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RESPONSE-RESTRICTION ANALYSIS: I. ASSESSMENT OF ACTIVITY PREFERENCES

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We used procedures based on response-restriction (RR) analysis to assess vocational and leisure activity preferences for 3 adults with developmental disabilities. To increase the efficiency of the analysis relative to that reported in previous research, we used criteria that allowed activities to be restricted at the earliest point at which a preference could be determined. Results obtained across two consecutive RR assessments showed some variability in overall preference rankings but a high degree of consistency for highly ranked items. Finally, we compared results of the RR assessment with those of an extended free-operant assessment and found that the RR assessment yielded (a) more differentiated patterns of preference and (b) more complete information about engagement with all of the target activities.

DESCRIPTORS: preference, reinforcer assessment, response restriction

A number of methods have been developed for assessing the preferences of persons with developmental disabilities. Although a common feature of these methods is the objective measurement of approach behavior in the presence of potentially reinforcing stimuli, a great deal of procedural variation exists. For example, stimuli for which preference is assessed have been presented in several different formats: singly (Pace, Ivancic, Edwards, Iwata, & Page, 1985), in pairs (Fisher et al., 1992), or in grouped arrays (DeLeon & Iwata, 1996). Most procedures, however, permit limited access to the stimulus chosen on a given trial. In an attempt to alleviate potential problems that might result from the repeated withdrawal of reinforcers, Roane, Vollmer, Ringdahl, and Marcus (1998) described a free-operant procedure in which item manipulation was measured while all stimuli were simultaneously available throughout the session. Their results showed that the procedure identified reinforcers for individuals with developmental disabilities, took less time than did a

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paired-stimulus procedure, and evoked fewer problem behaviors (presumably because reinforcers were not repeatedly presented and removed). In spite of its strengths, a potential limitation of the free-operant format is that exclusive interaction with one item, should it occur, would provide little information about preference for other items in the array. By contrast, responding is more restricted in trial-based procedures because stimuli are available only in pairs (Fisher et al., 1992) or in progressively smaller arrays (DeLeon & Iwata, 1996); this yields a ranked hierarchy of preference for all items included in the assessment.

Both of these problems (limited access and exclusive preference) might be alleviated by combining free-operant and trial-based methods. An initial free-operant assessment would overcome problems associated with limited access to preferred stimuli (Worsdell, Iwata, & Wallace, 2002). Subsequently repeating the assessment after removing the most preferred activity from the pool of available items would overcome problems associated with exclusive preference. Response-restriction (RR) analyses of this type have been used with both nonhumans (Lyons & Cheney, 1984) and humans (Bernstein & Ebbeson, 1978; Green & Striefel, 1988; McEntee & Saunders, 1997) to develop models that predict which of two or more alternative responses will emerge when other responses are restricted. The procedures differ along a number of dimensions, but all involve the measurement of response allocation among several concurrently available activities under conditions in which responding is progressively restricted to fewer and fewer options. For example, Green and Striefel initially measured free-operant engagement in six activities by 4 children with autism. Access to the most preferred activity was then restricted by removing the relevant materials across successive sessions, while time spent with the remaining sets of materials continued to be measured. Results showed that each participant initially engaged in one activity to a greater extent than others, but that responding was redistributed to remaining activities when highly preferred activities were removed. However, it was also observed in this study, as well in others (Bernstein & Ebbeson; McEntee & Saunders), that patterns of behavioral redistribution following restriction of preferred events were highly idiosyncratic and, therefore, should be established on an individual basis.

Green and Striefel (1988) described several rules for determining when to change assessment conditions (i.e., when to restrict the array by removing an activity). These criteria also were adopted by McEntee and Saunders (1997) and required that an activity be restricted when (a) interaction with one activity was observed for a larger percentage of session time than that observed for other activities across three sessions, and (b) the percentage of time allocated to that same activity in the subsequent (fourth) session was within one standard deviation of the mean percentage of allocation to that activity observed for the previous sessions. If these criteria were not met, the item with the largest overall percentage of time allocation was removed after 10 total sessions. Although not necessarily intended for use by practitioners, these criteria are somewhat cumbersome (requiring at least four and as many as 10 sessions per condition). In addition, these criteria do not readily accommodate situations in which two (or more) activities are associated with similar levels of interaction.

