

*A RESPONSE-RESTRICTION ANALYSIS OF STEREOTYPY IN  
ADOLESCENTS WITH MENTAL RETARDATION:  
IMPLICATIONS FOR APPLIED BEHAVIOR ANALYSIS*

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The behavior of 4 adolescents with severe or profound mental retardation was evaluated in the presence of four sets of materials during periods of unstructured leisure activity. Functional engagement with the materials, stereotypic engagement with the materials, stereotypy without interaction with the materials, and other aberrant behaviors were recorded. Across a series of experimental conditions, the number of sets of materials was reduced from four to one by eliminating the set most frequently manipulated in each preceding condition. In the final condition, four sets of materials were again made available for manipulation. The procedures replicated Green and Striefel's (1988) response-restriction analysis of the activity preferences and play behaviors of children with autism. In general, the results of the present experiment replicate those of Green and Striefel in that reallocation of responding was idiosyncratic and unpredictable as sets of materials were removed. Nevertheless, the results provided insight into how responding might be reallocated if it were restricted through behavioral interventions rather than by restriction of access. Thus, the results are discussed with respect to how response-restriction analyses may be useful in identifying topographies of behavior that could be included in differential reinforcement contingencies that are designed to affect stereotypic behavior and in the selection and arrangement of environmental stimuli to minimize the presence of evokers of stereotypy.

DESCRIPTORS: mental retardation, stereotypy, response deprivation, response restriction, functional analysis, evoker analysis

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Stereotypy is usually defined as repetitive and apparently nonfunctional behavior (Baumeister & Forehand, 1973; LaGrow & Repp, 1984). Many individuals with mental retardation engage in some form of stereotypy in excess of what is seen in persons without mental retardation. Excessive or "aberrant" stereotypy (Berkson, Baranek, &

Thompson, 1992) has been estimated to occur in one third (Dura, Mulick, & Rasnake, 1987) to two thirds (Berkson & Davenport, 1962; Hill & Bruininks, 1984; Kaufman & Levitt, 1965) of institutionalized individuals, the majority of whom have severe or profound mental retardation. Stereotyped behavior may take a variety of forms, including body rocking, hand flapping, complex finger movements, clapping, manipulation of objects, mouthing, and repetitive vocal behavior (LaGrow & Repp, 1984). Stereotypic behavior may also constitute a major portion of some individuals' repertoires. In a recent study that used continuous recording methods, duration of stereotypy averaged as high as 83% of leisure periods and 33% of vocational training periods for 4 students with severe mental retardation (M. Saunders, Saunders, & Marquis, in press).

Excessive stereotypy can be particularly re-

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sistant to efforts at replacement with more socially valued behaviors. Such persistent stereotypic repertoires are behaviors of particular concern among those who educate and support persons with developmental disabilities. Treatment goals for excessive stereotypy are found in the educational, service, or support plans for a high percentage of these individuals. As the settings for supportive services have shifted in the last 30 years to more integrated settings, the importance of diminishing the impact of these behaviors on independence, productivity, and social acceptance has increased. Thus, the need to identify more clearly the stimulus controls for stereotypy is apparent.

Many practitioners now begin the planning and treatment of aberrant behaviors such as self-injury and aggression with a functional analysis. Functional analysis as a formal, empirical process is often traced to Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994). The process is intended to identify one or more functions of the aberrant behavior, including social attention, access to materials or settings, escape from tasks or settings, and sensory stimulation. Formal assessments expose individuals to several different stimulus conditions that are purported to be analogous to various naturally occurring conditions that set the occasion for the various possible functions. Functional analyses as antecedents to interventions for stereotypy are reported far less often, however, than for other forms of aberrant behaviors. It may be that descriptive analyses based on naturalistic observations (e.g., Mace, Lalli, & Lalli, 1991) often indicate that stereotypy is maintained by some form of automatic reinforcement, such as sensory feedback (Thompson & Berkson, 1985), making further assessment unnecessary.

When automatic reinforcement is the function of stereotypy, an assessment of what stimuli are more likely to evoke ste-

reotypy may be important for treatment planning (e.g., Repp, Singh, Karsh, & Deitz, 1991; Schultz & Berkson, 1995; Wahler & Fox, 1981; Wetzel, Taylor, & Lachowicz, 1991). An analysis of evokers of stereotypy can contribute information that cannot be derived from formal functional analysis. First, in many settings, individuals with mental retardation spend considerable periods of time during which arranged contingencies (e.g., differential reinforcement of alternative behavior, payment for work behavior) are not in effect. An evoker analysis could suggest environmental arrangements that are less likely to produce stereotypy during periods when more aggressive interventions are not possible. Second, the analysis might indicate whether functional behavior is emitted in the presence of evocative stimuli, permitting differential reinforcement for these topographies as part of an intervention. Third, observation of the topography of stereotypy with different stimuli could suggest functional behaviors with similar topographies to reinforce.

Designing an assessment of the effects of different stimuli on stereotyped behavior should assume at least two possibilities: (a) Different topographies of object manipulation produce different reinforcers, such as different sensory feedback, and (b) different stimuli produce different rates or durations of reinforcement as a function of differences in how the stimuli may be manipulated. If at least one of these possibilities were not true, no systematic differences should arise in the allocation of responding across topographies. The relative effects of differences in reinforcement have been studied extensively in basic research on the matching law (e.g., Baum & Rachlin, 1969; Brownstein & Pliskoff, 1968; Herrnstein, 1961). Matching law experiments employ a closed behavioral system in which the responses of interest are mu-

tually exclusive and the reinforcement parameters are controlled by the experimenter. Unfortunately, this latter characteristic is incompatible with an experimental analysis of stereotypy that has automatic reinforcement as its function. Recently, we found that another basic research paradigm, response deprivation, included experimental variations that are applicable to an evoker analysis of stereotypy and did not require control of the reinforcers for stereotypy.

Response deprivation, often referred to as response restriction, is the restriction of an organism's opportunity to emit a response. Response restriction is usually created when a contingency is established between two responses: the instrumental response and a second, usually more probable, response, the contingent response (Lyons & Cheney, 1984). In a closed behavioral system, the contingency produces restriction of the contingent response, thereby forcing time that was previously allocated to the contingent response to be shifted to the instrumental response. In determining whether increases in the instrumental response are due to the contingency, however, the effects of restricting the contingent response without creating a contingency must be determined (Diorio & Konarski, 1989). For example, when only two responses are possible, increases in one response may occur entirely as a function of restriction of the other response (e.g., Allison & Timberlake, 1974; Dunham, 1972; Timberlake, 1979).

Response-restriction experiments are not limited to the study of only two mutually exclusive responses. Indeed, the inclusion of more than two possible responses creates conditions more analogous to natural settings. In a multiresponse situation, however, restriction of one response could affect each of the remaining alternatives differentially as a function of some existing

(e.g., relative reinforcer strength, response classes) or preexisting (e.g., reinforcement history) characteristics of the remaining alternatives (Thompson & Lubinski, 1986). Green and Striefel (1988), in a replication of a multiresponse study with rats in which no contingency was arranged (Lyons & Cheney, 1984), investigated allocation of response time with children with autism. Green and Striefel presented their participants with sets of preferred materials, and reallocation of time was measured while access to the sets of materials was restricted one at a time, beginning with the most preferred set. In general, restriction of a higher probability item caused the reallocation of time to one or two lower probability items idiosyncratically. Although Green and Striefel observed some stereotypic behavior in reallocation patterns, it was not measured separately and does not appear to have been a predominant behavior. Green and Striefel's methods, however, seem to be appropriate for within-subject investigations of the relationship among various stimulus materials and individual patterns of stereotypic and other more functional behavior.

