DIFFERENTIAL RESPONDING IN THE PRESENCE AND ABSENCE OF DISCRIMINATIVE STIMULI DURING MULTIELEMENT FUNCTIONAL ANALYSES

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We evaluated the extent to which discriminative stimuli (S^Ds) facilitate differential responding during multielement functional analyses. Eight individuals, all diagnosed with mental retardation and referred for assessment and treatment of self-injurious behavior (SIB) or aggression, participated. Functional analyses consisted of four or five assessment conditions alternated in multielement designs. Each condition was initially correlated with a specific therapist and a specific room color (S^Ds), and sessions continued until higher rates of target behaviors were consistently observed under a specific test condition. In a subsequent analysis, the programmed S^Ds were removed (i.e., all conditions were now conducted by the same therapist in the same room), and sessions continued until differential responding was observed or until twice as many sessions were conducted with the S^Ds absent (as opposed to present), whichever came first. Results indicated that the inclusion of programmed S^Ds facilitated discrimination among functional analysis conditions for half of the participants. These results suggest that the inclusion of salient cues may increase either the efficiency of functional analyses or the likelihood of obtaining clear assessment outcomes.

DESCRIPTORS: assessment, discriminative stimuli, functional analysis

Functional analysis methodology is a widely used assessment procedure for identifying variables that maintain problem behavior. The most common way of sequencing conditions in a functional analysis is the multielement design (e.g., Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994), in which behavior is measured under rapidly alternating conditions until differential responding is observed. The main advantages of the multielement design include its efficiency in comparing the effects of several independent variables on behavior and its ability to minimize multiple treatment interference due to historical effects associated with prolonged exposure to any one condition (e.g., as might occur in a reversal design).

The main disadvantage of the multielement design is another type of multiple treatment interference, that resulting from alternation or contrast effects associated with rapidly changing conditions (Higgins Hains & Baer, 1989). Such effects may either prolong the course of assessment or obscure its outcome entirely.

Several procedures have been developed to reduce multiple treatment interference in multielement designs. For example, McGonigle, Rojahn, Dixon, and Strain (1987) observed that longer intercomponent intervals (time between sessions) had an attenuating influence on multiple treatment interference. They obtained differential effects on hand mouthing and disruptive noncompliance when treatment conditions were separated by 120 min but not when they were separated by 1 min. Although similar results might be obtained with intercomponent intervals much shorter than 120 min, a more efficient method for producing differential

responding might consist of correlating differential consequences with distinctive cues (discriminative stimuli or S^Ds) to enhance discrimination among conditions. For example, Redd (1969) observed differential effects on the play behavior of 2 boys under alternating reinforcement schedules (contingent, noncontingent, and mixed) when each schedule was implemented by a different adult, suggesting that the adults came to function as S^Ds. That is, the participants reacted to the presence of the different adults in a manner consistent with the schedules of reinforcement those adults had implemented in the past. In a more recent study, Hanley, Piazza, Fisher, Contrucci, and Maglieri (1997) used different-colored poster boards to enhance discrimination between treatment conditions.

Although the effects of including S^Ds during multielement functional analyses have not been formally evaluated, results such as those reported by Redd (1969) suggest that the inclusion of S^Ds may facilitate differential responding and thereby reduce the number of sessions required to identify maintaining contingencies for problem behavior. In addition to increasing the efficiency of extended functional analyses, the inclusion of S^Ds during assessment might improve the accuracy of brief functional analyses. Rapid discrimination is especially critical when conducting brief functional analyses, in which exposure to assessment contingencies may be limited to one or two sessions. Under such circumstances, differential responding requires immediate contact with the contingencies of a test condition as well as immediate discrimination of the changed contingencies associated with a subsequent condition. For example, in a large-scale evaluation of the brief functional analysis ($N = 79$), Derby et al. (1992) noted that unclear outcomes were obtained in about half of their cases, and it is possible that discrimi-

nation failures accounted for some of these negative results.

Given the potential benefits of enhancing discrimination among functional analysis conditions, the purpose of this study was to determine the extent to which programmed S^Ds facilitated differential responding during mulielement functional analyses. Individuals referred for assessment of problem behavior were exposed to two functional analyses. During one analysis, each condition was correlated with a specific therapist and room color (S^Ds present); during the other analysis, all conditions were conducted by the same therapist in the same room (S^Ds absent).

