneous language is teaching the child functional communication skills (e.g., manding for a break) through a process called Functional Communication Training (FCT; Halle, 1987).

Problem behavior may arise because aspects of the instructional program are bothersome to the child. As noted, manual prompts are aversive to some children. Textures of instructional materials may be aversive, and sights or sounds may be frightening. Error correction procedures may provoke displays of frustration (Smith, Mruzek, Wheat, & Hughes, 2005). Overenthusiastic praise or applause may make the child cringe or cover her ears. Thus, the procedures in the instructional program may need to be revised.

In the event that a problem behavior persists after the strategies in Figure 4 are implemented, or if the behavior poses an immediate danger to the child or others, a more extensive functional analysis, with consultation from a professional behavior analyst, is necessary to evaluate the behavior and develop a detailed behavior plan to address it.

Failure to Generalize

The term *generalization* refers to the occurrence of relevant behavior under different, nontraining conditions (i.e., across subjects, settings, people, behaviors, and time). Lack of generalization despite apparent mastery of the skill during instructional sessions is a frequent occurrence. In this situation, as indicated in Figure 5, the first logical question is whether there is any plan in place for generalization. For example, are specific generalization steps built into the program? Although behavior analysts have known for many years that taking a "train and hope" approach to generalization is unrealistic (Stokes & Baer, 1977), this approach remains prevalent.

If there is a plan, the next question in Figure 5 is to consider whether the child demonstrates the skill when the instructional program is re-introduced. If not, it may be necessary to conduct teaching sessions of the program regularly until the child again demonstrates mastery. To prevent the loss of newly established skills, it may be useful to set up a skill maintenance schedule. For example, after mastery of a receptive label program, a practitioner may schedule maintenance sessions 2-3 times per week, then once per week, then bi-weekly, once monthly, etc. Alternatively, teams may set aside a particular day (e.g., "Maintenance Monday") to run through all of a child's maintenance programs. The additional teaching sessions above and beyond mastery are an example of a maintenance strategy called overlearning (Stokes & Osnes, 1989). Another overlearning method is to work on increasing fluency (i.e., rate and accuracy of responding; Binder, 1993). An additional overlearning approach is to introduce instructional programs that progress from foundational to more advanced skills. For example, letter identification is a pre-requisite to sight word recognition, then phonics, reading/writing words, and so on.

If the child demonstrates continued mastery in the instructional program but does not display the skill in other situations, it may be because the child responds only to the particular instructional materials used in the program (i.e., the skilled behavior is "stimulus bound"). It is often observed that children with autism attend to certain stimulus features present during discrimination training that may independently occasion the behavior of interest whereas other features do not, a phenomenon referred to as overselectivity (Lovaas, Koegel, & Schreibman, 1979). A common strategy to address this problem is to use different examples of an item (e.g., different types of toy school buses, pictures of school buses, models of school buses), including stimuli that the child is likely to encounter outside of instruction (e.g., picture of the child's school bus he takes to school). Similarly, a child may respond only to the S^D that was used in the program, in which case instructors may systematically vary the S^D (e.g., asking the child to respond to different greetings such as, "Hi," "Hello," and "How are you today?").

Sometimes, a child may display a skill only in the instructional setting (Rincover & Koegel, 1975). Instructors may then systematically provide instruction in different locations or recruit people in those settings such as peers or teachers to assist in providing instruction. In addition, they may use strategies to ensure that reinforcement is available across settings. For example, they may teach behaviors that are likely to produce reinforcement, such as requesting (e.g., manding for a break), tacting, greeting, or initiating conversations (Koegel & Koegel, 1995). Also, they may work on fluency, enabling the child to emit the response quickly.

For example, if a child takes several seconds to respond to a greeting from a peer, the peer may go on to another activity and not acknowledge the response. However, if the child responds as quickly as other children do, the greeter will probably smile, nod, or otherwise reinforce the response. Instructors also may thin the reinforcement schedule during instructional sessions, so that it more closely resembles the reinforcement available in other settings. Finally, instructors may teach the child to cue and reinforce him or herself. For example, instruction in visual activity schedules may include teaching the child to set up the schedule and obtain a reinforcer after completing the steps (Delmolino & Harris, 2004; McClannahan & Krantz, 1999). Alternatively, instructors can simply display visual prompts in the child's environment and prompt the child to refer to these cues.

Another frequent generalization problem is that, while a child may reliably display a skill whenever an instructor makes a direct request to do so, the child does not initiate use of the skill without a request (Smith, 2001). The incidental teaching strategies that were previously described may be useful in addressing this problem. Some of the prompting strategies that are listed in Table 1 also may be useful. For example, physical guidance, with the instructor staying behind the child and gradually reducing the level of guidance, is commonly used for this purpose. An instructor may use physical guidance as a prompt for responding to a visual schedule, instructions from the classroom teacher, or statements from a peer; the instructor then fades out this prompt gradually so that the child is responding only to the schedule, teacher or peer (Krantz & McClannahan, 1993). Another prompting procedure that is often used to promote initiation is time delay. As previously noted, in this procedure, the instructor simply waits expectantly and does not say anything. The child is thus encouraged to communicate without waiting for a direct request from the instructor to do so.

Another prompting procedure that has been found effective in several studies and is perhaps under-utilized for children with autism is tactile prompting. A tactile prompting device is a pager worn by the student that, when activated, vibrates for a designated time interval. The vibration provides a sensory cue for the student to engage in a target behavior. The first such device to be used in a DTT study was called the Gentle Reminder (Davidson, 1995). Another readily available device is the JTech pager (JTECH Communications Inc., 2004), which can be worn inconspicuously in a student's pocket or under clothing. Tactile prompts have been used to increase social initiations (Taylor & Levin, 1998; Shabani, et al., 2002) and safety skills such as requesting help in the community (Taylor, Hughes, Richard, Hoch, & Coello, 2004). They are not observable by anyone other than the instructor and child; for this reason, they are non-stigmatizing and useful in community settings such as regular education classrooms. Because instructors can administer tactile prompts at a distance, they can reduce their direct monitoring of and assistance to the child. They also can systematically fade the prompt so that the child responds with increasing independence.

In general, strategies for generalization involve planning for continued practice over time, systematically varying instructional procedures and the settings in which instruction takes place, providing opportunities for the child to obtain reinforcement for displaying the skill, and using instructional formats and prompting strategies that encourage initiation from the child rather than reliance on adult cues (Stokes & Baer, 1977; Stokes & Osnes, 1989).

Discussion

Even after thorough problem solving has been conducted, there are, of course, situations in which choosing to discontinue a program or a particular step or condition is a sound decision. If the above questions and suggested strategies for problem solving a particular problem prove to be unsuccessful, the best solution may be to put a program on hold and re-introduce it at a later date, or discontinue the goal and choose another target skill. The lead teacher, program consultant, or case manager, in conjunction with the parent or caregiver, typically best makes this decision with input from other team members. If it involves a severe and persistent problem behavior that is not responsive to the strategies addressing ways to decrease problem behavior (Figure 4), additional assessment and behavior support plans that are developed by a professional behavior analyst may be necessary. Nevertheless, systematic procedures are available that may be used to effectively analyze why a program is not progressing and how to help the child with autism successfully acquire target skills.

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The Utility of a Paired-Choice Preference Assessment in Predicting Reinforcer Effectiveness for an Infant

Karena S. Rush, Patricia F. Kurtz, Tara L. Lieblein and Michelle D. Chin

Abstract

This study examined the utility of a paired-choice preference assessment in predicting reinforcer efficacy for a 13-month old with a history of prenatal drug exposure. First, two paired-choice assessments were conducted one week apart, using the same items. A high level of correspondence between the two assessments was observed. Next, a reinforcer assessment was conducted indicating that the high-preference items identified by the paired-choice assessments served as reinforcers for the participant. The results suggest that the paired choice assessment was effective in predicting reinforcers for this infant. Limitations of the current study and suggestions for future early intervention research are discussed.

Key Words: paired-choice assessments, reinforcer assessments, early intervention.

A key component to developing appropriate interventions for children exhibiting severe behavior problems involves identifying potent reinforcers. One commonly used procedure for identifying potential reinforcers is the paired-choice preference assessment (Fisher et al., 1992). This nonverbal assessment method requires the individual to choose between randomly presented paired items (Fisher et al., 1992). Research has shown the procedure to be effective in identifying potential reinforcers, however, the majority of the research on this procedure has been conducted with individuals above the age of five (e.g. Fisher et al., 1992; Pace, Ivancic, Edwards, Iwata, & Page, 1985). To date, there have been no studies published on the utility of paired-choice and reinforcer assessments for children under 18-months old. Thus, the utility of the paired-choice assessment with young children is unknown. Given the considerable amount of research that emphasizes the importance of early identification and intervention, more research on the assessment and treatment of behavior problems in very young children is needed (Kurtz et al., 2003). In the present case study, the reliability and validity of a paired-choice assessment was evaluated for an infant.

METHOD

Participant and Setting

Kyle was a 13-month-old African American male with a history of prenatal drug exposure. Kyle was typically developing in the areas of language and physical development but displayed social and behavioral deficits as well as very high levels of hyperactivity and impulsivity. Kyle was referred for outpatient services for the assessment and treatment of self-injury, aggression, and severe tantrums. All sessions were conducted in a padded room with a one-way mirror.

Procedure, Response Measurement, and Reliability

Paired-Choice Assessment. First, a list of stimuli was generated from parental report using a structured interview, the Reinforcer Assessment for Individuals with Severe Disabilities (RAISD; Fisher, Piazza, Bowman & Amari, 1996). A paired-choice assessment was then conducted with Kyle as described by Fisher et al. (1992) and repeated one week later. A total of eight stimuli were used in the assessment with each stimulus being paired once with every other stimulus. During each trial, two stimuli were placed in front of Kyle. A choice response (i.e., Kyle contacted the item) resulted in 30

seconds access to the chosen stimulus. Data were collected on item consumption, approach, avoidance, and no response. Consumption responses were defined as the participant manipulating the stimulus. Approach responses were defined as the participant's hand moving at least six inches from the previous position and towards the object. Avoidance responses were defined as actively pushing or throwing the object, or the participant moving away within 3 seconds of the presentation of the stimulus. No response was defined as exhibiting no reaction to the stimulus within 5 seconds of its presentation.

Responses were recorded independently by two trained observers using a paper and pencil data collection system. Interobserver agreement was calculated across both assessments by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. Interrater reliability data were collected across 100% of trials with a mean interobserver agreement of 96.2%.

To obtain percentages used to develop a hierarchy of 'preferred' stimuli, consumption responses were added together and divided by the total number of presentations and multiplied by 100 for each stimulus. High preference stimuli were defined as the two stimuli with the highest percentage of consumption. Low preference stimuli were defined as the two stimuli with the lowest percentage of consumption. Using the hierarchy of preferred stimuli for each assessment, a Spearman's rank-order correlation was calculated to determine the level of correspondence between item rankings in each assessment.