These potential limitations were considered in applying the general strategy of response restriction to the evaluation of vocational and leisure activity preferences for adults with developmental disabilities. In an attempt to increase the efficiency of the RR assessments, we used visual inspection criteria that would allow activities to be re-

Table 1
Activity Descriptions

Activity	Description
Art book	Drawing books, markers, crayons
Arts and crafts	Colored paper, scissors, glue, glitter
Beads and string	Small plastic multicolored beads and colored plastic string
Jigsaw puzzles	25-piece puzzle with backboard or 100-piece puzzles
Magazines	*Dog Fancy, Bird Talk, Sports Illustrated, Good Housekeeping*
Massager	Snake massager (rubber exterior, 3 cm by 75 cm)
Electronic music	Electronic handheld musical toys shaped like instruments
Nuts and bolts	Three sizes of metal nuts, bolts, and washers
Perfection	Game in which shapes are fit into board while timer counts down
Sewing	Plastic sewing grid, needle, and yarn
Sort and pack	Soap, shampoo, pencils, sheets of paper, toothbrushes, toothpaste, deodorant, plastic bags
Stamp and stuff	Paper, folding guide, ink and stamp, envelope
Tear boxes	A variety of cardboard boxes to be recycled
Towel fold	Face cloths, hand towels, and bath towels
Weights	Two 3-lb handheld weights

stricted at the earliest point at which a preference emerged. We also examined the consistency of outcomes across two consecutive RR assessments. Finally, we compared the results of RR assessments with those of an extended free-operant assessment to determine whether the former would yield more differentiated patterns of preference than the latter.

GENERAL METHOD

Participants and Setting

Three adults with developmental disabilities who attended a workshop program participated. Amy was a 39-year-old woman who had been diagnosed with a seizure disorder and severe mental retardation. Roy was a 34-year-old man who had been diagnosed with a seizure disorder, moderate mental retardation, and a hearing impairment. Ned was a 66-year-old man who had been diagnosed with severe mental retardation. All participants were ambulatory and could follow single-step instructions. Sessions were conducted in the workshop or in conference rooms that contained tables, chairs, and, at times, other workshop employees.

Activity Selection

A group of activities was identified for each participant by administering a structured questionnaire (Fisher, Piazza, Bowman, & Amari, 1996) to either the participant or a staff member. Activities were included in an individual's RR assessments if they (a) were reported as preferred, (b) were reported or were observed to be available in the participant's home or workshop area, and (c) could be placed on a table and interacted with while alone. At least two additional activities reported to be less preferred or nonpreferred were included in the assessments. From this, a total of seven activities were included in the initial assessments for each participant (see Table 1 for descriptions of the types of activities included in the study).

Response Measurement

Trained observers used laptop computers to collect data on participants' interaction with each of the available activities during 5-min sessions. Interaction was scored during continuous 5-s intervals on a partial-interval basis and was recorded when a participant's hand contacted any part of the materials for

at least 1 s. Data were summarized as the percentage of intervals during which interaction with a particular activity occurred. Percentage of intervals of interaction was selected as the primary dependent measure because it provided a common basis for comparing data across a wide range of activities.

Interobserver Agreement

Interobserver agreement was assessed by having a second observer collect simultaneous but independent data during at least 30% of the sessions in each condition across participants (M = 59.7%; range across participants, 30.6% to 100%). Observers' records were compared on an interval-by-interval basis, and an agreement was scored in any interval in which the two observers both scored either the occurrence or nonoccurrence of behavior (interaction) with respect to each activity. Agreement percentages were calculated for each activity by dividing the number of agreement intervals by the total number of intervals and multiplying by 100%. Mean agreement for interaction was 98.6% across assessments and participants (range across individual sessions, 83.3% to 100%).