In the recent study cited above, M. Saunders et al. (in press) used observation and recording procedures that coded all forms of stereotypy together during leisure; neither the distribution of stereotypy across the various materials nor the relative distribution to stereotypic behaviors without materials manipulation was reported. The present study reports a systematic replication of Green and Striefel (1988), with the participants of M. Saunders et al., to analyze allocation of responding in individuals with high rates of stereotypic behavior. In the present study, these adolescents were presented with a diminishing array of sets of materials with which they had previously exhibited functional engagement as well as stereotypic manipula-

tion. The study permitted examination of reallocation of responding not only across materials but also across topographies of manipulation.

## METHOD

### *Participants*

Four male adolescents who met the criteria for severe or profound (Participant 3) mental retardation as outlined by the American Association on Mental Deficiency (AAMD, Grossman, 1983; version in use at most recent testing) served as participants. They ranged in age from 11 years 10 months to 14 years 11 months. Participant 4 was the only participant taking medication (Depakote® 750 mg for seizures). The participants lived at an intermediate care facility for persons with developmental disabilities and attended the affiliated school whose classrooms served as the research laboratory. Compared to the other children who attended the school, the participants displayed more stereotypic and problem behaviors. All participants were observed to engage in hand mouthing. Participants 1 and 2 repetitively hit solid objects and surfaces. Participant 1 also pinched and pulled clothing and hopped repetitively in place. Participant 2 also engaged in body rocking. Participant 3 engaged in hand biting and repetitive hand flapping. Participant 4 repetitively pressed a fingertip against his thumb and flicked the finger and thumb apart. All participants also engaged in repetitive manipulation of various objects and activity materials. Consent of the Human Rights Committee and the guardian was obtained for each participant's inclusion in the study.

### *Design and Procedure*

*Setting.* The sessions were conducted individually with each participant in an en-

closed section (4 m by 7 m) of a large classroom that contained two tables, two chairs, and a bookshelf. The participant's materials were arrayed on the tables and bookshelves. For the initial baseline session only, the participant was given the instruction, "Here are some things for you to play with." The sessions were 10 min in length and were conducted once or twice per day (depending on time and schedule constraints). A research assistant was present in the classroom with the participant at all times, and the participant's teacher (or one of her aides) was positioned behind a one-way mirror for supervision. The experimenter (the first author) was also present within the enclosed area and videotaped the sessions using a Panasonic AF Piezo VHS recorder.

*Response selection and definition.* In collaboration with the teaching staff, three sets of materials were selected for each participant with which he interacted both functionally (i.e., showed functional engagement with) and stereotypically. Some of these materials were available during the leisure periods observed by M. Saunders et al. (in press). Also, each participant received the materials for a work activity in which he had previously received training (differential reinforcement for work-related responses) from the teachers, but which had not been used by M. Saunders et al. Table 1 depicts the four sets of materials that were made available to each participant during the baseline conditions of the experiment.

Durations of functional and stereotypic engagement were recorded with each item. *Functional engagement* was defined as holding, carrying, or manipulating the object as the manufacturer intended for it to be manipulated. Functional engagement could involve repetition. *Stereotypic engagement* was defined as (a) any repetitive motor movement (not called for by functional

Table 1  
 Typical Functional and Stereotypic Response Topographies Observed With Each Set of Materials

| Set of materials          | Response topography   |  |
|---------------------------|---|--|
|                           | Functional  | Stereotypic  |
| Participant 1             |   |  |
| Magazines                 | Turning pages at rate of less than once per second  | Turning pages at rate of more than once per second; tearing pages into shreds; balling up shredded pages   |
| Blocks                    | Taking blocks out of bin; putting blocks into bin   | Banging blocks or bin against another object or floor  |
| Emptying spoon jig        | Removing spoons from jig and placing them into bin; removing spoons from bin and placing them into jig  | Banging jig or bin against another object or floor; rocking while leaning on jig   |
| Truck                     | Turning truck around in hands or on floor   | Banging truck against another object on floor  |
| Participant 2             |   |  |
| Slinky <sup>®</sup>       | Raising and lowering arms while resting each end of slinky on palm of hands                             | Holding each end of slinky with outstretched arms and shaking slinky repetitively while rocking; holding slinky in one hand while flipping it with the other |
| Shoe string with tokens   | None  | Flipping it in front of face   |
| Poker chips               | None  | Stirring or flipping poker chips in bin  |
| Assembling cassette tapes | Picking up or touching part of task   | Flipping parts of task   |
| Participant 3             |   |  |
| Tennis ball task          | Putting tennis balls into canister; putting lid on canister; putting canister into bin                  | Shaking can with less than three balls and cap on  |
| Shoe string               | Lacing shoe string through shoe; tying shoe string to shoe  | Flipping shoe string; mouthing shoe string; repetitively tying onto object or clothing   |
| Magazines                 | Turning pages at rate of less than once per second  | Turning pages at rate of more than once per second and/or flipping pages around back of magazine   |
| Music box                 | Turning knob once until music stops; holding music box  | Repetitively turning knob  |
| Participant 4             |   |  |
| Magazines                 | Turning pages at rate of less than once per second  | Turning pages at rate of more than once per second and/or flipping pages around back of magazine   |
| Pad of paper and pencil   | Holding either object   | Flipping paper   |
| Slinky <sup>®</sup>       | Raising and lowering arms while resting each end of slinky on palm of hands                             | Holding slinky in one hand while flipping it with the other  |
| Filling spoon jig         | Removing spoons from bin and placing them into jig; removing spoons from jig then placing them into bin | Mouthing or flipping spoons  |

use) with a set of materials (or any part of the materials), (b) mouthing the materials, or (c) body rocking while gazing at, holding, or pressing against materials. Table 1 describes the topographies of functional

engagement and stereotypic responding that were observed for each participant with each set of materials. Participant 2 was reported to manipulate very few items functionally during unstructured time. He

had been observed to sort and stack poker chips periodically and had been observed to snap tokens onto a string as a means of saving them for subsequent exchanges. These topographies did not occur during the study; thus, the table indicates no functional engagement. Participant 3 invariably arrived for the experimental sessions with the laces absent from one or both shoes, creating a functional use for the shoe lace.

A residual category for "other" behavior was used to record time spent not engaged with the materials. Stereotypy without materials could also occur when the participant was not in contact with materials as defined above. The durations of stereotypic behaviors with each set of materials and stereotypy without materials were measured separately. For any form of stereotypy to be recorded other than mouthing, a third occurrence of a behavior that did not meet the functional engagement definition was required to occur within 2 to 3 s of the first occurrence. A period of stereotypic behavior was defined as having ended when approximately 2 s had passed without an occurrence of the behavior. Other behaviors including aggression to objects, aggression to persons, and attempts to leave the leisure area were recorded as discrete events. *Aggression* was defined as biting, hitting, kicking, hair pulling, throwing objects, or tearing apart objects. Attempts to leave the area were blocked by the research assistant, who moved between the participant and the exit. Attempts at aggression toward the first author or research assistant were physically blocked.