Reinforcer Assessment. A reinforcer assessment similar to the one described by Piazza, Fisher, Hagopian, Bowman, and Toole (1996) was conducted to compare the reinforcing effectiveness of high preference stimuli to low preference stimuli, as well as to a control (no item). Prior to the assessment, training trials were conducted to train Kyle in the targeted response (sitting). A moderately preferred item not used in the reinforcer assessment was used during the training trials. One training session consisted of ten trials. Three-step guided compliance was used to train Kyle on the targeted response. Training was conducted until Kyle independently sat in a chair for 80% of the trials across two consecutive sessions.

At the beginning of each session of the reinforcer assessment, the items (or control "no item") were randomly assigned to one of two chairs and Kyle was placed equidistant from the chairs. Kyle gained access to a stimulus by sitting in a chair associated with that stimulus. Sessions were five minutes in length. Two independent observers collected data simultaneously but independently on lap top computers on the duration of task engagement (sitting) associated with each chair across 100% of sessions. Exact agreement for duration of task engagement was calculated by dividing the number of agreement by the sum of agreements plus disagreements and multiplying by 100. Mean exact agreement was 89.8%.

RESULTS AND DISCUSSION

Results of the paired choice assessments indicated a high level of correspondence between the two assessments (see Figure 1). Specifically, the majority of the items in the second assessment obtained the same ranking as obtained in the first assessment, or moved no more than one placement within the rank order. Two of the least preferred items moved 1.5 or 2 placements within the rank order (Maraca moved from 6 to 8, and Tambourine moved from 7.5 to 6). Finally, a Spearman's rank-order correlation revealed a high level of correspondence between the two paired choice assessments ($r=.874$, $p=.005$).

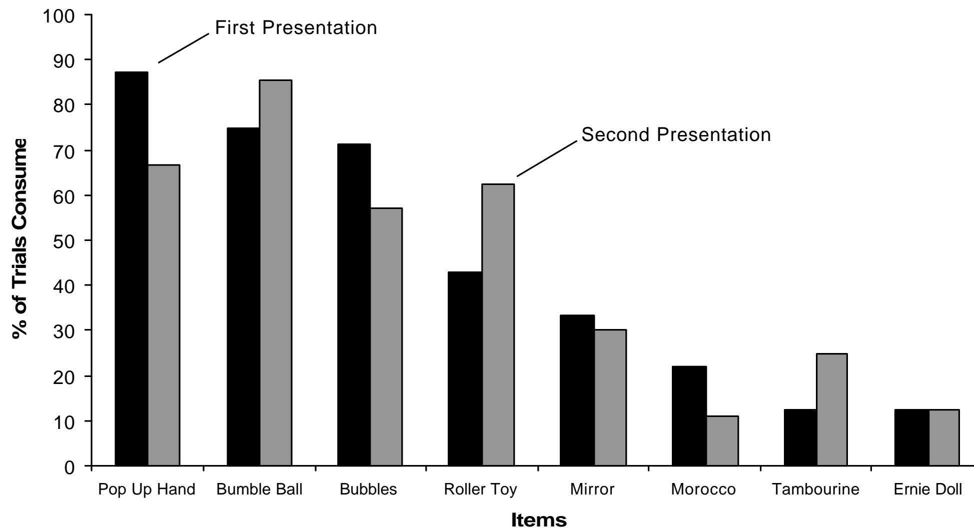

Figure 1. Paired-choice assessment results

As shown in Figure 2, the high preference item was associated with a higher percentage of task engagement (M = 55.1%) than the low preference item (M = 3.2%) and the control (M = 2.2%). The results of this assessment suggest that the highly preferred item served as a reinforcer for Kyle.

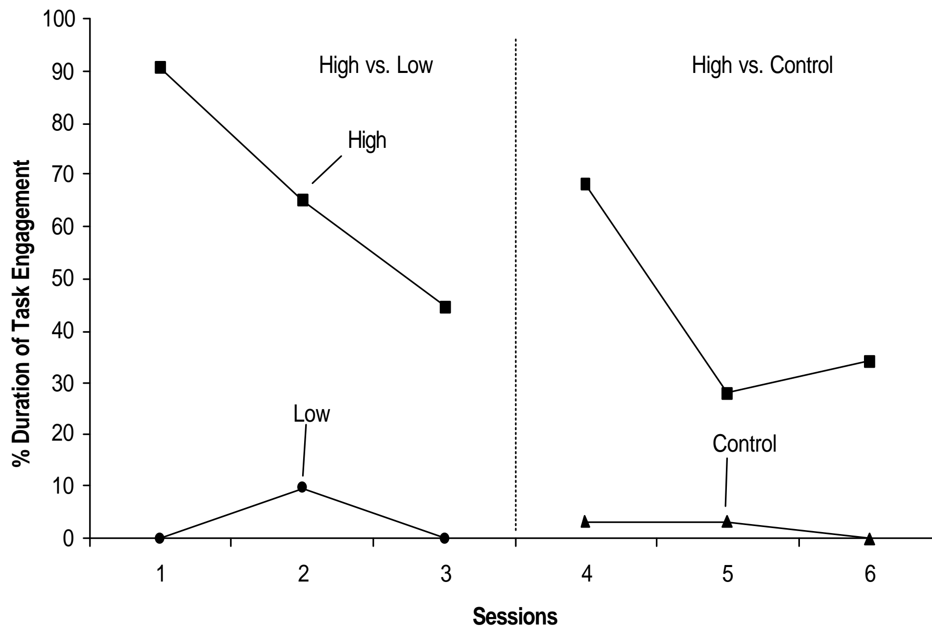

Figure 2. Reinforcer assessment results

These results suggest that paired choice assessments may be a reliable and valid method for identifying reinforcers for very young children. However, the generalizability of these results is limited in

that only one child participated in this study. Future studies should examine the reliability and validity of the paired-choice assessment with a larger number of infants and toddlers to determine the age at which these assessments are appropriate. In addition, the effects of satiation should also be explored when examining reinforcer efficacy with young children. Consistent with previous research on holding reinforcers constant (Egel, 1981), a decline in stimulus engagement was observed with this participant. Thus, future studies may want to examine the effectiveness of constant versus varied or multiple reinforcers with very young children. Finally, there is limited research on the utility of other assessment and treatment methods for young children. With an increasing emphasis being placed on prevention and early intervention, more research is needed on the utility and acceptability of other assessment and treatment techniques with very young children.

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An Empirical Analysis of the Effects of a Possible Sinus Infection and Weighted Vest on Functional Analysis Outcomes of Self-injury Exhibited By a Child with Autism

Stacy L. Carter

Abstract

Analogue functional analysis methodology was used to assess potential maintaining contingencies of episodic self-injurious behavior (SIB) of a 4-year-old child diagnosed with autism. Analogue conditions were presented within a multielement design when the child did, and did not exhibit signs of a possible sinus infection, and when the participant, did, or did not, wear a weighted vest. Findings revealed higher occurrences of SIB when a sinus infection was considered to be present vs. absent, and the weighted vest did not affect occurrences of SIB during the functional analysis. SIB was considered to be maintained by some form of automatic reinforcement. Implications for enhancing functional analysis methodology by including measures of biological events such as medical illness are discussed.
KEYWORDS: Functional analysis, self-injurious behavior, autism, sinus infection, weighted vests.

Functional analysis methods have been used to identify both social and nonsocial maintaining variables for various behavior disorders. Behaviors maintained by nonsocial variables have been referred to as being automatically reinforced through sensory stimulation or pain attenuation (Vollmer, 1994). Nonsocial maintaining variables have been shown to maintain behaviors such as pica (Piazza, Hanley, & Fisher, 1996), stereotypy (Hanley, Iwata, Thompson, Lindberg, 2000), and eye poking (Kennedy & Souza, 1995; O'Reilly, 1997). Although nonsocial variables may be relevant to several maladaptive behaviors, the direct manipulation of these nonsocial variables responsible for behavior maintenance may be difficult due to the complexities of separating the influence of stimuli from the response (Iwata, Dorsey, Slifer, Bauman, & Richman 1994; Vollmer, 1994). Some behaviors hypothesized to be maintained by automatic reinforcement have been assessed by directly manipulating various idiosyncratic stimuli that could be controlled and ruling out competing hypotheses (Kennedy & Souza, 1995; Piazza et. al. 1996).

Carr (1994) suggested extending the utility of functional analysis methodology by investigating the effects of nonsocial variables such as physiological or internal states. He referred to these variables as biological events such as physical illness or drug states. These types of biological events have been considered to act as establishing operations for the occurrence of problem behavior (Hanley, Iwata, & McCord, 2003; Kennedy & Meyer, 1996; Pace & Toyer, 2000). Kennedy and Meyer (1996) recommended expanding experimental analyses to extraexperimental events such as allergy symptoms and sleep deprivation, that occur outside functional analyses in order to obtain a better understanding of their impact on response rates and to conceptualize the effects of these events. Hanley et al. (2003) suggested conducting functional analyses with and without the presence of physiological or internal states such as illness or drugs in order to clarify the impact of these conditions on a specific behavior and to identify a more accurate and effective treatment. Carr (1994) recommended including information obtained from more comprehensive descriptive assessments to individualize functional analyses and enhance relevance of outcomes. The value of using descriptive assessment procedures to enhance functional analysis outcomes has not been clearly described in the literature (Iwata et al., 1994), primarily due to a lack of inclusion of descriptive assessment information in studies reporting on the use of functional analysis procedures (Hanley et al., 2003). The current literature suggests both discrepancies between descriptive assessment and functional analyses and synonymous relations (Carr, 1994; Galiatsatos & Graff, 2003).

O'Reilly (1997) determined that self-injury was associated with a biological event (otitis media) by conducting a functional analysis during periods when otitis media was and was not present. The results indicated that self-injury occurred only when otitis media was present and tentatively concluded that the self-injury served a sensory escape function from ambient noise. This study involved a biological event (otitis media) which could be clearly identified with medical evaluations or laboratory results. In many cases, a diagnosis is not clearly distinguishable due to a number of different reasons such as the unavailability of specific medical screening tests, imprecise laboratory results, rapid cycling of conditions, etc. In the event that a specific diagnosis cannot be determined, conducting a functional analysis while a specific condition is and is not present may not be an option.

Kennedy and Meyer (1996) conducted functional analyses in the presence and in the absence of a biological event (allergy symptoms) and a conditional state (sleep deprivation). The presence of these extraexperimental events was determined by agreements on the occurrence or nonoccurrence of the events by teachers and parents of the children in the study. The results indicated that these extraexperimental events influenced the outcomes of functional analyses. The presence of a possible sinus infection evaluated in the current study relied on a similar method of agreement on the occurrence or nonoccurrence of an illness.

