JOURNAL OF APPLIED BEHAVIOR ANALYSIS 2001, **34,** 57–60 NUMBER 1 (SPRING 2001)

A BRIEF COMPUTER-BASED ASSESSMENT OF REINFORCER DIMENSIONS AFFECTING CHOICE

NANCY A. NEEF
THE OHIO STATE UNIVERSITY
AND
MEGAN NOONE LUTZ
UNIVERSITY OF PENNSYLVANIA

In an extension of Neef, Shade, and Miller (1994), we used a brief computer-based assessment of differential responsiveness to reinforcer rate, quality, delay, and response effort in affecting the choices of 11 participants. The assessment involved successive presentations of two concurrent sets of math problems, each set associated with competing reinforcer or response dimensions in a counterbalanced fashion. The results showed that the reinforcer and response dimensions differentially affected choice, with time-allocation patterns varying across students.

DESCRIPTORS: assessment, choice, reinforcer dimensions, matching theory, concurrent schedules

The effects of a reinforcer on behavior are contextual and depend, in part, on the reinforcers for competing response alternatives. Extensive basic and, recently, applied research involving concurrent schedules has examined how choice (the distribution of responding between two or more simultaneously available alternatives) is affected by differences in one or more reinforcer or response dimensions (rate, quality, magnitude, delay, response effort) associated with those options (Fisher & Mazur, 1997). For example, Neef, Shade, and Miller (1994) examined how the reinforcer and response dimensions examined separately in previous studies combined to influence the choices of 6 youths with learning and behavior difficulties. The results showed that the time each student allocated to sets of math problems that competed with respect to reinforcer rate, quality, delay, or response effort was differentially affected by those dimensions. The purpose of the present investigation was to replicate and extend the study by Neef et al. with 11 additional participants, using a briefer assessment model that was computer based.

METHOD

The participants were 4 male and 7 female students, ages 9 to 13 years ($M = 9.8$), who were enrolled in an urban partial hospitalization program for children with emotional and behavioral problems. They were reported to function within the normal range of intelligence.

The experimental arrangements were similar to the automated procedures described in Neef et al. (1994): The student chose from among successive pairs of math problems presented on a computer choice screen, and then performed the selected problem that was displayed individually on the prob-

This research was supported by a grant from the U.S. Department of Education, Office of Special Education and Rehabilitation Services. The opinions expressed herein do not necessarily reflect the position or policy of that agency.

Address correspondence to Nancy A. Neef, PAES, College of Education, The Ohio State University, 1945 N. High St., Arps Hall, Columbus, Ohio 43210 (E-mail: neef.2@osu.edu).

lem screen. A correct response, three consecutive incorrect attempts, or not initiating a response within 10 s produced a new set of problems on the choice screen. The sets of math problems competed on two of four dimensions (reinforcer rate, quality, delay, and response effort). For example, in the rate versus effort (RvE) condition, completion of low-effort problems was reinforced on a variable-interval (VI) 120-s schedule, and completion of more difficult problems was reinforced on a VI 30-s schedule; reinforcer quality (items for which earned points could be exchanged) and immediacy (elapsed time to obtain earned items) remained constant across the two problem options (see Neef et al., 1994, for a description). *Rate* refers to the schedule of reinforcement in effect for correct problem completion (VI 120, VI 60, and VI 30 for high, medium, and low values, respectively). Point delivery was signaled with a tone for problems from one set and a chime for problems from the other, and the cumulative number of points earned for the respective sets was displayed under the problems on the choice screen. (Because the choice screen did not provide information on the schedules of reinforcement associated with the response alternatives, however, experimental sessions in the current study were preceded by a 5-min practice during which the student was allowed to sample the response alternatives and respective rates of point delivery for problem completion.) *Quality* refers to the participant's relative preference for items that could be purchased with points from the respective sets, which were designated as from Store A (three top-ranked items) or Store B (next three ranked items) under the respective problem sets on the choice screen. Designations were made on the basis of participant rankings of 10 items at the start of each session. *Immediacy* refers to when the earned item or items would be made available to the student (end of session or next day), and were also indicated under the respective sets on the choice screen. *Response effort* refers to the relative difficulty of the problems as determined by the rate and accuracy with which samples of problems of different types were completed on a pretest.