*Recording and reliability assessment.* Two research assistants and the first author served as observers. Two observers recorded data from a videotape for every experimental session. One observer (Observer A) recorded the mutually exclusive durations of functional or stereotypic manipulation of

each set of activity materials. If the participant was not interacting with any of the available materials, the mutually exclusive duration of other behavior was recorded by Observer A. The second observer (Observer B) used a similar mutually exclusive recording method to record the duration of an interaction with a second set of materials concurrent with the first set of materials (should such an event occur), the duration of stereotypy that did not involve activity materials, the duration of any residual time during which there were no targeted behaviors to record, and the discrete behaviors listed above. Few occurrences of concurrent manipulation of two sets of materials occurred, however. The two-observer system arose from the difficulties imposed by recording the durations of so many categories of behavior.

Data were recorded using a bar code data-collection system (M. Saunders, Saunders, & Saunders, 1994; R. Saunders, Saunders, Brewer, & Roach, 1996). Responding with each set of materials (functionally or stereotypically), other behavior, stereotypic behavior without materials, and other discrete responses were assigned separate bar codes. The bar codes were created and arranged on a data sheet for observations of each participant using an Apple Macintosh LC™ computer with a bar code font and Super Paint™ Version 3.0 (Silicon Beach Software, Inc.). The data sheets were printed using an Apple Laser Writer™ IINT printer. Videx TimeWand II™ bar code scanners with 128K memory were used. When a bar code was read, the numeric code for the particular event, the date (year, month, and day), and the time (hour, minute, and second) were stored in memory for future transfer to the computer for data processing. In contrast to the partial-interval method used by Green and Striefel (1988) in the primary phase of their study, the bar code method permitted

Table 2  
Average Percentage Agreement Across Sessions for Each Duration Category

| Dependent variable                    | Participant |       |       |       |
|---------------------------------------|-------------|-------|-------|-------|
|                                       | 1           | 2     | 3     | 4     |
| Engagement with each set of materials |             |       |       |       |
| Functional                            |             |       |       |       |
| 1st <sup>a</sup>                      | 98.61       | 100   | 78.70 | 87.14 |
| 2nd                                   | 93.75       | 100   | 100   | 92.86 |
| 3rd                                   | 100         | 100   | 100   | 93.65 |
| 4th                                   | 87.50       | 100   | 94.44 | 85.71 |
| Stereotypic                           |             |       |       |       |
| 1st                                   | 97.22       | 92.31 | 84.05 | 81.75 |
| 2nd                                   | 93.75       | 100   | 100   | 100   |
| 3rd                                   | 100         | 100   | 94.44 | 90.00 |
| 4th                                   | 75.00       | 100   | 88.89 | 85.71 |
| Stereotypy without materials          | 85.42       | 87.53 | 100   | 100   |
| Other behavior                        | 87.08       | 100   | 76.11 | 100   |

<sup>a</sup> The order of materials sets for each student matches the order in Table 1.

real-time records of events and their durations.

Assessments of interobserver agreement were conducted periodically (26.6% of the sessions) and at least once per condition, per participant, for each observer position (A and B). During the assessments, an additional observer (Observer C) was present to record the same behaviors as either Observer A or B. The two research assistants and the first author rotated among the three observer positions across sessions. Interobserver agreement was computed using a computer software program. For the discrete behaviors, a 3-s interval was overlaid on either side of the coded entry that was made by the primary observer (A or B; Repp, Harman, Felce, Van Acker, & Karsh, 1989). An agreement was scored when both observers (A and C or B and C) recorded the same event within the 6-s temporal window created by the software. A disagreement was scored if no event corresponding to the primary observer's record was found in Observer C's record or when Observer C's record contained an event not found in the primary observer's record (M. Saunders et al., 1994). Per-

centage agreement was calculated by dividing agreements by agreements plus disagreements and multiplying by 100%.

Interobserver agreement for the mutually exclusive duration categories was assessed by measuring the degree to which Observer C's second-by-second record was the same as that of the other observer (A or B). The number of seconds that a category was "on" simultaneously in both records was divided by that number plus the number of seconds in which either of the observers was scanning some other category. Because seconds of disagreement always apply to two categories simultaneously, the seconds of disagreement were distributed proportionately to the categories to which they could apply in a manner that prevented the double counting of seconds of disagreement.

Table 2 shows the interobserver agreement percentages for individual categories of behavior measured for duration. The order of materials sets in Table 2 matches the order in Table 1 for each participant. Agreement on a category, such as functional engagement with a particular set of materials, ranged as broadly as from 0% to

100% across sessions in some cases. The overall mean of individual-category agreement assessments, however, was 81% and the median was 90%. Virtually all low agreement results for particular categories arose in sessions in which a category was scored as "on" for one or more relatively brief occurrences only (i.e., no sustained periods of engagement were observed). Overall, however, agreement on mutually exclusive categories was very high. Specifically, when all categories of responding were collapsed, the software indicated that Observer C was scanning the same category as the other observer (A or B) for an average of 95.5% of all seconds observed in interobserver agreement assessment sessions. The discrete events recorded by Observer B occurred relatively infrequently, and only four interobserver agreement assessment sessions contained records of these behaviors. In those four sessions, the two observers agreed on 24 of 31 occurrences of aggression to objects (77.4%) and 28 of 30 occurrences of aggression to persons (93.3%). Attempts to leave the leisure area were not observed in any interobserver agreement assessment sessions.

*Experimental design.* A modified reversal design (ABCDA) was used for each participant, in direct replication of Green and Striefel (1988). The conditions that followed the first condition had fewer sets of materials available (three, two, and one) than the first condition (four sets). The set of materials removed for each condition subsequent to the first condition was the set with which the subject interacted the most, functionally and stereotypically combined, during the immediately preceding condition. Each condition ended and a set of materials was designated for removal when a stability criterion applied to response allocation patterns was met in the condition. Allocation of responding was deemed stable when (a) for a minimum of

three sessions, manipulation of one set of materials was observed to occur for a higher percentage of session time than manipulation of any other set; and (b) in the next session, the percentage of time allocated to the most manipulated set of materials was within one standard deviation of the mean of percentage allocation to that set of materials in the three previous sessions (Green & Striefel, 1988). Thus, a minimum of four sessions was required to meet the stability criterion in a condition. If the stability criterion had not been met for any set of materials within 10 sessions, the condition was ended and the set of materials with the highest mean percentage of allocation for the 10 sessions was selected for removal (Green & Striefel).

In addition to the modified reversal design, Green and Striefel (1988) used a multiple baseline across subjects design. Green and Striefel numbered their participants and required Participants 2 through 4 to remain in each condition at least two sessions longer than the participant lower in the order prior to beginning the sessions in which stability was to be evaluated. Thus, the length of exposure to each condition for each participant was indexed to the number of sessions required by their Participant 1 to reach stability in each condition. Because, in the present study, there appeared to be no reason to believe that manipulations made with 1 participant would or could affect the behavior of the other participants, and because the Green and Striefel design could create a very lengthy study as a function of the behavior of Participant 1, the multiple baseline aspect of their design was modified. In the present study, a requirement that no participant undergo a change in conditions within two sessions of a change in condition for some other participant was imposed as a modified control for subject interaction effects.