Pace and Toyer (2000) provided an option to conducting a functional analysis in determining the presence of a previously undiagnosed biological event (vitamin deficiency). They used an experimental design to evaluate the effects of a multivitamin on the pica of a 9-year old female diagnosed with severe mental retardation, iron deficiency, and anemia. The BAB design indicated that latency to pica increased during all sessions when the vitamin supplement was being administered. This study did not conduct a functional analysis of the pica behavior but instead manipulated a possible biological event which impacted latency to pica. The current literature examining the influence of physiological variables demonstrates that these variables may serve as establishing operations for severe problematic behaviors and may influence the outcomes of functional analyses.

Research on the use of weighted vests as a treatment for problem behavior reveals few empirical studies. Despite the lack of empirical research on the use of weighted vests, their use appears to be quite prevalent among young children with various disabilities. Olson and Moulton (2004a) surveyed pediatric occupational therapists from different geographic areas of the United States and found that 57% of the 350 respondents reported using weighted vests. Respondents primarily reported using weighted vests with preschool and elementary school age groups to treat symptoms of autism (82%) and Attention Deficit Hyperactivity Disorder (ADHD; 65%). Olson and Moulton (2004b) interviewed 51 pediatric occupational therapists about how weighted vests were used and found that weighted vests were most frequently recommended for treatment of problem behaviors frequently exhibited by children with autistic spectrum disorders (92.2%) and ADHD (76.4%). Their findings also revealed that weighted vests were recommended for the reduction of problem behaviors such as stereotypy (rocking/flapping), hitting, wandering, and tantrums. The weighted vests were also reportedly used to increase behaviors such as attention, eye contact, and staying on task.

Two empirical studies have been conducted on the treatment effects of a weighted vest, but none have focused on severe problem behavior or have incorporated functional analyses of the behaviors. Vandenberg (2001) evaluated the effects of a weighted vest on the on-task behaviors of four children between the ages of five and seven years. The vests were equivalent to approximately 5% of the children body weight. The results revealed an 18 to 25% increase in on-task behavior for all four children while wearing the weighted vests. Using an ABA design, Fertel-Daly, Bedell, and Hinojosa (2001) found a decrease in the number of distractions (off-task behavior) and an increase in the duration of a fine motor task for five preschoolers diagnosed with pervasive developmental disorders while they wore a weighted

vest. Additionally, all but one of the preschoolers demonstrated a decrease in the duration of self-stimulatory behaviors while wearing a weighted vest.

The current study examined the function of episodic self-injurious behavior in a 4-year-old child diagnosed with autism. Functional analysis procedures were conducted in an attempt to identify the function of the self-injury in the presence of possible sinus infection and during periods when a sinus infection was not considered to be present. The analysis also evaluated the effects of a weighted vest on the occurrences of SIB.

Method

Participant and Setting

Gagan was a 4-year-old Asian male who attended a pre-school classroom in a public school building. He was diagnosed with autism and functioned at the profound level of adaptive behavior as measured by the Vineland Adaptive Behavior Scale. Gagan was nonverbal but vocalized using short screams or by humming. His typical daily routine consisted of individualized instructional activities (stacking items, sorting, etc.), group instructional activities (singing songs, counting, etc.), various recreational activities (playground, ball pits, etc.), snacks and lunch. A review of available documentation indicated no significant medical problems other than repeated sinus infections and no complications associated with labor or during pregnancy. A history of maladaptive behaviors included the following: self-injury, spitting, and running away from staff. Previously recommended interventions for self-injury included sensory integration techniques such as swinging, applying pressure, and a weighted vest. The weighted vest manufactured by Velvasoft$_{TM}$ weighed three pounds (approximately 7.5% of Gagan's body weight) and had been recommended by an occupational therapist. In addition, physical blocking or restraint for self-injury had been used periodically. Previous interventions for spitting involved placing a brown paper towel to his lips following an incident of spitting, verbal reprimands, and an occasional requirement to clean the area effected by the spitting. Gagan was referred for assessment and treatment of self-injurious behavior by his teacher who reported a recent increase in self-injurious behavior. The functional analysis took place in the preschool classroom setting while other students were in another part of the room. The classroom furniture was arranged so that Gagan could not easily access or view the other students in the room. A classroom teaching assistant worked quietly with other students throughout all of the functional analysis conditions. Masters-level teachers trained in the application of functional analysis procedures conducted all experimental manipulations.

Dependent Variables, Data Collection, and Reliability

The dependent variables consisted of self-injurious behavior (SIB) and presence of a possible sinus infection throughout the investigation. SIB was defined as hitting head with hand, hitting head against object or person, and/or slapping the backside of hand against object such as floor or table. Data were collected on SIB using a 10 s tape-cued partial interval recording procedure. Inter-observer agreement for the occurrence/nonoccurrence of SIB was calculated based on an overall interval-by-interval comparison of observer recordings. Inter-observer agreement was obtained during 40% of functional analysis conditions and averaged 94% (range: 80% to 100%).

Gagan had a history of sinus infections which were medically diagnosed and correlated with the presence of colored nasal discharge. The presence of a possible sinus infection was determined by observing Gagan prior to conducting experimental analyses for visible signs of colored nasal discharge. A possible sinus infection was considered to be present if Gagan had a visible nasal discharge with a yellowish or greenish color. A possible sinus infection was not considered to be present if Gagan had no visible nasal discharge or had a visible nasal discharge with a clear color. Two experimenters

independently observed Gagan for the presence of a possible sinus infection and independently determined if a possible sinus infection was present. Inter-observer agreement for the presence of a possible sinus infection was evaluated for all sessions and was 100% agreement for all sessions.

Procedures

The functional analysis conditions consisted of procedures similar to those described by Iwata et al. (1994), except for a no interaction condition which resembled an alone condition. The no interaction condition differed from an alone condition due to researchers being present in the room with Gagan but providing no interaction. The presence of researchers during the no interaction condition was comparable to conditions observed in Gagan's classroom, and was necessary due to lack of observation facilities. The attention condition consisted of having a researcher nearby and within eyesight of Gagan but not interacting with Gagan unless he engaged in SIB at which time the researcher delivered a verbal reprimand for approximately 5 s. The demand condition involved the researcher delivering a prompt to work on a task every 30 s using a least to most intrusive prompt hierarchy of verbalization, gesture, or physical assistance, respectively. If Gagan engaged in SIB at any point during the prompting sequence, the demand was terminated until the next scheduled demand delivery. The play condition consisted of having tangible items available throughout the session and a researcher interacting with Gagan at least every 30 s in a non-instructional/non-demanding manner. Each functional analysis condition was conducted once per day. Each condition was 5 minutes in duration and was conducted during periods when a possible sinus infection was considered to be present and during periods when a sinus infection was considered to be absent. Gagan wore his weighted vest during all but 16 functional analysis sessions.

Results

Results obtained in the analysis are shown in Figure 1. During periods when a possible sinus infection was present, Gagan engaged in increased levels of SIB across all conditions. During sessions conducted when illness was considered to be absent, Gagan engaged in low or zero levels of SIB across all conditions. In addition, 8 sessions were conducted when a possible illness was present while Gagan was not wearing a weighted vest. These sessions had similar levels of SIB to sessions conducted when an illness was present and he was wearing a weighted vest. Eight sessions were also conducted with Gagan not wearing a weighted vest during periods when illness was considered to be absent. These sessions appeared similar to other sessions conducted when illness was considered to be absent. Thus, the results suggest that Gagan's SIB reliably occurred at considerably higher levels when signs of illness were present compared to times when there were no signs of illness. The presence and absence of the weighted vest did not affect levels of Gagan's SIB.

See figure 1, next page!

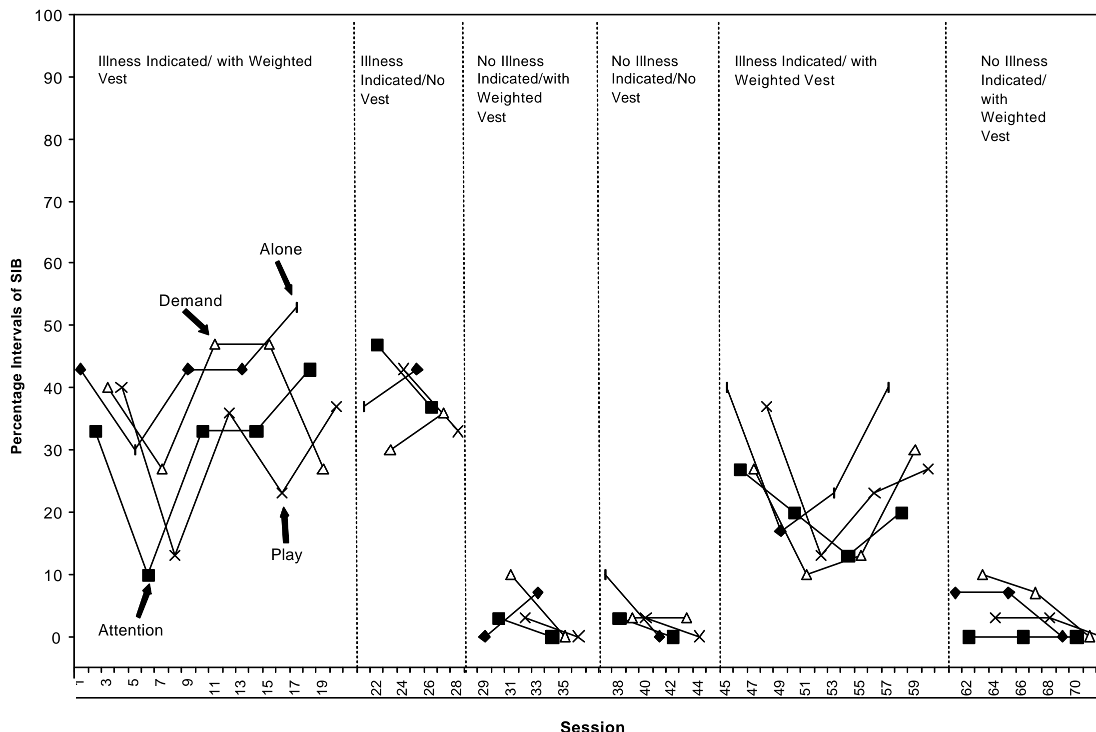

Figure 1. Percent of intervals with SIB.