METHOD

Participants, Setting, and Target Behaviors

Eight individuals who lived at a state residential facility participated. All had been diagnosed with profound mental retardation and had limited adaptive repertoires, including significant deficits in self-care skills, instruction following, and expressive language. They had been referred to a day-treatment program for assessment and treatment of self-injurious behavior (SIB) or aggression. Bob was a 45-year-old man who exhibited SIB (face picking, defined as pressing a fingernail against the skin on the face; or hand mouthing, defined as placing a hand past the plane of the lips or touching the hand to the tongue). Annette was a 31-year-old woman who exhibited SIB (hitting, defined as banging arms or wrists against hard surfaces) and aggression (hitting, scratching, pinching, or kicking others or throwing objects at them). Jed was a 33-year-old man who exhibited SIB (wrist biting, defined as closing the teeth against the skin on the wrist). Max was a 37-year-old man who engaged in SIB (striking his open or closed hand against any hard surface). Janet was a 43-year-old woman who engaged in SIB (face picking and tap-

ping, defined as scraping or touching either scar tissue or a wound on the face with her hand). Mary was a 52-year-old woman who engaged in SIB (head banging, defined as striking her head against any hard surface; and self-hitting, defined as striking her head or body with a hand). Richard was a 33-year-old man who engaged in SIB (face hitting, defined as striking the head or face with an open or closed hand; body hitting, defined as slapping an elbow into the side of the body; and hand biting, defined as closing the teeth against the skin of the hand). Shelby was a 29-year-old woman who engaged in SIB (head and face hitting, defined as hitting or slapping the hand against the head or face; and hand biting, defined as closing the teeth against the skin on the hand).

All sessions were conducted in therapy rooms at the day-treatment program, which contained tables, chairs, and other relevant session materials (see below). Sessions were 10 min in length and were conducted two to four times daily, 4 or 5 days per week.

Response Measurement and Reliability

Data on these behaviors were collected by trained observers using handheld computers (Assistant Model AST 102) and were summarized as number of responses per minute. Interobserver agreement was assessed during a mean of 33.5% of the sessions (range, 16.7% to 41.7%) by having two observers collect data simultaneously but independently. Session time was divided into continuous 10-s intervals, and interobserver agreement was determined based on interval-by-interval comparisons of the observers' records. Agreement percentages were calculated by dividing the smaller number of responses recorded in each interval by the larger number, averaging those fractions, and multiplying by 100%. Mean interobserver agreement across participants was 96.9% (range, 74.6% to 100%). The low of 74.6% agreement was atypical and occurred during one session in

which both observers scored over 200 occurrences of the target behavior in 10 min. Examination of the data for that session indicated that one of the observers was unable to score as quickly as the other observer. All other sessions had agreement scores that exceeded 80%.

Procedure

All individuals were exposed to four assessment conditions (attention, demand, alone, and play) based on procedures described by Iwata et al. (1982/1994), which were arranged in a multielement design. Annette, Jed, Max, Richard, and Shelby were also exposed to a fifth condition (tangible) based on reports from caregivers suggesting that access to specific items may have maintained their problem behavior. During the attention condition (a test for the influence of social-positive reinforcement), a participant and therapist were in a room containing leisure materials to which the participant had free access throughout the session. The therapist ignored all of the participant's behavior, except to deliver attention (expressions of concern accompanied by brief physical contact of a comforting nature) following each occurrence of a target behavior. During the tangible condition (another test for the influence of social-positive reinforcement), the participant and therapist were present in a room containing preferred items. The items were within sight of the participant, but were made available briefly only following occurrences of a target behavior. During the demand condition (a test for the influence of social-negative reinforcement), the participant and therapist were seated at a table. The therapist initiated learning trials using a three-prompt sequence (instruction, demonstration, physical guidance) either continuously (Annette) or every 30 s (all others). The therapist delivered praise contingent on compliance but terminated the trial and ignored the participant

contingent on occurrences of a target behavior. During the alone condition (a test for the influence of automatic reinforcement), the participant was in a room alone and had no access to any leisure materials. During the play condition (control), the participant and therapist were present in a room containing leisure materials. The participant had free access to the materials throughout the session, and the therapist delivered noncontingent attention to the participant at least once every 30 s.