In summary, in the first condition of the present study, the participant was provided with four sets of materials with which to interact. After the stability criterion had been met or 10 sessions had been conducted, the highest probability response (the response with the highest mean percentage of interaction time) was removed (i.e., the set of materials was not available in subsequent sessions), and the participant was presented with the three remaining sets of materials in the next condition. The procedure was continued until one set of materials remained with which the participant could interact. Then the condition with all sets of materials available was reintroduced.

## RESULTS

Figures 1 through 4 depict the average percentage of interaction time with the sets of materials, in stereotypy without materials, and in other behavior in each condition for Participants 1 through 4, respectively. Stereotypic engagement and functional engagement have been summed to produce the percentage allocation bar for each set of materials, with the bar divided to denote the relative contributions of each form of engagement. The figures also show the percentage of time that was allotted to each set of materials only; other behavior and stereotypy without materials are not shown.

The distribution of allocation of responding following the various response-restriction manipulations was idiosyncratic for each participant. As sets of materials were removed, Participant 1 (Figure 1) allocated some of his time to all of the remaining materials but primarily increased his involvement in other behavior (rubbing his groin area with his hand or against the floor, walking around the area, physically attempting to gain the experimenter's attention). During the final condition with all sets of materials

restored, he allocated his responding almost exclusively to his previously most preferred set of materials (magazines). Although time allocated to magazine manipulation was more than double the allocation in the first condition, the data for the final condition reflect a trend towards the first-condition pattern. For Participant 1, nearly all interaction with magazines was stereotypic. What little time was allocated to other sets of materials when magazines were restricted, however, generally reflected functional engagement. The four-session minimum for determining stability was violated in the condition with one set of materials due to privacy issues associated with how he rubbed himself. Thus, the final condition was instituted following only two sessions with only one set of materials present. Participant 1's behavior did not meet the stability criteria within 10 sessions in either the third or final condition.

Participant 2 (Figure 2) allocated his time almost completely, and exclusively stereotypically, to the Slinky<sup>™</sup> toy during the first condition. Some stereotypy without materials (e.g., body rocking) occurred concurrent with interaction with the Slinky<sup>™</sup>. In the next two conditions, he allocated a majority of his time to only one set of materials, and this manipulation was almost exclusively stereotypic. When only one set of materials (the cassette tapes) remained, he allocated most of his time to other behavior (mostly sitting quietly) and to some concurrent stereotypy without materials. During the final condition, with all sets of materials restored, his allocation of time showed some recovery of his preference for the Slinky<sup>™</sup> toy, combined with an increased allocation to other behavior, compared to his allocation to other behavior in the first condition. The data shown in the lower panel, however, indicate a trend to greater allocation to the Slinky<sup>™</sup> during the final condition. Participant 2's behavior did not meet the stability criteria

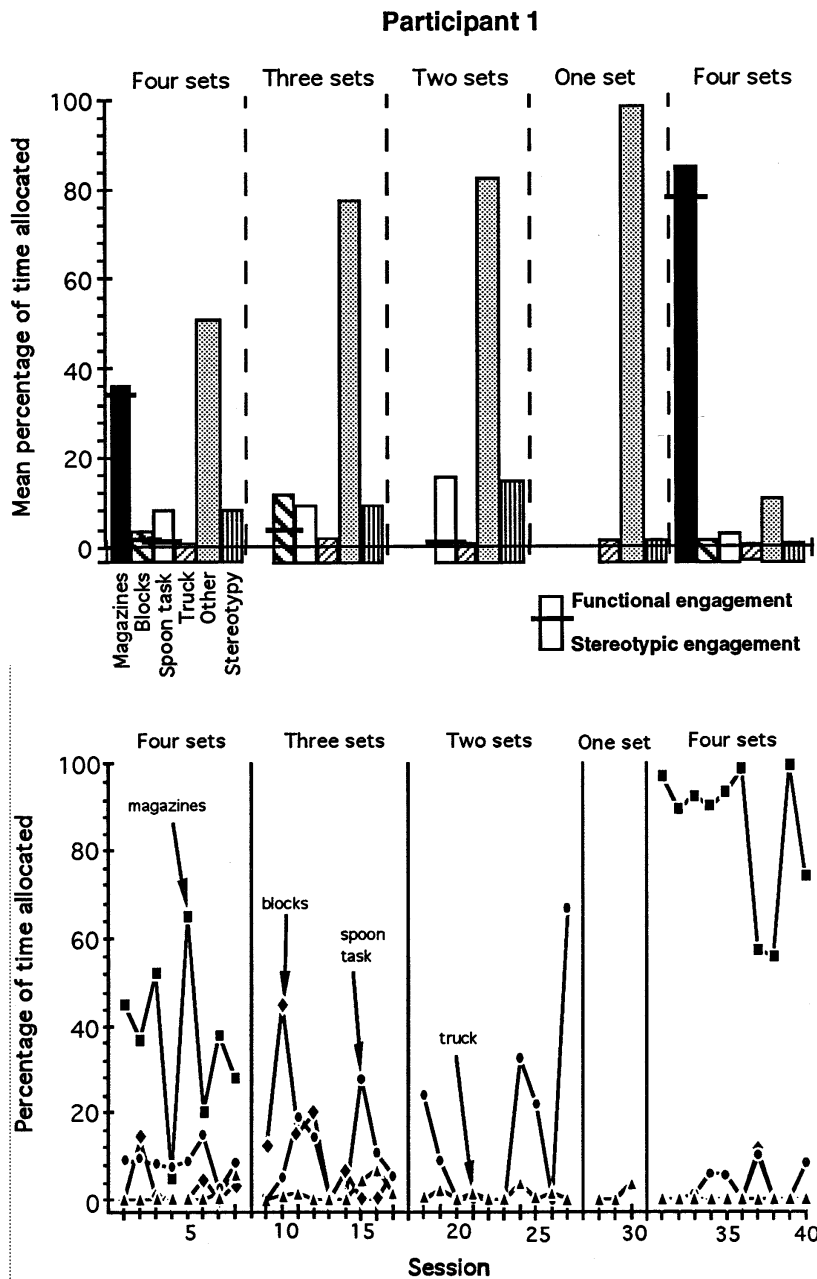


Figure 1. The upper panel shows the average percentage of time in which Participant 1 was engaged with materials stereotypically or functionally, in stereotypy without materials, and in other behavior across conditions. Each bar represents the percentage of the session duration in which the participant was engaged in that behavior. For the bars representing engagement with materials, the segment above the horizontal line, if any, represents functional engagement; the segment below represents stereotypic engagement. The left-to-right order of the bars is the same in each condition, with conditions separated by the vertical dashed lines. Stereotypy without materials plus all engagement with materials may sum to greater than 100% in a condition because some stereotypy without materials could occur simultaneously with engagement with materials. The sets of materials were removed in a left-to-right order, with removal reflected as the absence of bars. The lower panel shows, for Participant 1, the session-by-session engagement with materials. The lower panel does not reflect any stereotypy without materials or other behavior.