Discussion

The undifferentiated pattern of responding during the functional analysis combined with persistence of target behaviors during the no interaction condition indicated the SIB was maintained by automatic reinforcement. It was not determined whether the SIB was maintained by automatic negative or automatic positive reinforcement. An overall increase in the level of SIB displayed during sessions when a possible sinus infection was considered to be present provides some potential insight into the specific form of automatic reinforcement maintaining the SIB. An automatic negative reinforcement scenario could be conceptualized as Gagan exhibiting SIB because it may have resulted in a reduction or dispersal of the pain associated with the possible sinus infection. A positive reinforcement scenario could be conceptualized as Gagan exhibiting SIB because it had previously resulted in a pleasurable feeling especially in the presence of a possible sinus infection. In addition, SIB could have served as automatic reinforcement during periods when an illness was considered to be absent due to Gagan experiencing some minor or slight irritations associated with the weather, the temperature, humidity, etc. Based upon anecdotal information from teachers, and low levels of SIB observed during the periods when an illness was considered absent, no specific intervention was recommended other than general preventative strategies for avoiding sinus infections and the importance of treating possible sinus infections at the first indications of such problems.

The lack of a definitive medical diagnosis for the possible sinus infections considered present during the functional analysis is a limitation of this study. The criteria for determining the presence of a possible sinus infection were chosen because the colored nasal discharge had been noted in relation to previous medically diagnosed episodes of sinus infection. It should be noted that due to the lack of a medical diagnosis, a sinus infection may or may not have been present, or the nasal discharge observed

may have been indicative of another illness such as an ear infection. Additional limitations of this study include the lack of treatment data.

The implications of this study include further extending the use of functional analysis procedures to include measures of biological setting events. Kennedy and Meyer (1996) determined that allergy symptoms influenced the outcomes of functional analyses. The current study extended this line of research by evaluating the impact of a possible sinus infection on a young, nonverbal child diagnosed with autism in a classroom situation using teachers as therapists.

Additionally, this study provides a novel contribution to research on assessment of SIB in children with disabilities by evaluating the impact of a sensory integration technique (weighted vest) on the outcomes of a functional analysis for SIB. Considering the popularity of sensory integration techniques for children with autism such as brushing, swinging, and sensory diets; additional research may be warranted on analyzing their impact on functional analysis outcomes and on problematic behaviors. Further empirical evaluation of the effects of sensory integration techniques for treating problem behaviors commonly exhibited by children diagnosed with autism may be pertinent toward determining when and with whom these techniques may be beneficial.

Evaluating the relation between biological events, external environmental events, and behavior in young children through the use of functional analysis methodology may be an area in need of further research. Young children are susceptible to numerous illnesses during their early developmental stages and they may not have developed appropriate behaviors for coping with even minor illnesses. Some of these coping behaviors might include blowing nose, getting additional rest, taking medication, reporting discomfort to caregivers etc. Typically parents may train some appropriate behaviors which result in reinforcement by relieving symptoms of illness. But if these appropriate behaviors are not taught some children may come in contact with ubiquitous reinforcement for inappropriate behaviors which may result in symptom alleviation.

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Behavioral Treatment for Nocturnal Enuresis

Patrick C. Friman and Kevin M. Jones

Abstract

Nocturnal enuresis is one of the most prevalent and distressing of all childhood problems. The treatment of nocturnal enuresis has shifted in the past few decades from a strictly psychopathological perspective to a biobehavioral perspective. Although the primary clinical features of this disorder are medical/organic, there is currently strong evidence for a behavioral treatment package consisting of the urine alarm and various skills-oriented components. Alternative devices, methods, and adjunctive components are reviewed and presented in the context of an optimal treatment plan.
KEYWORDS: Nocturnal Enuresis, Bed-wetting, Urine Alarm

Nocturnal enuresis (NE) is one of the most common of all childhood problems. Prevalence rates vary according to diagnostic criteria, but “frequent” bedwetting, defined as 6 or more episodes in the past year, occurs in approximately 5.5% of children aged 5 to 17 years (Byrd, Weitzman, Lamphear, & Auinger, 1996). For most of these individuals, bedwetting occurs at least twice per week. The need for treatment of NE predates modern civilization and the variety of techniques used in antiquity have been limited only by the imagination of the ancient therapists and their tolerance for inflicting unpleasantness on young children in order to possibly secure therapeutic gain. Penile binding, buttock and sacrum burning, and forced urine-soaked pajama wearing are among the many highly aversive treatments reported in a review of ancient approaches to NE (Glicklich, 1951). In fairness to the ancient therapists, the health-based consequences of prolonged NE during their time were severe, due to the limited means for cleaning bedding and ineffective methods for managing infection. The evolution of treatment for NE that began in earnest early in the 20th century abandoned the physically harsh treatments in favor of approaches that were more humane from a physical perspective but still problematic from a psychological one. Specifically, with the rise of Freudian psychodynamics came psychopathological characterizations of common childhood problems such as NE. Although more protected from harsh physical treatment than their ancestral peers, early twentieth century enuretic children were often subject to stigma, isolation, and other negative social consequences.

The advent of behavioral theory and the conditioning type treatments derived from it inaugurated a virtual paradigmatic shift in the treatment of NE. Specifically, behavioral theory rendered psychopathological interpretations obsolete and highly aversive physical treatments unnecessary. The cardinal conditioning type treatment for NE has been the urine alarm and, if not the first, certainly the foremost early user of it was Herbert Mower (Mower & Mower, 1938). Since the mid 1970’s, psychological research on medically uncomplicated NE in children has been dominated by either the development of alternative behavioral procedures based on operant conditioning or improving urine alarm treatments (Houts, 2000; Mellon & McGrath, 2000). Controlled evaluations of the urine alarm indicate that this relatively simple device is 65 to 75% effective, with a duration of treatment around 5 to 12 weeks, and 6-month relapse rate of 15-30% (Butler, 2004). Most of this research has been conducted using the bed device and, more rarely, the pajama device.

Bed Devices

The urine alarm features a moisture sensitive switching system which, when closed by contact with urine seeped into pajamas or bedding, completes a small voltage electrical circuit and activates a stimulus theoretically strong enough to cause waking (e.g., buzzer, bell, light or vibrator). The device is placed on the bed or sewn into the pajamas (see Table 1 for sample alarms). The bed device typically involves two aluminum foil pads, one of which is perforated, with a cloth pad between them. The bed

pads are placed under the sheets of the target enuretic child's bed with the perforated pad on top. A urinary accident results in urine seeping through perforations in the top pad, collecting in the cloth pad, and causing contact with the bottom sufficient to complete an electrical circuit and activate a sound-based alarm mechanism. In principle, the awakened child turns off the alarm and completes a series of responsibility training steps associated with their accidents (Friman & Jones, 1998), such as completing urination in the bathroom, changing pajamas and sheets, and returning to bed. In practice, the alarm often alerts parents first, who then waken the child and guide them through the training steps.

Table 1.

Sample Urine Alarms

Device	Type	Manufacturer	Approximate Cost
Wet Stop	Pajama, buzzer	Palco Labs Santa Cruz, CA 800-346-4488	$65.00
Potty Pager	Pajama, buzzer	Ideas For Living Boulder, CO 800-497-6573	$49.95
Sleep Dry	Pajama, buzzer	Star Child Labs Aptos, CA 800-346-7823	$45.00
Malem Bedwetting Alarm	Pajama, various combinations of sounds and light	Bedwetting Store Olney, MD 800-214-9605	$74.95
Wet Call	Bed pad, buzzer	Bedwetting Store Olney, MD 800-214-9605	$84.95
Vibrating Enuresis Alarm	Pajama, vibrating	Enabling Devices Hastings on Hudson, NY	$58.95

Pajama Devices

Pajama devices are similar in function yet simpler in design. The alarm itself is either placed into a pocket sewn into the child's pajamas or pinned to them. Two wire leads extending from the alarm are attached (e.g., by small alligator clamps) on or near the pajama bottoms. When the child wets during the night, absorption of urine by the pajamas completes an electrical circuit between the two wire leads and activates the alarm. Wide ranges of stimuli are available for use with the pajama devices and include buzzing, ringing, vibrating, and lighting. In principle, as with the bed devices, the alarm is supposed to waken the child. In practice, the sound-based alarms sometimes alert parents first, who proceed to assist

the child through the steps mentioned above. The light and vibration based alarms have yet to be subjected to controlled evaluation and thus questions pertaining to whether they awaken parent or child, their effectiveness, and how they compare with sound-based alarms remain unanswered.

Child and Parent Focused Methods

Actual alarm use can be divided into different methods, depending on the primary management role of the child and parent. In the child-focused method, the alarm awakens the child, who independently completes the responsibility training procedure. In the parent-focused method the alarm awakens or alerts the parent, who awakens the child and guides them through the procedure. The training procedures vary across published accounts and guides, but generally include full arousal, going to the bathroom to complete (or attempt) urination, changing bedding and pajamas, resetting the alarm, and going back to bed. Parent-focused methods are obviously dependent on the saliency of the alarm stimulus, and with the bed device wire leads can be extended to the parent's auditory range (e.g., in their bedroom). For the pajama device, either a very loud alarm or periodic checking is necessary to allow parents to readily attend to accidents. Although it seems logical that no matter what method or device is used, reduced latency between onset of urination and awakening is best, no data are available to support this position.

Underlying Process

The mechanism of action in alarm treatment was initially described as classical conditioning, with the alarm as the unconditioned stimulus, bladder distention as the conditioned stimulus, and waking as the conditioned response (Mowrer & Mowrer, 1938). More recent literature emphasizes a negative reinforcement or avoidance paradigm (Friman, 1995; Friman & Jones, 1998) in which the child increases sensory awareness to urinary need and exercises anatomical responses (e.g., contraction of the pelvic floor muscles) that effectively avoid setting off the alarm (Mellon, Scott, Haynes, Schmidt, & Houts, 1997). Cures are obtained slowly; however, and during the first few weeks of alarm use the child often awakens only after voiding completely. The aversive properties of the alarm, however, inexorably strengthen those skills necessary to avoid it.

Evidence of Effectiveness

Reports of controlled comparative trials show the alarm-based treatment is superior to drug treatment and other non-drug methods such as retention control training. In fact, numerous reviews of the literature show its success rate is higher and its relapse rate lower than any other method (Doleys, 1977; 1995; Friman & Jones, 1998; Houts, Berman, & Abramson, 1994). One problem with interpreting the review literature on alarm treatment is that adjunctive components are often added to improve effectiveness, resulting in treatment "packages" such as dry bed training (Azrin, Sneed, & Foxx, 1974) or full spectrum home training (Houts & Liebert, 1985).

Contraindications and Initial Concerns

Prior to beginning alarm-based treatment, the child therapist should ensure that a physician has evaluated the enuretic child. Although fewer than 10% of NE cases have pathophysiological causes such as diabetes or urinary tract infections (Houts et al., 1994), alarm treatment for incontinence caused by them may be contraindicated. When organic complications are ruled out, age, developmental level, and motivation levels are cardinal concerns. For example, clinical treatment is not recommended until enuretic boys are at least seven years old or until girls are at least five years old. The difference in ages is due to the lower incidence of NE, higher motivation, and advanced maturation in enuretic girls versus boys. If the enuretic child is not motivated, treatment should be suspended for six months, with follow-up scheduled with the child and family again at that point. In every case, the history of punishment for accidents should be assessed and a verbal commitment obtained by parents, while all are present, to never

again punish or even criticize the child for having one.