Study 1: RR Assessments

Procedure

Two RR assessments were conducted with each of the 3 participants. Prior to the first assessment, the participant was prompted to manipulate each of the seven activities for 30 s. At the beginning of each session, the seven (or remaining) activities were arranged in an arc on a table in front of the participant, and the therapist pointed to each activity while naming it. The therapist informed the participant that he or she may interact with one, some, or none of the items, and then began the session. During the session, no prompts or consequences were delivered, and the participant was free to engage in activities simultaneously. Sessions were 5 min in duration, and four to eight sessions were conducted each day with 2- to 3-min breaks between sessions.

Several rules were developed for determining activity preference and restricting an activity in subsequent sessions. The simplest was that preference for (and subsequent restriction of) an activity was determined if 60% or more intervals of interaction were observed with that activity across two consecutive sessions (Rule 1). Additional sessions beyond two were conducted with the same number of activities if this rule was not met. If interaction with the same activity was observed in 60% or more intervals in two of three sessions and responding was not allocated to an alternative activity for 60% or more intervals in those same sessions, then that activity was restricted (Rule 2). If responding was variable (i.e., different activities were associated with the highest levels of interaction across sessions), sessions continued until (a) responding was consistently and evenly distributed among a small group of activities (two or more); then that entire group of activities was restricted (Rule 3) or (b) responding was more consistently allocated to one of the remaining activities (Rule 4). Removal of the next most highly preferred activity (or activities) continued across sessions until either high levels of interaction were observed with each of the seven activities or until little or no interaction (less than 20% of intervals) occurred with the remaining activities for at least two consecutive sessions (Rule 5; this never occurred with these 3 participants). Once an assessment was completed (either interaction was observed with all activities or little or no responding towards the remaining activities was observed), it was repeated to assess the consistency of preferences.

Results

Most preference assessment data are summarized either as a selection percentage

Table 2
Session-by-Session Results of Amy's Response-Restriction Assessments

Number of activities in array	Sessions	Sort and pack	Stamp and stuff	Jigsaw puzzle	Sewing	Bead and string	Art book	Towel fold
7	1	0	100	0	0	0	0	0
	2	95	0	0	0	0	0	0
	3	98.3	0	0	0	0	0	1.7
6	4		100	0	0	0	0	0
	5		95	0	0	0	0	0
5	6			81.7	0	0	0	0
	7			100	0	0	0	0
4	8				100	0	0	0
	9				100	0	0	0
3	10					0	0	100
	11					98.3	0	0
	12					96.7	0	0
2	13						98.3	0
	14						96.7	0
1	15							100
	16							96.6
Mean % interaction		64.4	59.0	26.0	22.0	16.3	13.9	18.5
7	1	96.7	0	0	0	0	0	0
	2	0	100	0	0	0	0	0
	3	0	0	100	0	0	0	0
	4	95.0	0	0	0	0	0	0
	5	0	100	0	0	0	0	0
	6	98.3	0	0	0	0	0	0
6	7		0	0	0	70	0	0
	8		0	100	0	0	0	0
	9		0	98.3	0	0	0	0
5	10		0		0	0	100	0
	11		0		0	0	100	0
4	12		96.7		0	0		0
	13		0		98.3	1.7		0
	14		0		96.7	0		0
3	15		0			95		0
	16		100			0		0
	17		0			0		100
	18		100			0		0
	19		0			98.3		0
	20		0			0		95
Mean % interaction		48.3	24.8	33.1	13.9	13.3	18.2	9.8

(number of times an item was selected given the number of times it was available; DeLeon & Iwata, 1996; Fisher et al., 1992) or as the percentage of session time in which the item was manipulated (Roane et al., 1998). When multiple activities are available in varying combinations and the participants' behavior with respect to the activities is measured over an extended period of time (as in the RR assessments), important aspects of the data may be lost when summarized. Therefore, session-by-session data for 2 of the 3 participants (Amy and Roy) are provided in Tables 2 and 3 to allow examination of shifts in activity. The data are also depicted in this manner to show patterns of responding that met the criteria of the five rules for restricting activities. Graph-