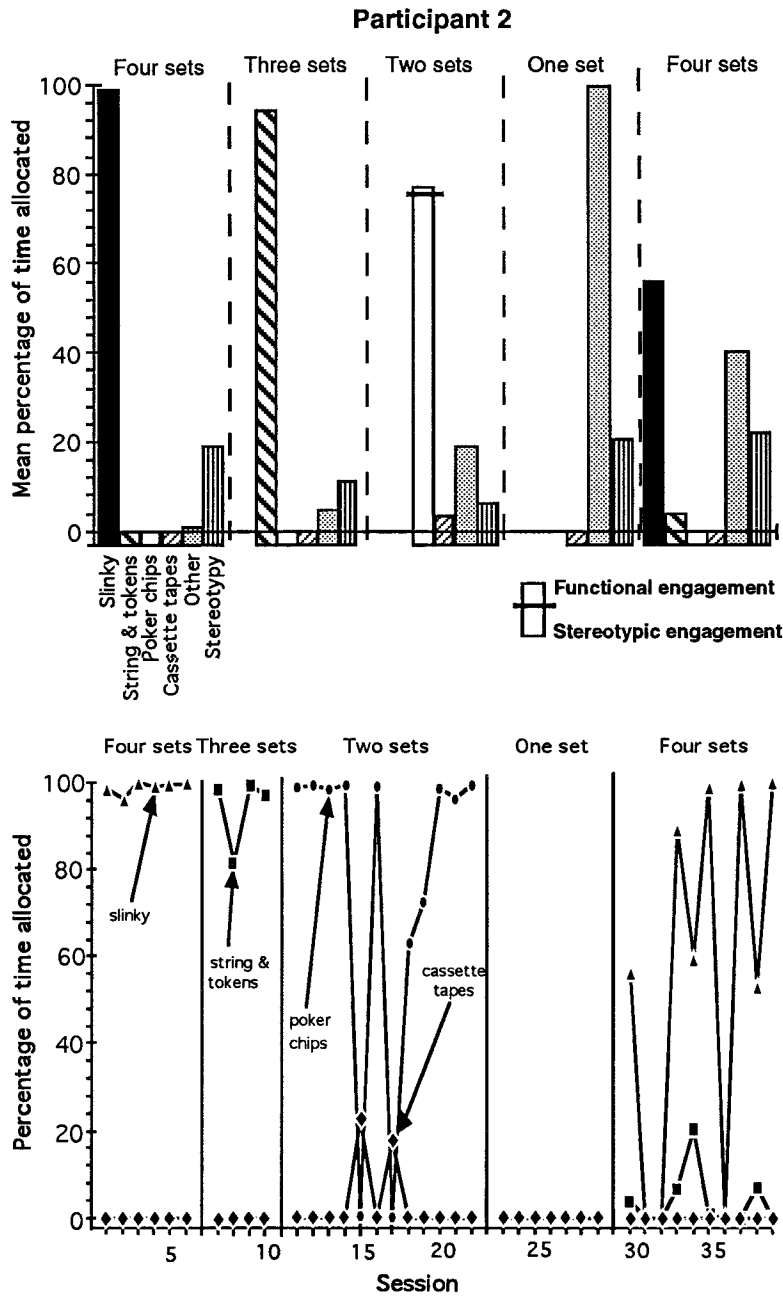


Figure 2. The upper panel shows the average percentage of time in which Participant 2 was engaged with materials stereotypically or functionally, in stereotypy without materials, and in other behavior across conditions. Each bar represents the percentage of the session duration in which the participant was engaged in that behavior. For the bars representing engagement with materials, the segment above the horizontal line, if any, represents functional engagement; the segment below represents stereotypic engagement. The left-to-right order of the bars is the same in each condition, with conditions separated by the vertical dashed lines. Stereotypy without materials plus all engagement with materials may sum to greater than 100% in a condition because some stereotypy without materials could occur simultaneously with engagement with materials. The sets of materials were removed in a left-to-right order, with removal reflected as the absence of bars. The lower panel shows, for Participant 2, the session-by-session engagement with materials. The lower panel does not reflect any stereotypy without materials or other behavior.

within 10 sessions in either the third or final condition. His fourth condition with one set of materials available was protracted beyond the point at which stability occurred due to delays that were produced by separating condition changes across subjects by the minimum of two sessions.

Participant 3 (Figure 3) allocated his time almost equally to three different sets of materials during the first condition. Although the tennis ball task had the highest overall percentage allocation, the data in the lower panel suggest a trend toward more allocation to magazines and the shoe string in the first condition. Manipulation of the work task—tennis ball packaging—reflected functional engagement, whereas manipulation of the magazines and shoe lace was mostly stereotypic. Restriction of the tennis ball task in the second condition led to increases in allocation to both the shoe lace and magazines. Next, restriction of the magazines led to nearly complete allocation to the shoe lace. Restriction of the shoe lace led to a combination of some functional engagement with the music box and allocation to other behavior (mostly walking around the area and physically attempting to gain the experimenter's attention). During the final condition, he allocated his time to the magazines and shoe lace. The pattern of allocation is somewhat similar to that observed in the latter sessions of the first condition and in the sessions of the second condition. The four-session minimum for determining stability was violated in the fourth condition due to increased agitation and increased attempts to leave the area. The experimenter and supervising teacher agreed that prolonging the condition was not in the best interest of the participant; thus, the final condition was instituted after only three sessions in the preceding condition. Participant 3's behavior did not meet the stability criteria in the first condition. His response allocation did meet the criteria in the final condition prior to its

termination; the final condition was protracted to insure the two-session separation rule for condition change.

As with Participant 2, Participant 4 (Figure 4) initially allocated his time to one set of materials, mostly stereotypically, and then primarily to one set of materials each time the highest probability response was removed, until the fourth condition. With only one set remaining, he allocated his time to other behavior (mostly walking around the area, appearing to search for new materials, and physically attempting to gain the experimenter's attention). Participant 4 underwent a change in classroom assignment near the end of the experiment and was not available to participate in the reintroduction of all materials sets. Participant 4's response allocation met the stability criteria in the fifth session of the first condition, but his condition change was delayed to meet the two-session rule for condition changes across subjects. His response allocation then completely changed for one session, after which he did not meet the stability criteria again by the 10th session.

Participant 1 exhibited a high rate of aggression to objects in the first condition ( $M = 10.75$ ), which decreased over subsequent conditions (three sets,  $M = 2.78$ ; two sets,  $M = 0.30$ ; one set,  $M = 0$ ; final condition,  $M = 0.80$ ). He also exhibited some aggression to persons, beginning in the second condition ( $M = 3.22$ ) and continuing into the third ( $M = 2.20$ ), but did not exhibit these behaviors in the last two conditions. He made one attempt to leave the area in the third condition. Although his behavior became increasingly inappropriate with only one set of materials remaining, he did not attempt to leave the room in these sessions.