Experimental Design

All functional analyses were conducted using multielement designs. Within-subject examination of the influence of S^Ds required that participants be exposed to two functional analyses (one with S^Ds present and another with S^Ds absent), which raises the issue of possible sequence effects. To the extent that S^Ds facilitated discrimination, differential responding would be expected to occur immediately in their presence if it already had occurred in their absence. That is, if differential responding was observed initially during the S^Ds-absent assessment, and if the S^Ds-present assessment always followed, the latter assessment would always prove superior. Therefore, the S^Ds-present assessment was always conducted first, followed by the S^Ds-absent assessment. Although this sequence biased results in favor of the S^Ds-absent assessment, it provided a more conservative estimate of the number of sessions required for each participant to show differential responding in the presence of S^Ds. The S^Ds were removed in a staggered fashion across participants, conforming to a multiple baseline design. A reversal design, in which the S^Ds were first removed and then later reinstated, was conducted with 1 participant (Max) because his results differed noticeably from those obtained for other participants.

Phase 1: S^Ds present. During this phase, each functional analysis condition was al-

ways conducted by a specific therapist in a room that was painted a specific color (e.g., attention sessions were conducted by Therapist 1 in the red room, demand sessions were conducted by Therapist 2 in the green room, etc.). Sessions continued until higher rates of target behaviors were consistently associated with a particular test condition.

Phase 2: S^Ds absent. At the beginning of this phase, the programmed S^Ds were withdrawn. That is, sessions were conducted as in Phase 1, except that the same therapist conducted all sessions in the same room (therapist and room selection were randomly determined across participants). Phase 2 was conducted until higher rates of target behaviors were consistently associated with a specific test condition, or until twice as many sessions were conducted as during Phase 1, whichever came first. The Phase 1 and Phase 2 functional analyses for Janet, Mary, and Shelby were separated by treatment conditions not reported in this study (all other functional analyses were conducted back to back).

RESULTS

Figure 1 shows results of the functional analyses for Bob, Annette, Jed, and Max (note that portions of the data for Annette, Jed, and Max also appear in Worsdell, Iwata, Hanley, Thompson, & Kahng, 2000). Bob's data in Phase 1 showed that his highest rates of SIB occurred in the attention condition. When the S^Ds were withdrawn in Phase 2, it took twice as many sessions (40) to identify the same behavioral function. Annette's SIB and aggression occurred most frequently in the attention condition during Phase 1, but this pattern was temporarily disrupted when the S^Ds were withdrawn in Phase 2. Jed's data in Phase 1 showed higher rates of SIB associated with the tangible condition. Withdrawal of S^Ds in Phase 2 resulted in a disruption that lasted for approximately 25
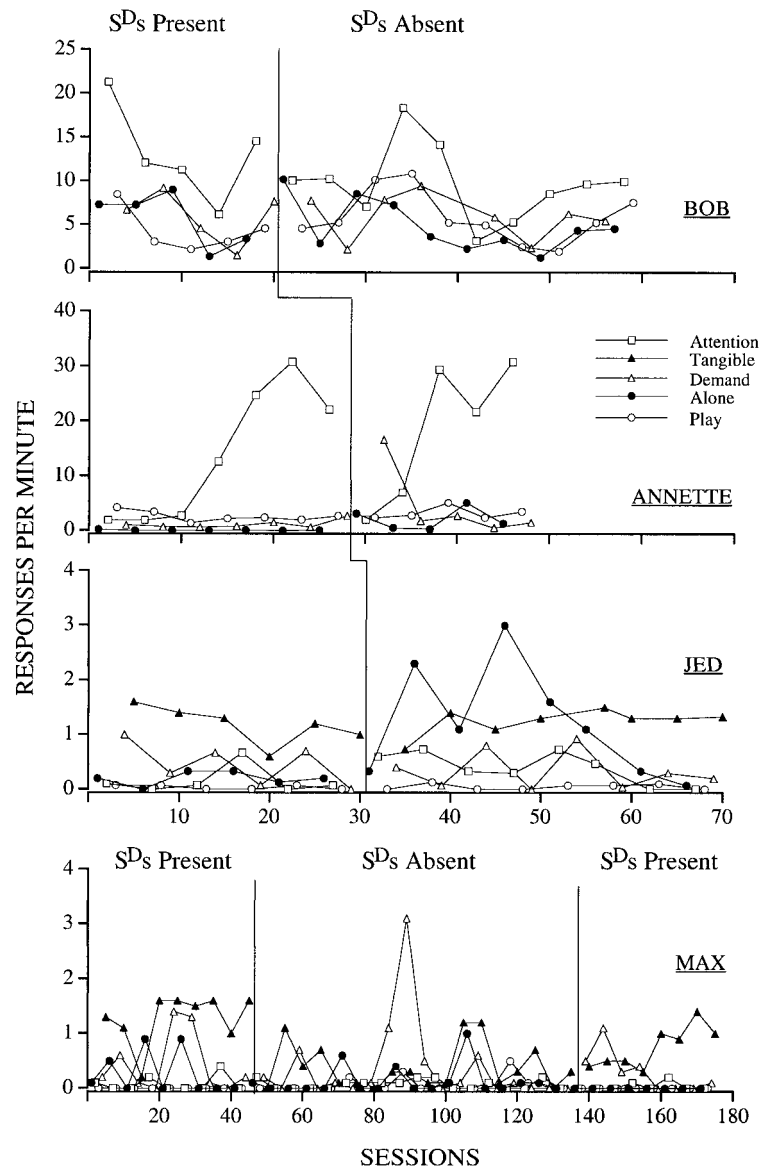
Figure 1. Results obtained for Bob, Annette, Jed, and Max from functional analyses conducted in the presence and absence of S^Ds.