Another issue pertains to whether enuretic children are more difficult to awaken than their nonenuretic peers. Enuresis is considered a parasomnia or a manifestation of sleep disturbance by some sleep researchers, and as an outcome of deep sleep by many parents (Friman & Jones, 1998). Generally, findings from studies are mixed and marred by experimental limitations (e.g., sleep stages are not established). A recent study with 15 enuretic boys and 18 controls addressed this problem by employing sleep EEGs and auditory tones delivered via earphones. During 512 arousal attempts enuretic children awoke 8.5% of the time compared to 39.6% of the time for controls (Gellis, 1994). Thus the common parental complaint about bed wetting children who are difficult to awaken may have an empirical basis. Still, sleep dynamics have not been established as a cause of enuresis. Wetting episodes occur in all stages of nonrapid eye movement (NREM) sleep and the probability of their occurrence appears to be a function of the amount of time spent in each stage. Enuretic episodes also rarely occur during REM sleep, therefore thematically related dreams (e.g., dreaming of urinating) may be a result rather than a cause of wetting.

Methods for Augmenting Alarm Treatment

Retention control training (RCT). RCT expands functional bladder capacity by increasing a child's capacity to forestall and thus increase the volume of their urinations. Training requires that children drink extra fluids (e.g., 16 oz of water or juice), notify parents of the urge to urinate and delay urination as long as possible. Parents should establish a regular time for RCT each day, and conclude the training at least a few hours before bedtime. Progress can be assessed by monitoring the amount of time the child is able to delay urination and/or the volume of urine they are able to produce in a single urination (Friman, 1986, 1995; Friman & Jones, 1998). Either or both can be incorporated into a game context wherein children earn rewards for progress.

Overlearning. An adjunct related to RCT involves overlearning. Like the RCT procedure, this method requires that children drink extra fluids – but just prior to bedtime. Overlearning is an adjunctive strategy only, and is used to enhance the maintenance of treatment effects established by alarm-based means. Thus, it should not be initiated until a dryness criterion has been reached (e.g., seven dry nights; Houts & Liebert, 1985).

Kegel/stream interruption exercises. Kegel exercises involve purposeful manipulation of the muscles necessary to prematurely terminate urination. Originally developed for stress incontinence in women, a version of these exercises called stream interruption is often used in NE treatment packages (e.g., Friman, 1995; Friman & Jones, 1998). For children, stream interruption requires initiating and terminating urine flow at least once a day during a urinary episode. "Dry practice" or actual Kegel exercises can be practiced far more frequently once the child has learned to detect and manipulate the requisite musculature while conducting stream interruption. Dry contraction of pelvic musculature consists of the child "holding" a contraction for 5 to 10 seconds, followed by a 5-s rest, at least 10 times on three separate occasions per day (Schneider, King, & Surwitt, 1994).

Paired associations. Paired associations involve pairing stream interruption with the urine alarm in a reward-based program (Friman, 1995; Friman & Jones, 1998). In one version, the parent stands outside the bathroom door with the alarm and activates it two or three times while the child urinates, whereupon the child practices stream interruption. The parent can also use the alarm to cue Kegel (dry practice) exercises. Alternatively, the parent can make an audiotape of the alarm that when played intermittently would allow the child to practice alone with stream interruption and/or Kegel exercises. To establish and maintain motivation, the parent should use praise and a reward system, described in the next section.

Reward systems. Contingent rewards alone are unlikely to cure NE, but they may be critical in

sustaining a child's motivation to participate in treatment, especially when the system reinforces success in small steps. An example involves a dot-to-dot drawing and a grab bag (Friman, 1986; 1995; Friman & Jones, 1998), wherein the child identifies an affordable and desirable prize and the parent draws (or traces) a picture of it using a dot-to-dot format, with every third or fourth dot larger than the others. The child is allowed to connect two dots for each dry night and each time the line reaches a larger dot, they earn access to a grab bag with small rewards (e.g., small toys, edibles, money, privileges, special time with parents). When all dots are connected, the child earns the prize. This system may also be used to motivate participation in other components of a package program (e.g., paired associations).

Waking schedule. This treatment component involves waking the child prior to accidents and guiding them to the bathroom for urination. Results obtained are attributed to a change in arousal, increased access to the reinforcing properties of dry nights, and increased awareness of urinary urge in lighter stages of sleep. Several schedules are possible, a minimally effortful example of which involves waking the child just before the parents go to bed and systematically waking them one-half hour earlier on nights following several successive dry nights, until the child awakens to urinate without assistance (Friman, 1986; 1995; Friman & Jones, 1998; Houts & Liebert, 1985).

Self-monitoring. Self-monitoring provides data that can be used to evaluate progress. One simple method for monitoring NE merely requires the child to record on a calendar whether the previous night was wet or dry. A more complex and more sensitive method involves placing tracing paper over the stain resulting from an accident and tracing the outline of the stain. Next, the tracing paper is placed over a grid, and the number of squares inside the area is recorded (Friman, 1986, 1995). Beyond progress monitoring, charting these data and setting goals may have the additional therapeutic benefit of reactivity: The direction of change is determined by the valence of the behaviors that are monitored (e.g., behaviors viewed negatively are reduced).

Visual sequencing. This procedure involves mentally rehearsing nightime continence skills. Although its empirical support is still at the successful case-report stage, visual sequencing is often included in multicomponent treatment plans (Friman & Warzak, 1990). The procedure involves visualization of the behavioral sequences leading to nocturnal continence. The sequence includes detection of urgency and subsequent contraction of the pelvic floor muscles, followed by either (a) holding urine throughout the night or (b) rising and going to the bathroom. The terminal step in the sequence will likely depend on whether holding urine throughout the night, based on the child's immediate skill level, is a realistic goal. The procedure can be taught and rehearsed in the office. First, the child is asked to sit in a comfortable chair, take three to four deep breaths, close their eyes, and relax fully. Next, the therapist discusses each detail of what will happen at night while asking the child to focus on a mental picture of the details (Friman, 1995; Friman & Jones, 1998).

Responsibility training. All of the skill-based components mentioned thus far (e.g., RCT, paired association) are designed to promote a mature voiding repertoire in the child (Ferber, 1989). To be consistent with this goal, the child should be treated in a way that promotes independence and responsibility. For example, a child should not be left in diapers at night. Rather, the enuretic child should be assigned reasonable household responsibilities associated with their accidents. In younger children this may merely mean bringing their sheets to the laundry basket. Older children, however, should be expected to actually launder sheets and clothing. These responsibilities should not be presented as a punishment but as a correlate of increased responsibility and a demonstration of the parent's confidence in and respect for their maturing child (Friman, 1995; Friman & Jones, 1998; Houts & Liebert, 1985).

Medication. There are two primary drugs used for treatment of NE, imipramine and DDAVP. The former is a tricyclic antidepressant that represents one of the most frequently prescribed drug treatments for NE, although its mechanism for reducing bed-wetting is not clear. Somehow, imipramine makes the bladder less sensitive to filling and thus allows it to hold more urine before urinary urge

(Stephenson, 1979). Synthetic antidiuretics such as DDAVP concentrate urine, thereby decreasing urine volume and intravesical pressure. Due to alarming reports of the potential cardiotoxic effects of imipramine overdose (e.g., Herson, Schmitt, & Rumack, 1979) and other side effects of imipramine, DDAVP has emerged as the most preferable adjunct to treatment (Friman & Jones, 1998).

It is imperative that therapists carefully consider several important issues related to any medication treatment of NE. First, the use of medication does not teach continence skills and may, in fact, diminish sensory awareness and thus reduce opportunities to practice needed responses. In some cases, medications may actually interfere with continence skill training programs (Houts, Peterson, & Liebert, 1984). Once withdrawn, there is a high rate of relapse (Friman & Jones, 1998), so the primary therapeutic gain from medication appears to be a respite from wetting episodes that may allow the enuretic child and family a temporary semblance of normality. Second, it is clear that psychological treatments are generally more effective than pharmacological ones, especially when one considers evidence of *cure* rate (Houts et al., 1994). Past reviews have indicated that research on psychological treatments has typically defined success in terms of the cessation of bed-wetting (e.g., 14 consecutive dry nights), while research on pharmacological treatments has focused on reducing the frequency of bed-wetting episodes. If the goal of treatment is to cure (rather than manage) enuresis, research on psychological treatments have been more closely aligned with this clinical outcome.

Despite its superior efficacy, the urine alarm has only recently gained acceptance in the medical community. A recent survey indicated that physicians recommend this treatment for 80% of enuretic cases, compared to only 5% in prior studies (Vogel, Young, & Primack, 1996). This same survey indicated, however, that medication continues to be recommended for more than half of cases. Although drugs should not be used as a primary treatment (Friman, 1986, 1995; Friman & Jones, 1998), one advantage of medication is that the effects, when they occur, are often established the night they are ingested and thus can be used to improve a child’s chances of having an isolated “dry night” while on a sleep over or at camp. Obviously a physician’s assistance would be necessary to add these drugs to a treatment plan.

Sample Treatment Plan

A sample treatment plan is presented in Table 2. During the assessment phase (Steps 1 – 4), the initial concern is to obtain a history of wetting episodes. There is some evidence that children who wet less frequently and children who wet only at night have a better prognosis (Houts et al., 1994), although the type of enuresis (primary or secondary) does not appear to moderate treatment outcomes. Next, the therapist provides information about enuresis, including the most effective parental response to accidents. For example, the child and parents should be informed that numerous other children, many probably in the child's neighborhood and school, also experience NE. With the child in attendance, the therapist should tell the parents to avoid blaming or shaming the child for wetting. The therapist should then enthusiastically solicit the child's cooperation in treatment and work with the child and family on a treatment plan. No direct treatment is planned until a medical examination is completed and pathophysiological variables are ruled out (Friman, 1986, 1995).

Table 2.

Sample Treatment Plan

Assessment
1. Have physician rule out pathophysiology.
2. Begin initial data collection (e.g., for two weeks prior to first visit).
3. Assess developmental and motivational readiness.
4. Eliminate punishment.

Treatment Planning
5. Establish a trial treatment period (e.g., 3 months).
6. Parent and child select alarm type.
7. Instruct parent to purchase alarm (see Table 1) and protective bed covering.
8. Negotiate for inclusion of adjunctive treatment components with special emphasis on the waking schedule, reward system, and responsibility training.
9. Instruct parent and child to conduct daytime practice of nighttime procedures.

Progress Monitoring and Evaluation
10. See parent and child at least once per month for three months.
11. If progress is limited, negotiate for additional adjunctive components with special emphasis on retention control training and stream interruption.
12. When initial dryness goal is achieved (e.g., one week) add in overlearning component.
13. When 14 consecutive days of dryness have been achieved, discontinue alarm and overlearning.