Participant 2 did not exhibit any aggression to objects, aggression to persons, or attempts to leave the area. Participant 3 displayed a low rate of aggression to objects, beginning in the first condition (four sets,

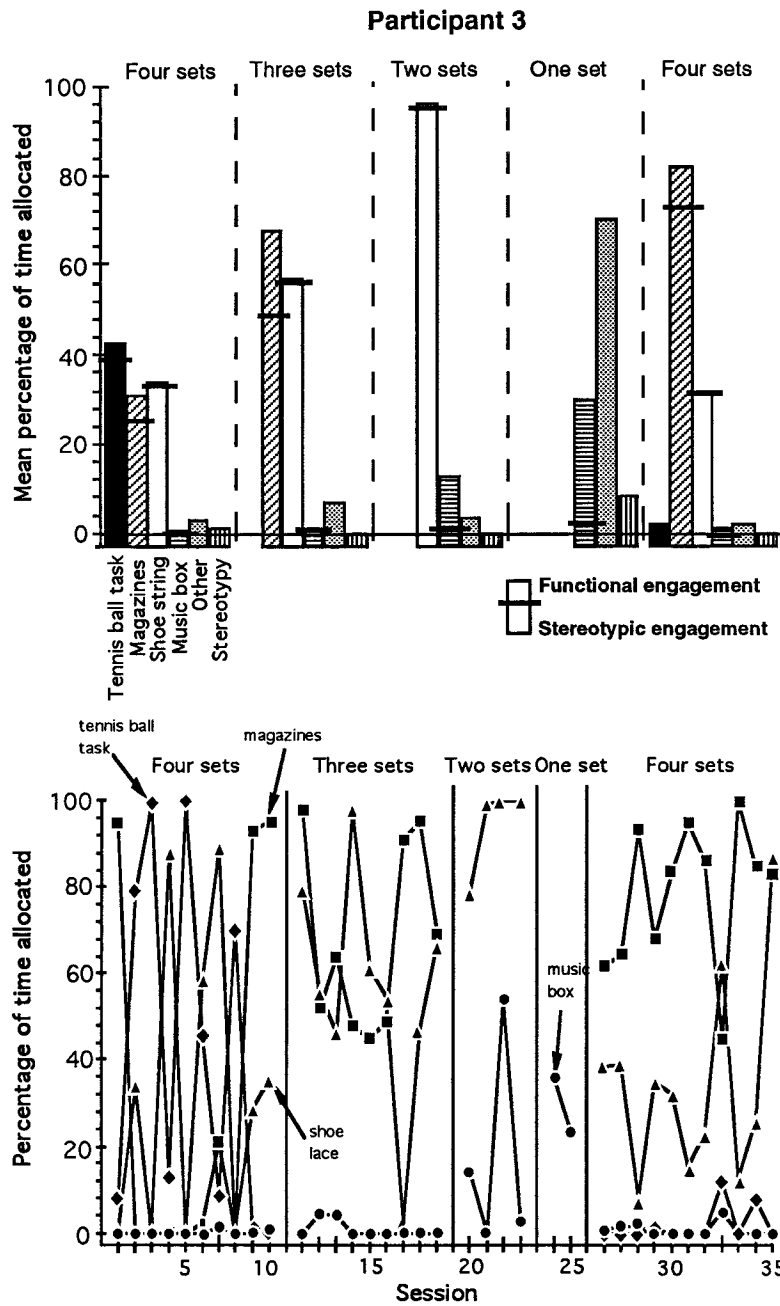


Figure 3. The upper panel shows the average percentage of time in which Participant 3 was engaged with materials stereotypically or functionally, in stereotypy without materials, and in other behavior across conditions. Each bar represents the percentage of the session duration in which the participant was engaged in that behavior. For the bars representing engagement with materials, the segment above the horizontal line, if any, represents functional engagement; the segment below represents stereotypic engagement. The left-to-right order of the bars is the same in each condition, with conditions separated by the vertical dashed lines. Stereotypy without materials plus all engagement with materials may sum to greater than 100% in a condition because some stereotypy without materials could occur simultaneously with engagement with materials. The sets of materials were removed in a left-to-right order, with removal reflected as the absence of bars. The lower panel shows, for Participant 3, the session-by-session engagement with materials. The lower panel does not reflect any stereotypy without materials or other behavior.

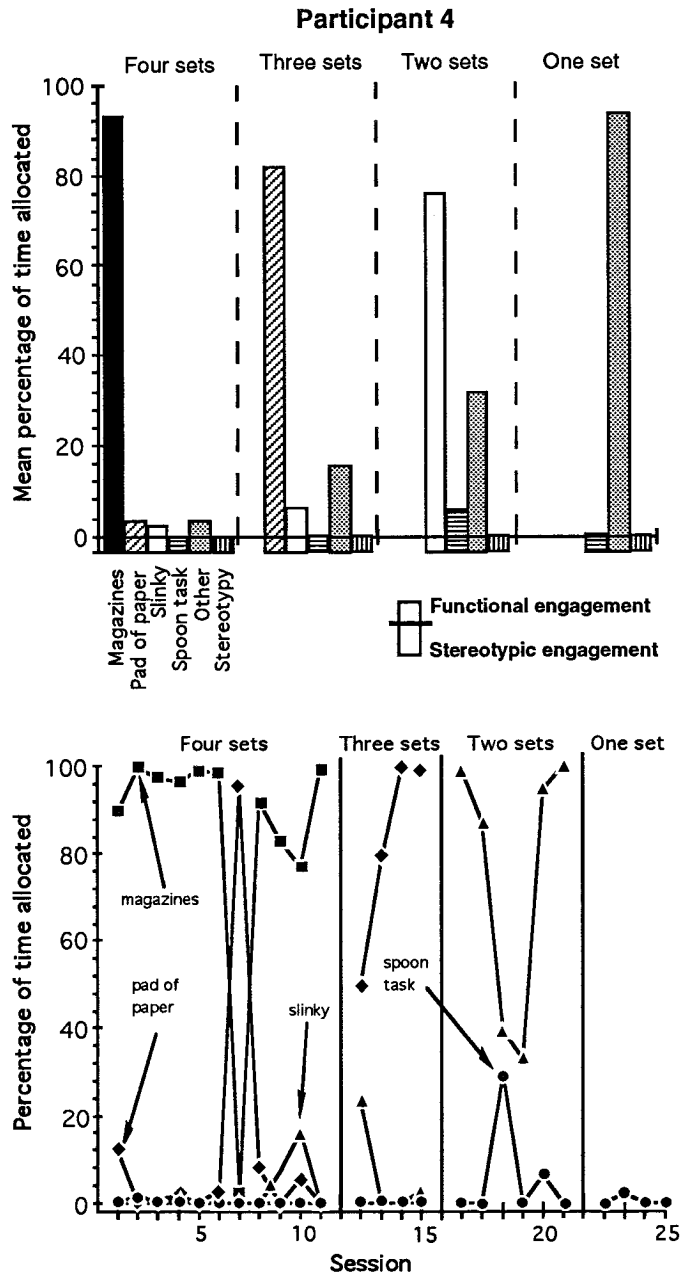


Figure 4. The upper panel shows the average percentage of time in which Participant 4 was engaged with materials stereotypically or functionally, in stereotypy without materials, and in other behavior across conditions. Each bar represents the percentage of the session duration in which the participant was engaged in that behavior. For the bars representing engagement with materials, the segment above the horizontal line, if any, represents functional engagement; the segment below represents stereotypic engagement. The left-to-right order of the bars is the same in each condition, with conditions separated by the vertical dashed lines. Stereotypy without materials plus all engagement with materials may sum to greater than 100% in a condition because some stereotypy without materials could occur simultaneously with engagement with materials. The sets of materials were removed in a left-to-right order, with removal reflected as the absence of bars. The lower panel shows, for Participant 4, the session-by-session engagement with materials. The lower panel does not reflect any stereotypy without materials or other behavior.