sessions before behavior was observed to decrease in the alone condition. Jed's Phase 2 was conducted for 40 sessions before the same results observed in Phase 1 again became evident. Max's data during Phase 1 reflected a clear tangible function after 45 sessions. When the S^Ds were withdrawn in Phase 2, Max's data showed no clear pattern of results for an additional 90 sessions. At

that point, the S^Ds were reintroduced, and differential responding recovered during the tangible condition within 40 sessions. Thus, results obtained for Bob, Annette, and Jed suggest that the S^Ds present in Phase 1 facilitated differential responding. Max's results suggest that the presence of programmed S^Ds was perhaps necessary to establish differential responding.
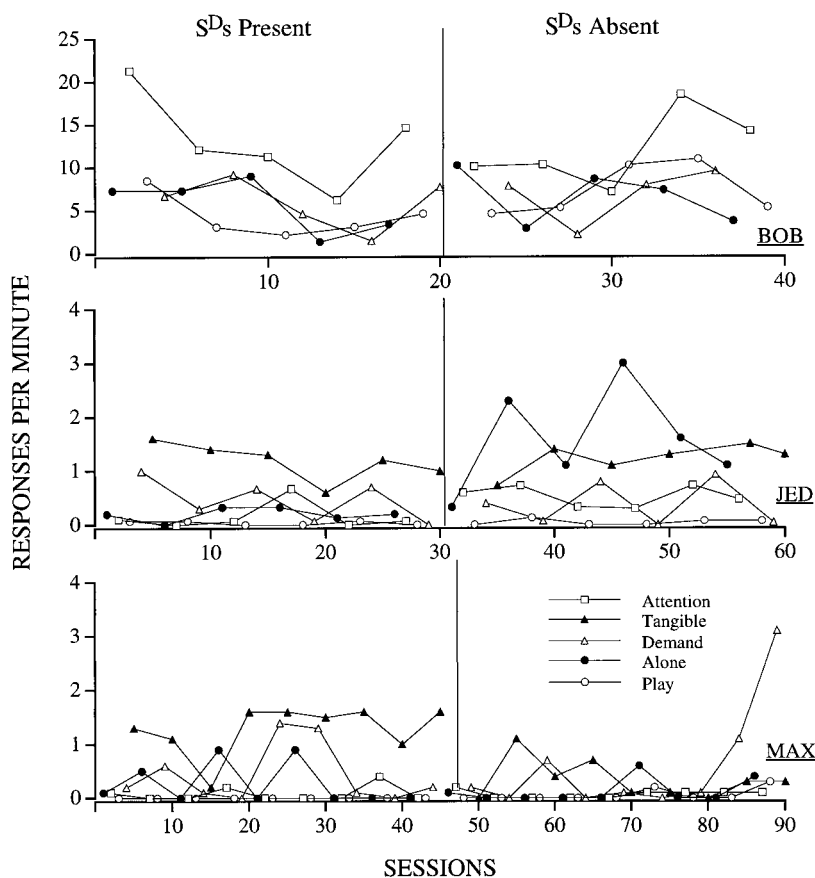
JULIET CONNERS et al.

Figure 2. Bob's, Jed's, and Max's data regraphed showing equal numbers of sessions in the presence and absence of S^Ds.