Address relapses by revisiting steps 4 through 13.

Treatment planning, described in steps 5 – 9, consists of establishing a trial treatment period, the selection and purchase of necessary materials, and the negotiation of treatment components such as daytime practice. The number and selection of treatment components should be based on the provider's assessment of child readiness, child and parent willingness, and family resources, but it is recommended that primary elements include waking schedule, reward system, and responsibility training. These components in the plan can be "titrated" over time in accord with family resources and motivation until cure is obtained. For example, a two-parent, one-wage earner middle-income family with a motivated 10 year-old bed-wetting child whose parents are also motivated could be started out on an alarm-based package that also includes all three adjunctive components. In subsequent weeks, as the child and parents gain facility with the initial alarm package, other treatment components could be added as needed, along with a small prescription of (DDAVP or imipramine) for sleep-overs or campouts.

Families with fewer resources or less motivation to conduct treatment may be given only the alarm until they succeed with it, the home situation changes in a way that favors more complex treatment, or the child’s and/or parent’s motivation heightens. In the rare case in which the child is motivated but the parents are much less invested, only the treatment components that can be independently completed by the child should be prescribed. Unfortunately, this may preclude use of the alarm either because the parents are not willing to purchase one or because the child is not capable of using it without assistance. If an alarm can be obtained, however, older children or sophisticated younger children may be able to master independent use with minimal training provided by the therapist. If not, treatment components that can readily be performed independently may be prescribed (e.g., stream interruption, self-monitoring, urine retention, possibly a waking schedule). The chances for cure are less likely when fewer components are used (especially if the alarm is not used) but still higher than if no treatment were used. Furthermore, the active involvement of the child may lead to increased involvement by the parent, at which point the provider could add more components.

Treatment planning concludes with progress monitoring and evaluation, described in steps 10 – 14. If progress is limited, additional adjunctive components may be added, with primary emphasis on retention control training and stream interruption. When 14 consecutive days of dryness have been achieved, the alarm may be discontinued. As with most enuretic treatments, the potential for relapse is serious concern and follow-up contact should be a routine element of treatment plans.

Conclusions

Bedwetting is the third most distressing experience reported by children, exceeded only by divorce and parental fights (Van Tijen, Messer, & Namdar, 1998). Left untreated, NE will likely persist for years and, in some cases, into young adulthood, with considerable negative social consequences and disruption of family life. Urine alarm treatment is an easily used, highly effective method for treating one of the most prevalent and chronic of all childhood problems. It represents an enormous breakthrough for enuretic children because it does not involve the physically aversive experiences typical of ancient treatments, its effectiveness undermines the historical psychopathological characterization of NE, and it eliminates much of the expense, high relapse, and potential side effects of medication treatment. Furthermore, its effectiveness can be enhanced by combining the alarm with various adjunctive treatment components (Houts et al., 1994). At this point in the evolution of alarm-based treatment, it seems safe to assert that it should be part of the armamentarium of every child therapist seeing children with NE and if it is not, it seems appropriate to pointedly ask why.

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Understanding Intra-response Class Covariation From the Matching Theory Perspective

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Abstract

The purpose of this study was to utilize the matching theory to understand intra-response class covariation as a result of extinction for selected members of the response class versus functional communication training. The participant was a 9-year old girl with a severe disability and problem behaviors. Experimental procedures included functional analysis, extinction, and functional communication training. Results showed that in accordance with the matching theory, responses (problem or adaptive) that were continuously reinforced occurred at a higher rate when compared to responses on extinction. In addition, extinction for some problem responses increased the rate of non-targeted problem responses; however, concurrent reinforcement of a newly learned functionally equivalent communication response increased the rate of this behavior and decreased all problem behaviors.

Keywords: Matching theory, response class, covariation, extinction, functional communication training, developmental disabilities, problem behavior.

Researchers and practitioners continue to be fascinated with understanding and analyzing operant behavior patterns to facilitate the development of enduring behavior support strategies. Toward that goal, the matching theory continues to serve as a foundation for furthering our understanding of the causes of socially mediated behavior specifically for individuals with disabilities and/or behavior disorders. Herrnstein (1970) describes the matching law as a mathematical means for elucidating how behavior responds to concurrent schedules of reinforcement. Stated simply, responses that are consequated with a higher number of reinforcers occur at higher rates than responses that are reinforced at lower (or zero) rates. Both rational and irrational behavior has been explained using the matching theory (Borrero & Vollmer, 2002; Bulow & Meller, 1998; Shriver & Kramer, 1997; Skinner & Robinson, 1996). The basic assumption is that response allocation of operant behavior is a matter of choice.

A choice of any topography over the others at a given point in time is possible only when multiple responses are involved, all of which produce the same functional effect. The literature has described this pattern as a functional response class (Lalli, Mace, Wohn, & Livezy, 1995; Shukla & Albin, 1996; Shukla-Mehta & Albin, 2003; Sprague & Horner, 1992). The concept of response classes is not novel. Still, researchers and practitioners continue to focus attention on understanding what governs choice or the allocation of specific topographies from a class of responses. Such interest has been generated due to observed covariation as a function of concurrently varying rates of reinforcement for the different topographies within a response class (Magee & Ellis, 2000; Parrish, Cataldo, Kolko, Neef, & Egel, 1986). In addition, there has been an observed philosophical shift in the field from the use of decelerative techniques alone in favor of strategies that also lead to increases in adaptive behavior (Carr, Coriaty, & Dozier, 2000; Carr & Durand, 1985; Day, Horner, & O'Neill, 1994; Dunlap, et al, 1995; Horner & Carr, 1997; Horner, Sprague, O'Brien, & Heathfield, 1990; Sugai et al., 2000).

With the advent of hypotheses-based interventions and the focus on identification of multiple topographies within a functional response class, application of the matching theory to understand behavioral allocation has gained momentum. If some topographies within a response class are consequated with a richer schedule of reinforcement (positive or negative), these will occur at higher rates. Our clinical experiences show that more severe topographies of problem behaviors usually lead to a functional reinforcer, example, escape from non-preferred tasks, attention form others, access to tangible objects, and/or sensory reinforcement. Less severe topographies of problem behavior tend to be inadvertently ignored or systematically placed on extinction (which technically means no delivery of a

functional reinforcer). From the matching theory perspective, if less severe topographies from a functional response class are placed on extinction, other, perhaps more severe topographies of problem behavior will occur at higher rates, especially if they successfully produce a functional reinforcer. Therefore, it appears to be more logical to add a functionally equivalent response to the existing class of responses that would produce the same functional reinforcer, yet, be socially appropriate in nature (Day, Horner, & O'Neill, 1994; Durand, & Carr, 1992; Lalli, Casey, & Kates, 1995; Shukla & Albin, 1996; Shukla-Mehta & Albin, 2003; Sprague & Horner, 1992).

The matching theory is a useful heuristic for understanding laws that govern human behavior. This purpose of this study was to assess intra-response class covariation as a function of implementation of (a) continuous reinforcement versus extinction for one or more problem behaviors within a response class, and (b) functional communication training concurrently with extinction on the rate of occurrence of both problem and adaptive responses within the response class.

Method

Participant and Setting

Hanna was 9 years old at the time of the study. She was labeled as having severe to profound mental retardation. She also received medication for seizure control. Hanna used verbal language but her speech was mostly unintelligible even in her native language. Hanna was selected to participate in this study because she displayed severe problem behaviors included piercing screaming, throwing/kicking objects, and arching head/body backwards. All direct observations, functional assessment and intervention procedures were conducted in the participant's home environment.

Measurement

Equipment. A direct-videotaped observation of student and instructor behaviors was conducted. Video data were directly coded on a PC using a software package for simultaneous real-time recording of multiple behaviors (Portable Computer Systems for Observational Use) (Repp, Harman, Felce, Van Acker, & Karsh, 1989; Repp, Felce, & Karsh, 1991). A keyboard key for each measurement variable was assigned in order to record the rate, frequency, and duration of events.

Measurement variables. The primary dependent measure was the response per minute of problem and communication behaviors for Hanna. Target behaviors included screaming (loud and piercing), throwing/kicking objects (hurling objects across the room), and arching head/body backwards (jerking head or whole body backwards). Other topographies that emerged later include flopping on the floor (sitting down and refusing to get up), and hitting and kicking others (making audible contact with any part of another person's body).

Interobserver agreement. Two undergraduate students received extensive training in data collection and coding activities. One of these students served as a primary coder and another was a reliability coder. Both were naive to the hypotheses of the study. Training was provided by the first author until a criterion of at least 90% overall and at least 80% agreement on each individual behavior was achieved for three consecutive sessions. A tolerance setting of 3 seconds was used to compute reliability, meaning that an agreement was scored if both observers pressed the same key within +/- 3 seconds of each other. Interobserver agreement was computed for 40% of the sessions where the overall agreement across all variables was reported to be 97% (range 60-100).

Assessment of conditional probability. The secondary dependent measures were conditional probabilities computed at lag 1 for the various experimental phases. Video data coded on desktop

computers were analyzed to assess the sequential relationships between variables of interest (Bakeman & Gottman, 1986). The software program called Sequential Data Analysis (SDA) developed by Sprague and Shamee (1992) was used to calculate sequential relationships through computation of conditional probabilities. The SDA program generated conditional probabilities and Z scores (Whitehurst, Fischel, DeBaryshe, Caufield, & Falco, 1986). The Z scores determine the statistical significance of conditional probabilities, when compared to the base rates for each variable. Sequential relationships were assessed between (a) multiple problem behaviors within the response class, and (b) problem and communication behaviors given a specific instructor behavior (e.g., give desired object).

Assessment of response effort and intensity. Indirect measures were used to assess the physical effort involved in performing specific behaviors and their intensity (i.e., impact on others). Perceived response effort and intensity for individual problem and communication behaviors for Hanna were measured on a scale of 1-10. Sixteen experienced special education professionals who were naïve to the purpose of this assessment, observed selected video clips (3-5 second duration each) of the participant performing individual responses from the response class. Three independent samples of each behavior were presented in a random order. Special education professionals first rated and then rank ordered Hanna's these responses on a scale of 1-10, from least to most on perceived physical effort and intensity. These ratings and rankings were compiled to analyze the relation between perceived response effort and intensity, and the observed hierarchy of responses in a response sequence.

Design and Procedures

An Alternating Treatment design (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982; Northup et al., 1991; Steege, Wacker, Berg, Cigrand, & Cooper, 1989) was used to document the result of functional analysis of problem behavior. An ABAB'CDC design was used was used to document the effect of implementation of continuous reinforcement (CRF) for all responses, extinction (EXT) for selected responses, and functional communication training (FCT) (Barlow & Hersen, 1987). Procedures for each are described below.