For each 10-min session, a computer-generated record was obtained of time allocated to, and number of reinforcers obtained for, each problem set. The initial assessment consisted of one session for each of the six experimental conditions, presented in a random order. The set of conditions arranged the counterbalanced presentation of each dimension in relation to every other dimension. Thus, each dimension was assessed three times (e.g., high-quality reinforcers for one problem set vs. low-quality reinforcers for the other problem set) in competition with another dimension (e.g., low vs. high values for rate of reinforcement, immediacy of reinforcer access, and response effort). Selected conditions, including those producing the greatest and least percentage of time allocation to a response alternative, were then replicated. A dimension that consistently produced the highest proportion of time allocation in relation to any of the other three dimensions with which it competed was determined to be the most influential.

RESULTS AND DISCUSSION

Table 1 shows the proportion of time each student allocated to problem alternatives (Set 1 vs. Set 2) associated with the competing dimensions of rate (R), quality (Q), immediacy (I), and effort (E). Conditions of the initial assessment are shown in an identical order across students to facilitate interpretation. The students are ordered on the basis of their assessment profiles.

Results for students whose choices were influenced principally by reinforcer quality (Student S1), immediacy (Students S6 and S7), and rate (Student S8) are described here

Table 1
Percentage of Time Allocated to Response Alternatives Across Assessment Conditions for Each Student

	Initial assessment						Replications			
Conditions	RvQ	RvE	RvI	QvE	IvQ	IvE	QvE	RvQ		
S1	15/85	36/64	48/52	85/15	46/54	64/36	69/31	24/76		
Conditions	RvQ	RvE	RvI	QvE	IvQ	IvE	IvQ	RvQ	IvE	RvI
S6	0/100	16/84	0/100	77/23	92/8	100/0	100/0	2/98	100/0	15/85
Conditions	RvQ	RvE	RvI	QvE	IvQ	IvE	IvQ	RvI	RvE	
S7	92/8	100/0	0/100	92/8	100/0	100/0	0/100	0/100	75/25	
Conditions	RvQ	RvE	RvI	QvE	IvQ	IvE	EvR	RvQ	RvI	
S8	93/7	97/3	92/8	93/7	68/32	96/4	14/86	100/0	100/0	
Conditions	RvQ	RvE	RvI	QvE	IvQ	IvE	QvE			
S2	39/61	22/78	2/98	0/100	70/30	0/100	0/100			
Conditions	RvQ	RvE	RvI	QvE	IvQ	IvE	RvE	IvE	EvR	
S3	75/25	0/100	100/0	0/100	69/31	0/100	0/100	0/100	100/0	
Conditions	RvQ	RvE	RvI	QvE	IvQ	IvE	RvE	IvE	EvQ	
S4	30/70	59/41	86/14	0/100	28/72	0/100	0/100	0/100	100/0	
Conditions	RvQ	RvE	RvI	QvE	IvQ	IvE	EvI	QvE		
S5	37/63	23/77	23/77	4/96	53/47	0/100	100/0	2/98		
Conditions	RvQ	RvE	RvI	QvE	IvQ	IvE	EvQ	QvI	IvQ	EvI
S9	0/100	62/38	0/100	81/19	0/100	92/8	20/80	0/100	58/42	0/100
Conditions	RvQ	RvE	RvI	QvE	IvQ	IvE	IvQ	QvI		
S10	28/72	98/2	100/0	100/0	100/0	100/0	9/91	100/0		
Conditions	RvQ	RvE	RvI	QvE	IvQ	IvE	IvQ	EvI		
S11	43/57	79/21	20/80	89/11	45/55	90/10	50/50	10/90		

for illustrative purposes. S1 allocated the majority of his time to the high-quality alternative regardless of the competing dimension: During the initial assessment, he allocated 85%, 85%, and 54% of his time to the high-quality alternative when it competed with a high rate of reinforcement (RvQ), low-effort problems (QvE), and immediate reinforcer access (IvQ), respectively. Similarly, in the replication phases, he allocated 69% and 76% of his time to completing problems associated with high-quality reinforcers in the competing effort (QvE) and rate (RvQ) conditions, respectively. When reinforcer quality was equal between problem sets (i.e., in the RvE, RvI, and IvE conditions), his choices were not consistently affected by differences in the other dimensions.