Figure 2 may help to clarify the differences in responding in the presence and absence of S^Ds suggested above. Figure 2 contains portions of the data shown in Figure 1: All of the data from Bob's, Jed's, and Max's Phase 1 assessments are shown, and data from an equal number of sessions from their Phase 2 assessments are shown by way of comparison. Thus, Figure 2 shows results from functional analyses of similar duration when S^Ds were present and absent. Different conclusions about behavioral function are suggested by the response patterns observed during Phases 1 and 2. For example, Bob's and Jed's Phase 1 results show no overlapping data points (for any set of conditions) between the condition in which responding was highest and any other condition. By contrast, both participants' Phase 2 assessments contain several overlapping data points, making conclusions more tenuous. Max's results showed some variability even during Phase 1, yet his responding was clearly highest during the tangible condition. By contrast, his Phase 2 results showed a much different pattern of responding.

Figure 3 shows the results obtained for Janet, Mary, Richard, and Shelby (note that portions of Janet's data also appear in Worsdell et al., 2000). Data for each of these individuals show that there were virtually no differences between outcomes of their functional analyses when S^Ds were present (Phase 1) or absent (Phase 2).
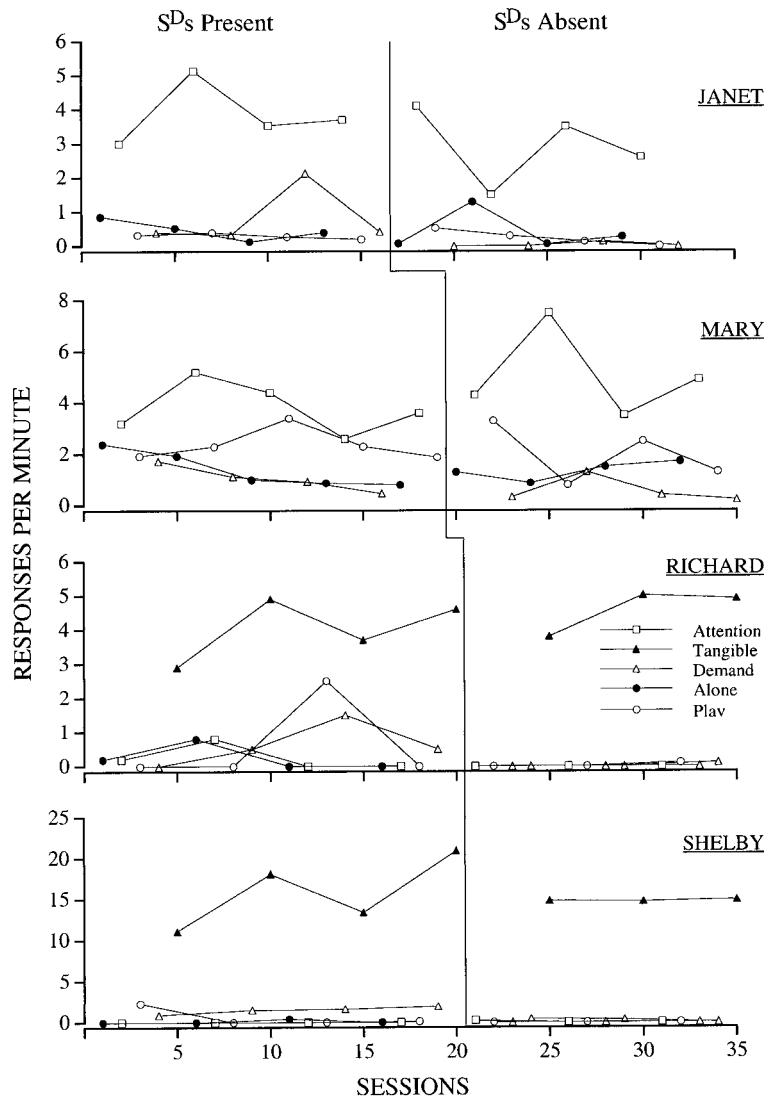
Figure 3.   Results obtained for Janet, Mary, Richard, and Shelby from functional analyses conducted in the presence and absence of S^Ds.

DISCUSSION

We examined the extent to which the inclusion of distinctive visual S^Ds might facilitate differential responding during multielement functional analyses by exposing 8 individuals to a series of two assessments. When each condition was conducted by a specific therapist in a room painted a specific color (Phase 1, S^Ds present), differentially high response rates during one condition were observed for all participants. When all

conditions were subsequently conducted by the same therapist in the same room (Phase 2, S^Ds absent), responding was disrupted for 4 participants (Bob, Annette, Jed, and Max). Bob, Annette, and Jed eventually showed recovery of differential responding; however, Max failed to show recovery after exposure to twice as many sessions during Phase 2 as during Phase 1 (although he did show recovery when Phase 1 was reinstated). These results suggest that the inclusion of salient

cues may increase either the efficiency of functional analyses or the likelihood of obtaining clear outcomes, which may be particularly helpful when conducting assessments comprised of either very few sessions (Northup et al., 1991) or brief session duration (Wallace & Iwata, 1999).