$M = 0.20$ ; three sets,  $M = 1.71$ ; two sets,  $M = 0.33$ ) but not thereafter. He did not display any incidence of aggression to persons. He did begin to attempt to leave the area in the second condition and continued to do so until the final condition (three sets,  $M = 0.57$ ; two sets,  $M = 2$ ; one set,  $M = 2$ ; final condition,  $M = 0$ ). Participant 4 did not exhibit any aggression to objects or persons. He did attempt to leave the area twice during the fourth condition with only one set of materials available.

### DISCUSSION

The results show that the participants allocated their time principally to stereotypic behavior with materials when the number of sets of materials available was highest. Further, restriction of responses to materials did not increase time allocated to stereotypy without materials, but rather increased time allocated to functional interaction with materials or produced other behavior. Contrary to the belief that persons with mental retardation engage in stereotypic behavior without materials because they are restricted from engaging with materials, these results showed that as the availability of materials to manipulate decreased, the time allocated to stereotypy without materials changed little. Conversely, Horner (1980) found that "self-directed" aberrant behavior was inversely related to the presence of "enriching" stimulus materials. Horner's self-directed category, however, included both stereotypic behavior and other self-directed behavior such as self-injury and rubbing body parts against other body parts or objects. The results of the present study suggest that the covariation effect seen by Horner in the enrichment condition could have been a function of changes in the pattern of response allocation among self-directed behavioral topographies other than stereotypy. Studies that have specifically investigated stereotypy

without materials, however, have reported decreases in rates of such stereotypy as a function of increases in rates of functional object manipulation (Berkson & Mason, 1963a, 1963b; Davenport & Berkson, 1963; Guess, 1966; Guess & Rutherford, 1967; Hollis, 1965a, 1965b). Similarly, Horner observed the lowest rates of self-directed aberrant behavior when differential reinforcement of functional behavior was introduced under the enriched environment condition.

In the present study, the response-restriction series was conducted only once; the effects of each condition were not replicated with a second exposure series. The session-by-session data in the lower panel of each figure show, however, that the allocation patterns across sessions in the three response restriction conditions are generally consistent. Participant 1 exhibited rather stable patterns of preference for materials within conditions. Participant 2 exhibited ambiguity in preference for only a short series of sessions in the third condition. Participants 3 and 4 showed generally stable patterns within the three restriction conditions or trends toward stable patterns. Participants 1, 2, and 3 did not have overall allocation patterns in the final condition that were completely representative of their patterns in the initial condition. Their trends within the final condition, however, suggested a return to patterns that were observed at the end of their initial condition. Overall, the data suggest that the allocation patterns were reliable indices of the participants' preferences for the materials and that a replication restriction series would have produced similar response allocations. The degree of consistency within conditions and the idiosyncratic results across subjects suggest that the data were a function of within-session variables (i.e., internal validity was not compromised).

Stereotypy with materials and stereotypy without materials were recorded by different observers and, because of the recording sys-

tem used, could total more than 100% of the total session time (e.g., Participant 2). In contrast, M. Saunders et al. (in press) collapsed all stereotypy into one category for recording during leisure sessions. Thus, the results of the two studies cannot be compared precisely. Nevertheless, comparing the first condition of the present study with the results of the previous study, for Participants 1, 2, and 4, the majority of leisure time was spent engaged in stereotypic behavior in both studies. The consistency of allocation to stereotypy in these participants is similar to that found by Repp, Karsh, Deitz, and Singh (1992). Participant 3 was engaged in less stereotypic behavior in the M. Saunders et al. study than he exhibited in the present study. In the M. Saunders et al. study, the participants were observed as a group wherein Participant 3 was anecdotally noted to devote considerable time watching the stereotypic performances of other participants closely.

The results with children with mental retardation also replicate Green and Striefel's (1988) results with children with autism, although the topographies of the play behaviors differed with respect to the type of engagement. The present results are also consistent with the results of several studies that found no single rule with which to predict response allocation after response restriction (Green & Striefel, 1988; Lyons & Cheney, 1984; Thompson & Lubinski, 1986). In the present study, Participant 3's reallocation patterns were fairly predictable, but the shifts in allocation by Participants 2 and 4 were not predictable from each preceding condition, because virtually all responding was restricted to one set of materials in each condition. For Participant 1, responding was usually distributed to all the remaining alternatives in unpredictable proportions (cf. Luce, 1959; Rachlin & Burkhard, 1978). Thus, in general, the data confirm that a series of response restrictions similar to that

conducted in the present experiment is necessary for a thorough analysis of response context for each individual (Morris, Higgins, Bickel, & Braukmann, 1987). Adoption of the stability criteria that we and Green and Striefel used, however, is not recommended without comment. In two notable instances (Participant 1, final condition; Participant 2, first four sessions of third condition), visual inspection suggested stable allocation (cf. Perone, 1991), but the very small standard deviations derived from the tightly grouped percentages led to mathematical disconfirmation of stability. Conversely, the final four sessions in the second condition of Participant 1, for example, met the criteria despite considerable variability. Abandoning the statistical test for stability using means and standard deviation may be appropriate; disconfirmation of stability in the two notable examples, however, did precede large unexpected shifts in allocation.

The present results also have implications for applied behavior analysis. The generally low or declining acts of aggression and attempts to leave the area that were observed across the experimental conditions suggest that response restriction may be used to assess the stimulus control of stereotypy without increasing the rate of destructive behavior. The changing rates of these discrete events and the shifts in allocation of time to different behaviors, however, have important implications for formal functional analysis protocols. For example, with Participant 4, if the fourth condition with only the spoon task available had comprised the stimulus conditions in a test of the function of stereotypy, a likely conclusion would be that stereotypy was not maintained by automatic reinforcement. If, in contrast, the stimuli in the first condition had been present, the conclusion would be that stereotypy was a function of automatic reinforcement. Further, the differences across conditions in rates of aggression to objects and persons by



Participant 1, and the changes in his allocation of responding with other behavior, also raise questions regarding the validity of analogue test results when only one variation of environmental stimuli is used. Thus, a response-restriction test prior to testing with functional analysis analogue conditions not only could identify analogue conditions but could also increase the generality and validity of the analogue test results.

The data also have implications for treatment methodology following assessments. In particular, the present results have implications for interventions based on differential reinforcement procedures. For example, a differential-reinforcement-of-other-behavior (DRO) contingency could effectively restrict the topography of stereotypy to which it applies as a function of the punishing aspects of such a contingency (i.e., delay of reinforcement). The results suggest that the present participants, if exposed to a DRO intervention, probably would reallocate their responding to other topographies of stereotypic behavior with other materials or to other relatively unproductive behaviors, such as walking around or seeking attention. If the DRO contingency was applied to all topographies of stereotypy and if the contingency effectively restricted stereotypic behavior, the present results suggest that only some other unproductive behavior would be likely to occur. Such a contingency might also result in increases in other behaviors such as escape behaviors, as produced by Condition D in the present study. Further, reinforcers delivered under either a momentary DRO schedule (e.g., Barton, Repp, & Brulle, 1985) or a whole-interval DRO schedule (e.g., Repp, Deitz, & Deitz, 1976; Reynolds, 1961) would not likely follow and potentially reinforce functional engagement with materials because such engagement occurred so seldom.