Table 3
Sessions-by-Session Results of Roy's Response-Restriction Assessments

Number of activities in array	Sessions	Art book	Jigsaw puzzle	Magazines	Nuts and bolts	Towel fold	Sort and pack	Weights
7	1	88.3	0	0	0	1.7	0	0
	2	0	0	0	98.3		0	0
	3	0	58.3	0	0	36.6	0	0
	4	88.3	0	0	0	0	0	0
	5	0	91.6	0	0	0	0	0
	6	100	0	0	0	0	0	0
	7	0	100	0	0	0	0	0
5	8			0	100	0	0	0
	9			100	0	0	0	0
	10			98.3	0	0	0	0
4	11				100	0	0	0
	12				0	96.7	0	0
	13				0	0	86.7	0
	14				0	100	0	0
	15				100	0	0	0
	16				0	0	100	0
1	17							98.3
	18							100
Mean % interaction		46.1	35.7	19.8	24.9	14.7	11.7	11.0
7	1	0	98.3	0	0	0	0	0
	2	100	0	0	0	0	0	0
	3	90	0	0	0	0	0	0
6	4		0	0	0	95	0	0
	5		0	0	0	100	0	0
5	6		85.0	0	0		0	0
	7		0	0	0		55.0	0
	8		98.3	0	0		0	0
4	9			0	0		96.7	0
	10			0	0		0	98.3
	11			58.3	0		0	0
	12			0	0		0	100
3	13			0	100		0	
	14			95	0		0	
	15			0	100		0	
	16			100	0		0	
1	17						98.3	
	18						100	
Mean % interaction		63.3	35.2	15.8	12.5	39.0	19.4	16.5

ically summarized results for each participant are also presented in the context of Study 2 (Figure 1).

The results of Amy's RR assessments are shown in Table 2. High levels of interaction with the stamp-and-stuff activity were observed in the initial 5-min session. However, the sort-and-pack activity was associated with high levels of interaction in the second and third sessions; therefore, sort and pack was removed from the array first (Rule 1). Responding was reallocated to the remaining activities following restriction of the more preferred activities from the array, and the Rule 1 criterion was successively met by the remaining activities during Sessions 4 through 16. When only the towel-folding activity remained, Amy engaged in that ac-