Initial functional assessment interviews and observations were conducted to obtain preliminary information regarding the events and conditions that maintained problem behaviors for Hanna (O'Neill, Horner, Albin, Storey, & Sprague, 1990). Descriptive data indicated that Hanna engaged in multiple topographies of problem behaviors that appeared to be maintained by access to preferred objects, escape from task demands, and access to social attention from adults. Observations also indicated that when task demands were presented, Hanna's problem behavior escalated when she was unable to access task materials and/or objects like magazines, being able to hold a book herself instead of an adult reading the book to her and working with a preferred person. The focus of this study was to intervene in the Tangible context where problem behaviors were maintained by positive reinforcement (access to desired objects).

Functional Analysis. An experimental analysis of problem behaviors was conducted to isolate maintaining variables and to verify multiple topographies that formed a single or multiple functional response classes (Iwata et al., 1982; O'Neill et al., 1990). Procedures for Hanna included 5-min sessions across 4 different conditions, i.e., Demand, Tangible, Attention, and Play. During these procedures, each occurrence of problem behavior was functionally reinforced with escape, access to desired objects, and attention respectively. Any occurrence of problem behavior during Play was ignored.

Extinction. An EXT procedure was implemented using an ABAB' design for Hanna using strategies recommended by Iwata, Pace, Cowdery, and Miltenberger (1994). Phase A (Baseline) represented continuous reinforcement (CRF) for all (problem) behaviors. During Phase B, a single behavior (i.e., screaming) was placed on extinction while all other problem behaviors were maintained on a CRF schedule via access to preferred objects. The purpose was to document the effect of putting the

most frequently occurring behavior on EXT. This condition was followed by a reversal to the CRF schedule. This phase was followed by implementation of EXT for throwing objects (phase B') while other problem behaviors including screaming were maintained on a CRF schedule. In accordance with the matching theory, it was hypothesized that responses placed on EXT (which technically means no delivery of reinforcement) would occur at a lower rate when compared to the base rate for these responses or other responses that were on concurrently on a CRF schedule.

Functional Communication Training. An experimental analysis of functional communication training (FCT) was conducted demonstrate (a) the effectiveness of FCT in decreasing or eliminating problem behaviors, and (b) the pattern of intra-response class covariation as a function of addition of a new, functionally equivalent response to the extinction process. Analysis of FCT (phase C) was documented across three phases following the extinction analysis. Hanna was taught to verbally ask for preferred objects ("I want ...") in her native language. Training for the new response followed similar procedures as documented in the existing literature for FCT and the matching theory (Bird, Dores, Moniz, & Robinson, 1989; Carr & Durand, 1985; Jayne, Schloss, Alper, & Menscher, 1994; Wacker et al., 1990). This phase (D) was followed by concurrent implementation of EXT (communication) and CRF (problem behaviors). The study ended with a reversal to CRF for all communication responses (phase C). It was hypothesized that a CRF schedule for a functionally equivalent response would increase its rate when compared to responses concurrently on EXT.

Results

Visual Analysis of Data

Functional Analysis. Functional analysis data for Hanna are presented in Figure 1. Data indicated the highest rate of problem behaviors for Tangible (*M* = 2.3, range = 1.2-3.6 per minute) followed by Demand (*M* = 1.7, range = 0.8-3.4) and Attention (*M* = 1.2, range = 0.0-5.0) where three of the five sessions showed zero rates. Data showed fairly low rates of problem behaviors in the Play condition (*M* = 0.3, range = 0.0-0.9 per minute). The different topographies of problem behaviors observed in the Tangible condition included screaming, throwing/kicking objects, and arching backwards. No adaptive behavior was observed.

Overall, data from functional analyses for Hanna supported the hypothesis that problem behaviors were positively reinforced by access to tangible objects and negatively reinforced by escape from task demands. Because inability to access tangible objects appeared to be of greater concern for parents, it was determined that subsequent experimental procedures related to this function would be addressed.

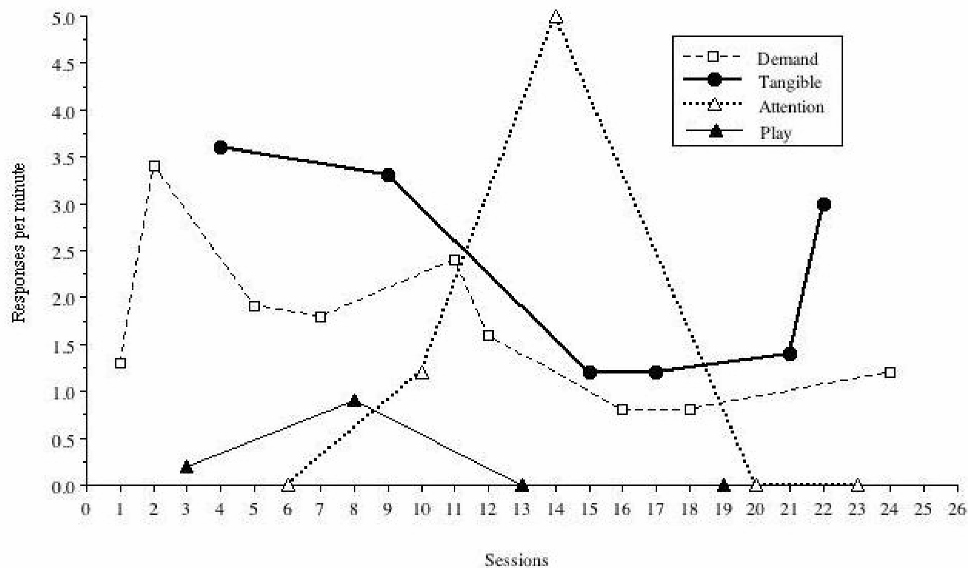

Figure 1. RPM of total problem behaivors for Hanna during Functional Analysis.

Extinction: Data are presented in the ABAB' portion (first four panels) of the design in Figure 2. Data for the first CRF condition (Baseline, phase A) indicated that when all problem behaviors were on a CRF schedule, they occurred at the mean rate of 2.3 per minute (range = 0.3-3.2). Of the total problem behaviors, screaming occurred at the highest rate per minute (*M* = 1.2, range = 0.4-3.1) (charted separately in Phase A). Figure 3 shows the mean rate for individual responses across the different experimental phases. Other problem behaviors included throwing objects (*M* = 0.7, range = 0.0-2.6), arching backwards (*M* = 0.3, range = 0.0-0.6), and walking away (*M* = 0.1, range = 0.0-0.4). Data indicated a pattern of intra-response covariation where early responses (e.g., screaming or throwing) occurred at a higher rate because of contingent reinforcement.

The next phase involved EXT for screaming while all other responses were maintained on the CRF schedule. The purpose was to document the effect of putting the most frequently occurring behavior on EXT. Results showed that while the mean rate of screaming slightly decreased from 1.2 pm to 1.0 pm (range = 0.0-2.3), no dramatic effects or changes were observed as a result of EXT. However, the mean rate of other problem behaviors which were on a CRF schedule, showed an increase including throwing/kicking objects (*M* = 1.0, range = 0.2-1.6), and arching backwards (*M* = 0.8, range = 0.0-1.6). It is interesting to note, however, that as a function of implementation of EXT for one response, two new responses emerged during this condition, namely, flopping on floor (*M* = 0.1, range = 0.0-0.2) and hitting instructor (*M* = 0.1, range = 0.0-0.2) even though the mean rates were low (see Figure 3). Another outcome was that EXT for screaming was that this response started to co-occur with other topographies of the same response class, example, throwing objects and arching backwards.

A reversal to CRF (all responses) showed a high variability in the rate of individual responses (see Figure 2). Throwing/kicking objects occurred at the highest rate during this phase (see Figure 3). This response was placed on extinction during the following phase (B'). Results showed a dramatic decrease in the mean rate for that response, reducing from 1.5 pm in the previous phase to 0.4 per minute. However, when compared to the previous phase, screaming and walking away occurred at a higher rate per minute (see Figure 3). Decrease in throwing/kicking objects may be because (a) the extinction contingency was in effect for each occurrence regardless of whether it occurred by itself or co-occurred

with other responses, and (b) other problem behaviors inadvertently got extinguished when they co-occurred with throw/kick, e.g., screaming.

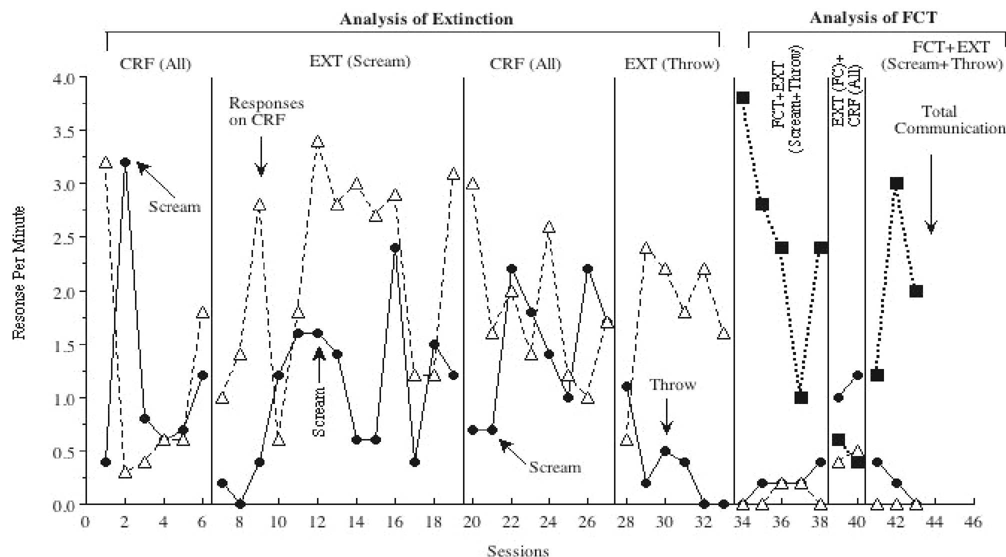

Figure 2. Response per minute of total problem behaviors and total communication versus behaviors on Extinction for Hanna.

To summarize, the first four experimental phases (ABAB') for Hanna showed that responses on a CRF schedule occurred at higher rates whereas responses on EXT occurred at a relatively lower rate. Implementation of EXT also produced new topographies of problem behavior and screaming started to co-occur with other responses. From the perspective of the matching law, if problem behavior is more likely to occur until a functional reinforcer is produced, it appears to be more logical to add a functionally equivalent response to the existing class of responses that would produce the same functional reinforcer, yet, be socially appropriate in nature.

