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EFFECTS OF UNINSTRUCTED VERBAL BEHAVIOR ON NONVERBAL RESPONDING: CONTINGENCY DESCRIPTIONS VERSUS PERFORMANCE DESCRIPTIONS

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Undergraduates' button presses occasionally made available points that were exchangeable for money. Lights over left and right buttons were respectively correlated with multiple random-ratio random-interval components. During interruptions of the multiple schedule, students filled out sentence-completion guess sheets. When shaping of these guesses produced performance descriptions (e.g., "press slowly" for the left button and "press fast" for the right), button-pressing rates typically were consistent with the verbal behavior even when rates were opposite to those ordinarily maintained by the respective schedules. When shaping instead produced contingency descriptions (e.g., the button works "after a random number of presses" or "a random time since it worked before"), pressing rates were inconsistently related to the descriptions; for some students descriptions of ratio contingencies generated higher corresponding pressing rates than were produced by descriptions of interval contingencies, but for others contingency descriptions and pressing rates were unrelated.

Key words: rule-governed behavior, contingency-shaped behavior, multiple RR RI schedules, point reinforcer, verbal behavior, contingency reports, performance reports, button press, undergraduates

Accounts of human operant behavior often assert the importance of one's awareness or knowledge of the contingencies. In such accounts, knowledge of contingencies is defined by whether verbal responses have been established on the basis of the relation between one's own behavior and its consequences. Cognitive accounts of conditioning in humans (e.g., Brewer, 1974; Dulany, 1968) have argued further that knowledge of the contingent relation between one's behavior and its consequences is a prerequisite for responding that is appropriate to contingencies. Even researchers working from a behavioral orientation have suggested that a description of contingencies may be sufficient, if not necessary, for contingency-appropriate performance (e.g., Harzem, Lowe, & Bagshaw, 1978; see also Catania, 1979, pp. 246-247). But this may be in error. Describing contingencies is different from performing in accordance with them, and the relation between these two kinds of behavior deserves experimental analysis.

Catania, Matthews, and Shimoff (1982) examined the relation between nonverbal performances and verbal descriptions of those performances. They arranged that college students' button presses produced points exchangeable for money according to multiple random-ratio (RR) random-interval (RI) schedules, with separate buttons for each schedule. Every 3 min, students completed written sentences describing "the way to turn the green lights on" (i.e., to earn points) on each of the two buttons. When sentence completions were shaped (by differentially awarding points for written descriptions of high- and low-rate pressing), pressing rates without exception conformed to those behavior descriptions, even in opposition to the scheduled contingencies for

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pressing (i.e., students who wrote "press slowly" for the RR button pressed that button slowly, and those who wrote "press fast" for the RI button pressed that button rapidly). But when sentence completions were instructed (students were told what to write to earn points for sentence completions), the relations between verbal and nonverbal responding were inconsistent; the descriptions of pressing behavior sometimes controlled, sometimes were controlled by, and sometimes were independent of the pressing.

The verbal reports in the Catania et al. procedure were performance descriptions rather than contingency descriptions, but some unpublished preliminary data bear directly on the question of how contingency descriptions affect performance. One student, A, served in pilot sessions using identical procedures, except for guess sheets that differed only in the space available for sentence completions. Figure 1 shows A's response rates on the left (RR) and right (RI) buttons in successive multiple-schedule cycles (1.5 min of responding on each button).

In the first session, A's sentence completions described the "way to turn the green lights on with the left button" as "press until a random # has been reached" and the "way to earn points with the right button" as "press until a time interval has been reached." These verbal reports were occasionally given points in the course of shaping and occurred fairly consistently by the middle of the first session. Although these reports corresponded to the respective schedule contingencies, RI rates during this time became consistently higher than RR rates. On a review of the data at the end of the session (dashed line), the difference between contingency descriptions and performance descriptions was explicitly recognized, and it was decided that shaping of performance descriptions might proceed more effectively if no points were ever awarded to contingency descriptions. Performance descriptions were shaped by the end of the second session and continued throughout the third, as shown by the guess points in the lower frame of Figure 1. Sentence completions began to take the form