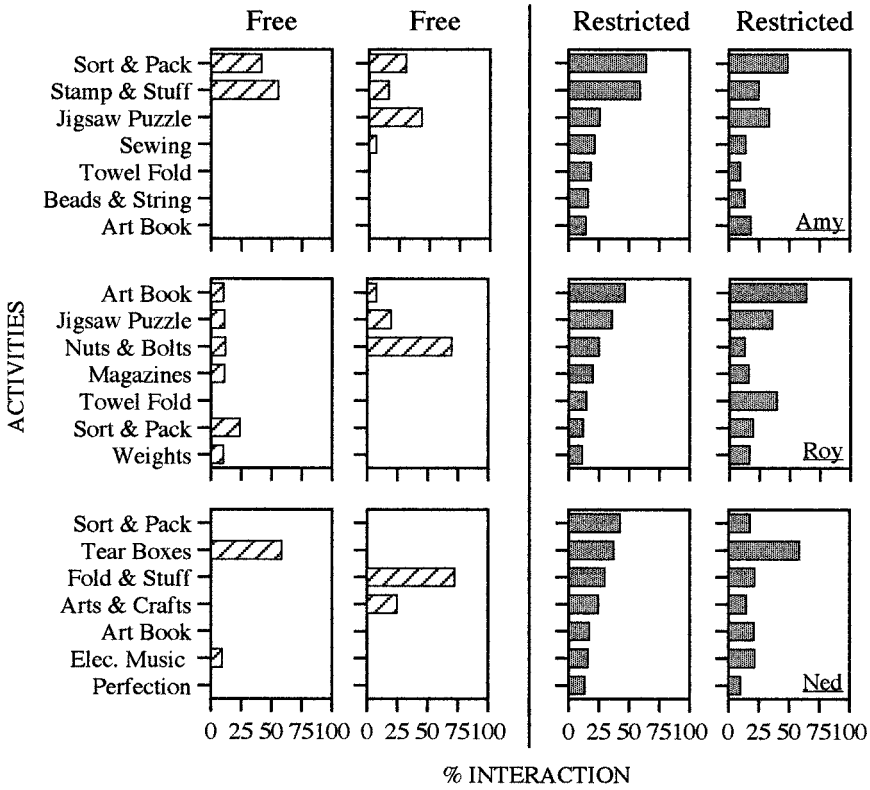

Figure 1. Results obtained from free-operant (graphs left of the vertical line) and RR (graphs right of the vertical line) assessments for Amy, Roy, and Ned.

tivity at high levels, suggesting that towel folding may have been least preferred but not necessarily nonpreferred. The mean percentage of interaction for each activity represents the total number of intervals of interaction divided by the total number of intervals in which that activity was available multiplied by 100%.

More variability in response allocation was observed in Amy's second assessment (bottom half of Table 2). Responding was initially distributed among the three most highly preferred activities from the first RR assessment. By the sixth session, however, higher levels of engagement were observed with the sort-and-pack activity, which was removed from the array in subsequent sessions (Rule 4). Three additional activities were then successively restricted (jigsaw puzzle, Session 10; art book, Session 12; sewing, Session 15) after meeting the criterion described by Rule 1. Amy's responding was evenly distributed among the remaining three activities during the final six sessions (Rule 3); therefore, the assessment was terminated.

Roy's responding (Table 3) during his first assessment was variable initially and was distributed across four activities, although he eventually alternated between the art and jigsaw activities (Sessions 4 through 7), both of which were then removed from the array (Rule 3). Magazines were then removed after Ray engaged in this activity exclusively for two consecutive sessions (Rule 1). Thereafter, Ray's responding alternated among three of the four remaining activities (nuts and bolts, towel folding, and sort and pack) during the next six sessions, which were removed from the array as a group (Rule 3).

Table 4
Preference Rankings and Correlation Coefficients Across Two Response-Restriction Assessments for Each Participant

	RR assessment	Preference rankings (based on mean percentage of interaction)							Correlation coefficients
	First	1	2	3	4	5	6	7	
Amy	Second	1	3	2	5	7	6	4	.71
Roy	Second	1	3	7	6	2	4	5	.32
Ned	Second	5	1	3	6	4	2	7	.32
						Mean correlation coefficient			.45

Without other activity options, Roy interacted with the weights in the final two sessions.

In Roy's second RR assessment, the art and the towel-folding activities were successively removed from the array because high levels of responding were allocated to these activities for two consecutive sessions (Rule 3). Rule 2 was invoked during Sessions 6 through 12 and resulted in the successive removal of the jigsaw puzzle and weights activities. An even distribution of responding was observed for the magazines and nuts-and-bolts activities, both of which were removed from the array following Session 16 (Rule 3). Finally, Roy showed high levels of interaction with the sort-and-pack activity when it was the only remaining option.

The length of the RR assessments averaged 18.8 sessions (94.1 min of session time) across participants, with a range of 16 to 21 sessions (80 to 105 min of session time). Interestingly, all participants showed a complete reallocation of responding following each activity restriction, suggesting that all of the activities were reinforcing to some extent. Activities were ranked according to interaction percentages (the item with the highest interaction percentage was assigned a rank of 1). Preference rankings for the participants' seven activities from the first and second assessments are shown in Table 4. Although rankings varied across the two assessments, two of the three most highly preferred activities remained the same across both assessments for all participants. Spearman rank-correlation coefficients were calculated for each participant using SYSTAT 10 (2000) and averaged .45 (see Table 4).