Functional Communication Training: Data for functional communication training (FCT) concurrent with EXT for screaming and throwing (CDC phases in Figure 2) showed an immediate increase in both prompted (1.3 per minute) and unprompted (1.2 per minute) communication, and a dramatic decrease in the mean rate for total problem behaviors (from 2.2 to 0.2 per minute) (See Figures 2 and 3). Throughout FCT, the mean rate for total (prompted and unprompted) communication was as high (2.5) as total problem behaviors (2.7 per minute) during CRF (All) and EXT conditions. Interestingly, while responses on EXT (throw/kick and scream) occurred at a lower rate, zero rates were observed for other problem behaviors on a CRF schedule. Overall data for this phase showed support for the matching theory, demonstrating increases in communication responses as a function of CRF for these behaviors.

FCT was followed by an EXT for communication and CRF for all problem behaviors. Data for this phase need to be treated with some caution because effect was documented only for two sessions due to ethical considerations. Data indicated a decreasing trend for UC demonstrating the effect of EXT. As a result of the CRF schedule, problem behavior showed an increasing trend (Figure 2). A reversal to CRF (UC/PC) and EXT (throw/scream) showed an increase in mean rate for UC (*M* = 1.4, range = 0.6-2.2) and PC (*M* = 0.7, range = 0.6-0.8). Problem behaviors decreased in mean rate from 1.4 in the previous phase to 0.2. Both throw/kick and screaming showed zero rates for the last session and UC showed a reasonably high rate (1.4). As before, since the initiation of FCT, zero rates were also observed for arching backwards, hitting instructor, walking away, and flopping on floor (see Figure 3).

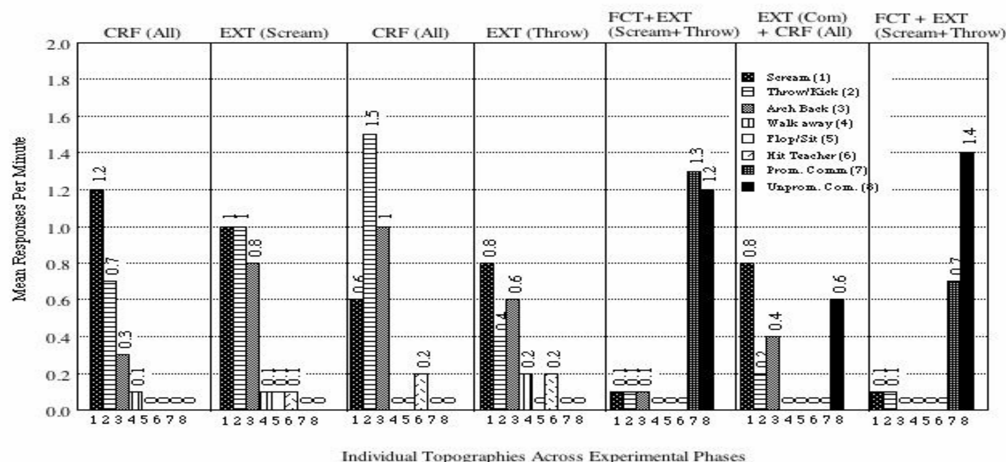

Figure 3. Mean rate of individual topographies across the experimental phases for Hanna.

A summary of results of functional communication training for Hanna combined with extinction for two problem behaviors from the response class showed that (a) a functionally equivalent communication response successfully competed with and replaced or decreased problem behaviors, and (b) Intra-response class covariation as a function of CRF for communication and EXT for problem behaviors was more successful in managing severe problem behavior.

Assessment of Conditional Probabilities

As noted earlier, conditional probabilities (CP) were computed at lag 1 to assess the sequential relationship between (a) individual problem behaviors, responses on EXT, and communication responses within a response class maintained by access to tangible objects, and (b) problem and communication behaviors given a specific instructor behavior (e.g., give desired object). The data are presented in Tables 1 through 4. When all problem behaviors were on a CRF schedule, the CP of screaming given flopping was 50% and given arching backwards, the CP of walking away was 25% (see Table 1).

Table 1
Lag 1 Conditional Probability of Individual Problem Behaviors for Hanna given CRF (All Responses)

Behaviors	Scream	Throw	Arch Back	Walk	Flop	Hit
Scream	0.03	0.02	0.10	0.0	0.0	0.0
Throw	0.12	0.37	0.01	0.0	0.0	0.0
Arch Back	0.09	0.03	0.02	0.25**	0.0	0.0

Walk Away	0.0	0.0	0.50	0.0	0.0	0.0
Flop on Floor	0.50**	0.0	0.0	0.0	0.0	0.0
Hit Instructor	0.0	0.0	0.0	0.0	0.0	0.0

**p<.01

When screaming was placed on EXT (see Table 2), the CP of other behaviors given screaming was 47%. When throwing objects was placed on EXT (see Table 3), given throwing objects, the CP of another throw was 42%. Data also showed that given other problem behaviors not on EXT, the CP of occurrence of any of these behaviors was 93%. When FCT was implemented, the CP of communication given hitting instructor was 100% even though communication was not prompted whereas hitting was reinforced with a tangible item (see Table 4). The CP of screaming following the first scream was 20%.

Table 2
Lag 1 CP of Screaming versus other Problem Behaviors during EXT (Scream)

Behaviors	Scream	Other
Scream	0.38	0.47*
Other	0.07	0.93

**p<.05. **p<10. ***p<001

Table 3
Lag 1 CP of Throwing versus Other Problem Behaviors given EXT (Throw)

Behavior	Throw	Other
Throw	0.42***	0.16
Other	0.20	0.93*

**p<.05. **p<10. ***p<001

Table 4
Lag 1 CP of Communication versus Problem Behaviors given FCT+EXT (Scream & Throw) and for EXT (FC) + CRF (All Responses)

FCT+EXT (Throw & Scream)

Behavior	Communication	Scream	Throw	Arch Back	Hit
Communication	0.31	0.0	0.0	0.0	0.0
Scream	0.20	0.20**	0.02	0.10	0.0
Throw	0.0	0.0	0.37	0.01	0.0
Arch Back	0.0	0.0	0.03	0.02	0.0
Hit Instructor	1.0*	0.0	0.0	0.0	0.0

EXT (FC) + CRF (All Responses)

Behavior	Communication	Scream	Throw	Arch Back
Communication	0.31	0.0	0.0	0.0
Scream	0.20	0.20**	0.02	0.10
Throw	0.0	0.0	0.37	0.01
Arch Back	0.0	0.0	0.03	0.02

**p<.05. **p<10. ***p<001

Data that address the hypothesis regarding the relationship between Hanna's and instructor behavior (e.g., give tangible object) are presented in Table 5. When a tangible object was given for screaming, the CP of screaming 50% during the first CRF phase, whereas the CP of occurrence of other responses was 11%. When screaming was placed on EXT, the CP of throwing was 31%. During the second CRF condition, giving a tangible was more likely to be followed by throwing (49%) and other problem behaviors (34%). The CP of communication responses during FCT was 44%.

Assessment of Response Effort and Intensity

As noted earlier, sixteen special education professionals rated and rank-ordered Hanna's individual topographies on a scale of 1-10 from least to most physical effort and intensity. Rating for physical effort showed the following order from least to most effortful: Saying, "I want..." (1.8), throw objects (2.7), walk away (3.0), flop on the floor (3.3), scream (3.5), arch backwards (3.5), and hit/kick instructor (4.1). Rank ordering of the effortfulness of responses from least to most showed the following

order: Saying, "I want..." (1), walk away (2), throw objects (3), scream (4), flop on the floor (5), arch backwards (6), and hit/kick instructor (7).

A rating of response intensity showed the following order from least to most intense: Saying, "I want..." (1.7), walk away (3.2), throw objects (3.5), flop on the floor (3.5), arch backwards (3.8), hit/kick instructor (4.1) and scream (4.1). Interestingly, the rank order of responses from least to most intense showed an identical order.

Table 5
Lag 1 CP of Communication versus Problem Behaviors given Instructor "Giving Object"

	Communication	Scream	Throw	Other
Phase 1: CRF (All)	0.0	0.50*	0.17	0.11*
Phase 2: EXT (Scream)	0.0	0.27	0.31*	0.29
Phase 3: CRF (All)	0.0	0.14	0.49	0.34*
Phase 4: EXT (Throw)	0.0	0.36***	0.13	0.49*
Phase 5: FCT + EXT (Throw & Scream)	0.44**	0.0	0.12	0.0
Phase 6: EXT (FC) + CRF (All)	0.0	0.0	0.0	0.20
Phase 7: FCT + EXT (Throw & Scream)	0.0	0.0	0.0	0.0

**p<.05. **p<10. ***p<001

Discussion

The purpose of this investigation was to explain intra-response class covariation from the matching theory perspective. Visual and conditional probability data showed that when EXT was applied to some early occurring members of the response class, (a) the same behavior (e.g., screaming) occurred at a higher than baseline rate (i.e., extinction burst) or co-occurred with other problem behaviors, and (b) new topographies of problem behaviors emerged even though others members of the class were reinforced (i.e., allocation of new responses to the existing class). Similar results were noted in a study involving two students with disabilities (Magee & Ellis, 2000). The authors placed one less severe but more frequent problem behavior on extinction. As a result, the behavior on extinction decreased but other more severe problem behaviors which were not on extinction (e.g., object destruction for one student and aggression for another) increased in occurrence.

It is this reason that addition of a functionally equivalent alternative response to the response class is essential. Research has shown that FCT has been very effective in not only increasing adaptive behavior but concurrently decreasing problem behavior. In fact, some researchers are using FCT as a tool for preventing severe problem behavior (Reeve & Carr, 2000).

One variable that makes functional communication so effective is its relative efficiency. Efficiency is described with respect to the amount of physical effort it takes to produce a response, the schedule and quality of reinforcement, and the latency of effect (Billington & DiTommaso, 2003; Day, Horner, & O'Neill, 1994; Horner & Day, 1991; Horner, Sprague, O'Brien, & Heathfield, 1990). Horner and colleagues have demonstrated that when a functional equivalent response is less effortful, operates on a rich schedule of reinforcement, and/or also provides immediate reinforcement, it successfully competes with problem behavior. From the perspective of the matching theory, as more efficient responses (e.g., functional communication) increase, less efficient responses (e.g., severe problem behavior) decrease.

In this study, the perceived ratings and rankings of response effort and intensity by special education professionals showed screaming as the most intense and effortful response. Screaming also produced an immediate effect through access to a tangible object more often than not due to the impact of the response on others including in contexts outside of the intervention. Thus, if immediacy of effect is critical, then the response would be more likely to occur even if it is physically more effortful. The only other response that competed successfully with problem behavior was functional communication. Again, using the Matching Theory's explanation, because functional communication operated on a CRF schedule, its rate of occurrence increased, whereas the most frequent problem behaviors which were placed on EXT, showed a decreased rate of occurrence. Future research might apply the matching law using the power equation formula to compare conditions for FCT versus EXT to study the effects on response covariation.

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