S6 allocated her time exclusively or near exclusively to response alternatives that offered immediate access to earned reinforcers (see RvI, IvE, IvQ of the initial assessment and IvQ and IvE replications). Reinforcer quality was an influential dimension (as demonstrated by her almost exclusive responding to the higher quality alternative) except when it competed with immediacy. S7 also responded exclusively to the alternative associated with more immediate access to reinforcement; however, reinforcer rate was an influential dimension when it did not compete with immediacy.

S8 demonstrated near exclusive responding to the alternative that produced the higher rate of reinforcement during both the initial assessment and replication conditions. When rate was equal across the problem alternatives (i.e., not a competing dimension), however, she allocated more time to either the higher quality or more immediate reinforcer alternative, even when those problems were more difficult. S8 was the only student for whom reinforcer rate was an influential dimension, despite the added provision of sampling the rates of reinforcement associ-

ated with the respective alternatives before beginning the experimental sessions. This suggests that matching law equations based on relative rates of reinforcement alone may have limited applicability to humans in natural environments in which choices differ on other dimensions.

Students S2, S3, S4, and S5 each allocated the majority (and usually all) of their time in both the initial assessment and replication phases to the alternative associated with the least response effort. In conditions involving equal response effort, the choices of S3, S4, and S5 varied across the other three dimensions. Thus, low response effort, which appeared to rarely affect the choices of students in the Neef et al. (1994) study, was the most influential dimension for S2, S3, S4, and S5 in the current study. In addition, reinforcer quality, which was the most or next-to-most influential dimension for all 6 students in the Neef et al. study, was one of the least influential dimensions for the above 4 students, suggesting that the qualitatively different reinforcers were substitutable for the latter individuals. The choices of S9, S10, and S11 appeared to be multiply controlled (i.e., equally influenced by more than one dimension).

In summary, the results support those of Neef et al. (1994) in that the choices of each student were differentially influenced by one or more reinforcer or response dimensions, and relative sensitivity to those dimensions varied across individuals. This was demonstrated with a computer-based assessment that was briefer than that used by Neef et al. Information revealed by the assessment might prove helpful in several respects. First, it allows the assessment to serve as an instructional tool in which influential dimensions could easily be arranged to promote students' completion of target (e.g., higher level) academic tasks. Second, it remains to be determined in future research whether influential dimensions revealed by the assessment correlate with specific diagnoses. For example, children diagnosed with attention deficit hyperactivity disorder might show differential responsiveness to reinforcer immediacy, because impulsivity is a diagnostic criterion that can be defined as choices governed by smaller, more immediate versus larger delayed reinforcers (Neef et al., 1994). Third, the assessment may provide a more efficient alternative to trial-and-error manipulation of reinforcer and response dimensions in the development of interventions (Neef & Lutz, in press).

REFERENCES

Fisher, W. W., & Mazur, J. A. (1997). Basic and applied research on choice responding. *Journal of Applied Behavior Analysis, 30,* 387–410.

Neef, N. A., & Lutz, M. N. (in press). Assessment of variables affecting choice and applications to classroom intervention. *School Psychology Quarterly.*

Neef, N. A., Shade, D., & Miller, M. S. (1994). Assessing influential dimensions of reinforcers on choice in students with serious emotional disturbance. *Journal of Applied Behavior Analysis, 27,* 575–583.

Received December 30, 1999
Final acceptance September 11, 2000
Action Editor, Robert Stromer