Similarly, reinforcers delivered on a fixed-time or noncontingent (NCR) schedule

would have a high probability of following stereotypy rather than functional engagement, thereby potentially reinforcing stereotypy. Moreover, fixed-time reinforcement and fixed-interval reinforcement of functional behavior have been reported to induce stereotypy (e.g., Emerson & Howard, 1992; Wieseler, Hanson, Chamberlain, & Thompson, 1988). Recently, however, Vollmer, Iwata, Zarcone, Smith, and Mazaleski (1993) demonstrated that self-injurious behavior could be reduced as effectively with an NCR schedule as with a DRO schedule. In this demonstration, attention was used as the reinforcer in both schedules because self-injury had been maintained by attention during preexperimental functional assessments. Vollmer et al. suggested that NCR's effectiveness was probably derived from concurrent extinction of the self-injury and satiation produced by the rich schedule of noncontingent attention. Thus, an NCR treatment for stereotypy might have similar positive effects for stereotypy that is maintained by attention. Controlling the reinforcers and, thus, the operative processes hypothesized by Vollmer et al. may be more difficult for stereotypy that is maintained by sensory stimulation or some other form of automatic reinforcement. Thus, a functional analysis prior to treatment is essential for informing choice among treatment options.

The results show that for Participants 1 and 3, some functional engagement with materials occurred in the first condition. Thus, introducing a reinforcement contingency that involved those specific topographies would be possible. For example, differential reinforcement of alternative behavior or incompatible behavior might have a greater chance for altering allocation patterns across and within sets of materials. Alternatively, the patterns of allocation observed in response-restriction tests could suggest different activities to reinforce. These would be alternatives selected because they

involve performances with characteristics similar to those observed in the response-restriction tests, but with more functional or social value. Responses with similar performance characteristics (e.g., involving repetition, fine motor movements, materials manipulation) would not necessarily be as probable initially as those identified on restriction tests, but might be easier to bring under schedule control due to their similarities. For example, Participant 1's banging of most objects suggests that a vocational task involving hammering, tapping, or tamping might provide an initial response rate that could be brought under schedule control.

Conversely, other functional performances may acquire characteristics that establish them as substitutable for stereotypic responding. Participant 3 exhibited considerable functional engagement with the tennis ball task in the initial condition in the absence of experimenter-arranged reinforcing consequences. Although this result may be attributable to a prior reinforcement history, it may indicate acquisition of characteristics that are similar to some form of stereotypy. Of particular relevance to substitutability may be the similarity of sensory feedback produced by functional and stereotypic performances. Responding stereotypically has been hypothesized to be maintained and strengthened by stimulating feedback (Azrin, Kaplin, & Foxx, 1973; Lovaas, Newsom, & Hickman, 1987; Rincover, 1978). Berkson and colleagues suggested that aberrant stereotypy is also a function of a desire for personal control and becomes a predominant way for some individuals to gain access to or control reinforcers, such as sensory feedback (Berkson et al., 1992; Buyer, Berkson, Winnega, & Morton, 1987). Recognition of control or increased control of reinforcing consequences, including sensory feedback, may be helpful in the development of durable interventions. For example, some investigators have included a functional re-

sponse in a contingency with the opportunity to engage in aberrant behavior (e.g., Charlop, Kurtz, & Casey, 1990; also cf. Allison, 1993; Premack, 1965). In this approach, the degree of effectiveness of the contingency also may be a function of the substitutability of the two responses (Allison, 1993).

A cautionary note seems warranted; substitutability may be a two-edged sword in the design of durable interventions. For example, M. Saunders et al. (in press) found that although the rates of onset of stereotypy were often lower during vocational training (with reinforcement for on-task responding) than during leisure (without scheduled reinforcement), a much larger effect was observed in the percentage-of-time data. That is, the largest effects of reinforcing a functional alternative to stereotypy were decreases in the length of stereotypic episodes. Both vocational tasks involved manipulation of paper: placing advertising inserts into a local newspaper and mechanically shredding unwanted office documents. In the present study, magazines evoked stereotypy in 3 of 4 participants. Thus, selection of a topography similar to stereotypy with magazines by M. Saunders et al. may have facilitated acquisition of high-rate performance of the tasks. The remaining brief episodes of stereotypy, however, also may have been a function of the evocative effects of the task materials.

M. Saunders et al. (in press) hypothesized that an important variable in establishing functional alternatives to stereotypy is insuring that there are no discernible deficits in cognitive or motor ability that would preclude the rate of the functional alternative from rising under differential reinforcement conditions. That is, schedule control must not be impeded because the individual cannot emit (control) a higher rate of responding due to a lack of fluency in the response (cf. Binder, 1996; Lindsley, 1996a, 1996b).

Several recent studies have shown that the higher the rate of reinforcement produced by higher rates of responding in vocational tasks, the lower the rates of stereotypy and stereotypic self-injury during work periods (M. Saunders & Saunders, 1997; M. Saunders et al., in press; R. Saunders et al., 1996). Increases in rate leading to increased efficiency in reinforcer production may be indications of increases in fluency or competence (R. Saunders et al., 1996; R. Saunders & Spradlin, 1991). Thus, an important component of a response-restriction test may be to compare the topographies of the most probable responses with those less probable for detection of characteristics that are relevant to the potential for increased fluency. Repeated response-restriction tests with different combinations of sets of materials may be necessary for the most precise identification of the relevant characteristics.

In summary, the response-restriction tests permitted comparisons of response allocation under several different environmental conditions (numbers of sets of materials) and permitted observation and analysis of allocation preferences and response topographies across and within sets of materials. Thus, the results of these observations can be informative for the selection of additional assessment conditions and postassessment treatment methods and of specific alternative responses to establish with those treatment methods. Basic research on response restriction, therefore, yields a new methodology for the growing field of applied behavior analysis.

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## STUDY QUESTIONS

1. What is “stereotypy” and why is it considered maladaptive behavior?
2. What is an “evoker” analysis, and what are its potential benefits as an assessment tool? What other terms have been used in the literature to describe such an analysis?
3. What is response deprivation or restriction, and in what way was the general methodology of the study different from that of a typical response deprivation experiment?
4. An important aspect of the study involved measurement of both “functional” and “stereotypic” engagement with materials. How were these response classes defined, and to what extent do the examples listed in Table 1 differentiate between the two classes?

5. Summarize the conditions of the study and the sequence in which they were introduced.
6. Although some within-participant variability was evident in the results, it appeared that three general response patterns were observed across the 4 participants. Briefly describe these patterns and the conclusions they suggest about the effects of materials restriction on (a) functional engagement with materials, and (b) stereotypy in the absence of materials.
7. In the present study, the authors attempted to identify the effects of discrete stimuli on stereotypy. What other class of antecedent events might also influence stereotypy, and how might its influence be examined?

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