Study 2: Free- Versus Restricted-Operant Assessments

Results of Study 1 showed that RR assessments may be useful in identifying preferences among groups of activities. The restriction procedure (successively removing more highly preferred activities across sessions) seemed to yield more differentiated results than might be observed under a free-operant arrangement (exclusive preference for a single item was observed for about half of the participants during the free-operant assessments in the Roane et al., 1998, study). However, it is also possible that simply measuring free-operant interaction over an extended time period (similar in duration to that involved in RR assessments) may have yielded comparable results in the absence of the restriction procedures. Therefore, we compared outcomes of free-operant assessments to those obtained from RR assessments.

Procedure

Prior to the initial free-operant session, participants were prompted to manipulate each set of materials for 30 s. The free-operant assessment involved continuous access to the seven target activities during an 80-min period, which was selected because it

equaled the duration of observation for an RR assessment conducted with a pilot participant (data not shown). Session time was suspended if the participant requested a break (for the bathroom or to get a drink of water) and was terminated when 80 min of observation in the presence of the seven activities was completed. Two free-operant assessments (conducted at least 2 days apart) were followed 2 days later by two RR assessments (described in Study 1).

Results

Data for Amy's, Roy's, and Ned's assessments were graphed as the mean percentage of interaction with the seven activities during each free-operant (two left columns of Figure 1) and RR (two right columns of Figure 1) assessment. The length of each horizontal bar represents the mean percentage of interaction with a given activity. Large variation in the lengths of the bars (i.e., sharper slopes) indicates more highly differentiated preferences, whereas small differences among the bars (i.e., flatter slopes) indicate weaker preferences. Complete response reallocation during RR assessments, in which participants interacted with all activities, is shown by the presence of seven bars. By contrast, incomplete reallocation, in which participants stopped interacting with activities at a certain level of restriction (RR assessment) or did not interact with all of the continuously available activities (free-operant assessment), would be evident by the absence of a bar for one or more activities.

Response allocation was observed across several activities during the free-operant assessment (first two columns of Figure 1), indicating that these activities were preferred relative to the other activities. However, the free-operant assessment did not reveal a preference hierarchy among all of the activities, nor did it indicate whether all of the activities would support interaction. These limitations were evident in the data for all 3 participants. By contrast, the RR assessments (second two columns of Figure 1) provided information about preference for all seven activities (i.e., a preference hierarchy was evident). Interaction with all seven activities was observed for each participant, and even the least preferred activities supported interaction during the RR assessment.

DISCUSSION

Although free-operant assessments may be useful due to their simplicity and efficiency, they may yield limited information if responding is allocated exclusively to one or a few items. That is, a free-operant assessment may indicate which activity is most preferred but may not indicate whether the other activities are simply less preferred rather than nonpreferred. This may not be a problem if the goal of the assessment is to identify one (or possibly two) highly preferred activities. However, if identifying preference among concurrently available responses is desirable, or if determining the extent to which each activity supports behavior is important, successive restriction of highly preferred activities, a key feature of the RR assessment, may be necessary.

In addition to identifying preference for all of the activities in the array, the RR assessment retains a desirable feature of the free-operant assessment noted by Roane et al. (1998): Items are not removed during a session but, rather, are simply not present during a subsequent session. This arrangement might evoke fewer problem behaviors that are maintained by access to preferred items (Day, Rea, Schussler, Larsen, & Johnson, 1988) than might be expected from assessments that require removal of an item soon after its delivery, as in the paired-stimulus (Fisher et al., 1992) and multiple-stimulus (DeLeon & Iwata, 1996) assessments.

These data also suggest that the common practice of assessing preferences and abilities

simply by watching people behave in the natural environment may not be very informative. Natural environments may be similar to the conditions of a free-operant assessment; if so, exclusive engagement in one activity may persist. An interesting extension of the current study may be to conduct RR procedures under more natural conditions to determine if information about a wider range of preferences (similar to that observed in this study) is gained. This "in vivo" type of preference assessment might prove more accurate than caregiver report (see Fisher et al., 1996; Green & Striefel, 1988; Reid, Everson, & Green, 1999; on the limitations of verbal report) and may provide rich information about preferences in the work, home, or school environments.