Assuming that the inclusion of S^Ds during a functional analysis may be helpful for only some individuals, as was the case in this study, it would be difficult to predict who might benefit from such a procedure on an a priori basis. Three of the 4 participants whose data showed no disruption when the S^Ds were removed in Phase 2 (Janet, Richard, and Shelby) also showed extremely rapid discrimination in Phase 1. However, we were unable to identify any other participant characteristics, such as communicative ability, that seemed to be correlated with differential outcome. Thus, it seemed that some participants' behavior was simply more or less sensitive to the contingencies presented in the functional analysis. To the extent that the clinical utility of the S^D arrangement cannot be predicted ahead of time, its value can be determined only by using it after unclear assessment results are first obtained without it (i.e., reversing the assessment sequence used in this study only when necessary). Given the relative costs of arranging distinct stimulus conditions during an initial assessment versus doing so for a proportion of individuals while repeating the assessment, the benefits of the former strategy seem clear.

It is important to note that the S^Ds-present assessment always preceded the S^Ds-absent assessment. As noted earlier, this sequence potentially biased our results in favor of continued differential responding in Phase 2 once it had already been established in Phase 1. Thus, it is unclear how many sessions would have been required to obtain clear outcomes if S^Ds had been absent from the outset of assessment. That is, although

4 participants showed immediate differential responding during the S^Ds-absent assessment, and 3 others showed eventual recovery, it is possible that these results would not have been obtained as quickly or at all if participants had no previous exposure to the S^Ds-present assessment. The fact that disruptions in responding were observed in spite of such exposure suggests that the inclusion of S^Ds facilitated discrimination among the functional analysis conditions. It is possible, of course, that the disruptions observed for 4 participants in Phase 2 may have been affected by sequence effects in a different way. That is, any stimulus control over behavior exerted by either therapist or room color in Phase 1 may have been lost when these characteristics were removed in Phase 2. Given the within-subject nature of the comparisons undertaken in this study, the complete elimination of potential sequence bias was impossible, and we opted for an arrangement that minimized sequence effects during the S^Ds-present condition.

In addition to potential sequence bias, this study contained two limitations that should be noted. First, all of the participants in this study had been diagnosed with profound mental retardation. As such, it is unclear whether similar results would have been obtained with participants whose discriminative abilities were more highly developed. Second, the specific stimuli that were correlated with assessment conditions in this study were selected based on the availability of multiple therapists and different-colored rooms. These characteristics may be difficult to manipulate in clinical settings having very limited staff resources or space. Other arrangements, however, may prove equally effective. For example, given the availability of one therapist and one room location, it may be possible to vary characteristics such as (a) shirt color worn by the therapist, (b) table cloth color, (c) poster color hung on a wall, or (d) background music or noise played

through a cassette. As long as the cues are sufficiently salient and are consistently paired with unique contingencies, discriminated responding should emerge.

Finally, in addition to suggesting a role for the use of S^{D}s during assessment, results of the present study have implications for treatment. For example, Lerman and Iwata (1996) noted that therapists often implement extinction merely by changing their behavior and that, under such an arrangement, there is a shift from baseline to treatment contingencies while many of the stimuli associated with both remain constant. The results obtained in this study indicate that an interesting avenue for future research would be to determine whether faster treatment effects are obtained if baseline and treatment sessions are correlated with highly salient S^{D}s.

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STUDY QUESTIONS

1. Describe two types of multiple treatment interference. To which type are multielement designs susceptible?

2. How might one minimize multiple treatment interference within the multielelement design?

3. Construct a table listing the antecedent and consequent events in effect during the five functional analysis conditions included in the study. What features of these conditions may hinder discrimination?

4. What supplementary stimuli were manipulated in the S^Ds-present assessment?

5. The S^Ds-present assessment always preceded the S^Ds-absent assessment. What type of bias might this have prevented, and what type of bias might it have introduced?

6. Summarize the results obtained during the two assessments.

7. How do the data in Figure 2 differ from those presented in Figure 1? What additional information does Figure 2 provide?

8. What are some examples of S^Ds that could be used during functional analyses conducted in clinical settings that do not have sufficient resources to present the same S^Ds used in this study? What other types of procedures (aside from presenting S^Ds) might facilitate rapid differential responding during functional analyses?

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