Neither Green and Striefel (1988) nor McEntee and Saunders (1997) reported the total number of sessions conducted or the total RR assessment time for each participant; therefore, it is not possible to compare the efficiency of the assessments, given previously described restriction rules and those used in the current study. However, the rules used in the current study allowed items to be removed following two (rather than a minimum of four) sessions, and a condition was never conducted for more than seven sessions (a 10-session criterion was often used in the Green & Striefel and McEntee & Saunders studies). The generally consistent outcomes across each participant's first and second RR assessments suggest that accuracy in identifying high- and low-probability responses was not sacrificed for the sake of efficiency. However, the more rigorous restriction criteria described by Green and Striefel may lead to better predictions about preferences and response reallocation. An interesting direction for future research might be to conduct RR assessments long after the different criteria for changing conditions are met to determine whether similar (redundant) or dissimilar patterns of response allocation are observed. The results may be helpful in expanding or reducing the necessary time spent in any one condition of an RR assessment.

In contrast to the generally consistent outcomes observed between RR assessments, the outcomes and the resulting conclusions regarding preference varied considerably across free-operant assessments and between the free-operant and RR assessments. Variables that may be responsible for these observed differences were not evaluated, but results such as these are not surprising in light of previous research showing a high degree of variability when the same preference assessment procedure is applied at different points in time (Carr, Nicolson, & Higbee, 2000; Mason, McGee, Farmer-Dougan, & Risley, 1989; Zhou, Iwata, Goff, & Shore, 2001). The stability of preference may be affected by a number of factors. For example, an activity may acquire reinforcing properties merely as a function of repeated exposure or through experiences with an activity in a highly reinforcing context. Alternatively, engagement in activities outside of sessions (a possibility for all participants) may have produced satiation for a form of reinforcement provided by one of the activities (Klatt, Sherman, & Sheldon, 2000). Finally, artifacts of different assessment procedures may influence the results of preference assessments (e.g., puzzles may not be selected when only brief access is arranged during a preference assessment).

That differences in preference assessment data may be obtained at different points in time is apparent; the variables responsible for these differences are not. Experimental analyses of the factors that may influence preference stability, as well as studies that demonstrate direct effects of reinforcement during subsequent training programs, will expand our understanding of the significance of differences observed between preference

assessment outcomes conducted using the same or different procedures.

In summary, the RR assessment provided a basis for identifying preferences among a set of concurrently available activities. The procedure was clearly time consuming, and several rules for determining when to restrict an activity require consideration. Thus, features of the RR assessment may seem inconsistent with current trends in preference assessment research aimed at increasing simplicity and efficiency. However, rules for changing conditions in free-operant multiresponse environments are necessarily more complex than in discrete-trial contexts, requiring evaluation of trend, level, and variability across one or more data paths. Furthermore, successive restriction may be necessary to identify the extent of interaction with all activities in an assessment. Finally, the RR procedure provides a rich amount of information with respect to the order in which activities are selected (used as a preference indicator) and their ability to support interaction over an extended time periods (5 min as opposed to 5 to 10 s). These features of the RR assessment may be helpful in identifying preference among leisure or vocational activities when extended assessment duration is not problematic, or in serving as a baseline of response allocation for measuring shifts in preference as a function of altering environmental arrangements (Hanley, Iwata, Roscoe, Thompson, & Lindberg, 2003).

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STUDY QUESTIONS

1. What are some limitations of discrete-trial and free-operant methods for assessing preference?

2. Describe the general procedure used in the response-restriction (RR) analysis (Study 1).

3. What rules were used to determine when to restrict the array by removing an activity?

4. Summarize the general pattern of responding observed during Amy's RR analysis.

5. How was the free-operant assessment conducted in Study 2 so as to yield data that corresponded to those obtained during the RR analysis (Study 1)?

6. Summarize the results of the free- versus restricted-operant assessments (Study 2).

7. What factors may influence the stability of preferences?

8. Given the results of this study, what appear to be the advantages and disadvantages of RR assessments?

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