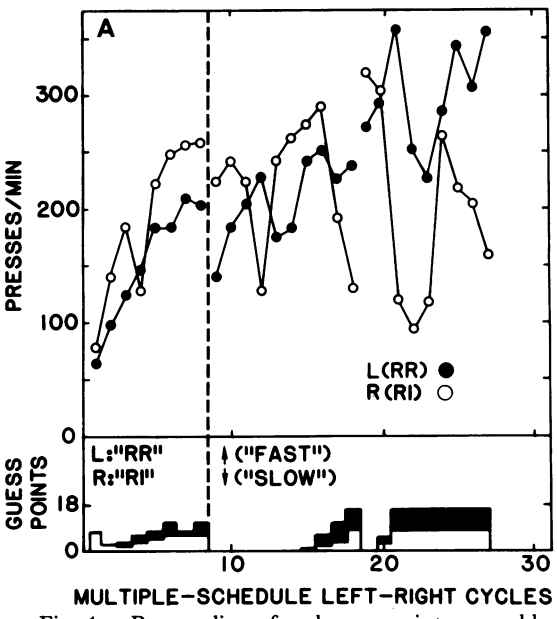

Fig. 1. Responding of and guess-points earned by Student A in a pilot study on the relation between nonverbal and verbal behavior. Button-pressing rates, maintained on a left (L) button by the random-ratio (RR) component and on a right (R) button by the random-interval (RI) component of a multiple schedule, are shown in successive 1.5-min components in the top frame. Data connected by lines were obtained within a daily session; successive sessions are separated by unconnected data. The points awarded in the shaping of guesses are shown in the bottom frame; left-button points are shown by filled and right-button by unfilled areas. A maximum of 18 points could be earned in the guess period that followed each multiple-schedule cycle. In the first session, the guesses that were shaped were descriptions of the RR and RI contingencies; thereafter, in the second and third sessions, performance descriptions were shaped ("fast" for the left button and "slow" for the right).

of "press at proper rhythm (fast)" and "press at proper rhythm (slow)" for the left (RR) and right (RI) buttons, respectively, and pressing rates conformed to these performance descriptions, with left-button rates becoming consistently higher than right-button rates.

These data did not of course prove that the performance descriptions controlled the button pressing; higher left-button rates could have been a function of the RR schedule of point deliveries. They were also obtained at a time when the experimenters were learning some of the skills of shaping

verbal behavior; for example, it was not at first obvious that complications could quickly follow from the shaping of descriptions that specified variable time intervals but did not yet specify the events from which those intervals were measured (i.e., previous responses or previous point deliveries). Nevertheless, the data suggest that the effects of contingency descriptions may not be the same as those of performance descriptions. The present experiment investigated that possibility more systematically.

METHOD

Subjects

Seven UMBC undergraduates, five males and two females ranging from 18 to 22 years of age, participated in sessions at two- to four-day intervals as an option in satisfying Introductory Psychology course requirements. Introductory Psychology sections were taught by different instructors who covered at different times and gave varying emphasis to operant behavior and related topics. No attempt was made to assess students' familiarity with reinforcement schedules, however, because previous findings (Catania et al., 1982) suggested that a questionnaire or interview sufficiently detailed to distinguish between superficial and thorough familiarity would probably have affected the students' subsequent behavior within sessions.

Apparatus

In a sound-attenuating cubicle, each student was seated facing a console and a set of "guess sheets." The upper portion of the console contained a point-counter, two green lamps, and a small black button. Whenever the two green lamps were lit, a press on the black button turned them off and added a point to the counter. The lower portion of the console contained two 2.4-cm diameter red buttons, each beneath a blue lamp and operable by a minimum force of 15 N. White noise presented through headphones masked sounds from electromechanical recording and control equipment in an adjacent room. When the blue lamp above either red button was lit, presses on that button briefly interrupted the masking noise.

Procedure

Procedures were identical to those described by Catania et al. (1982) for shaped verbal behavior, except for changes in the guess sheets described below.

Button presses. Presses on the red buttons occasionally initiated the nominal reinforcement cycle (the lighting of the green lamps, during which a press on the black button produced a point). Presses on one red button became eligible to do so according to a random-ratio schedule that selected responses with a probability of .05 (RR 20). Presses on the other became eligible after a random interval determined by selecting pulses generated at the rate of 1 per second with a probability of .1 (RI 10-s with $t = 1.0$ and $p = .1$). In most conditions, the RR schedule was arranged for left-button presses and the RI schedule for right-button presses; schedule assignments were briefly reversed at the end of one student's last session.

The left-button and right-button lamps lit alternately (multiple RR RI) for 1.5 min each (excluding reinforcement cycles), and sessions always began with the left-button (RR) schedule. The two lamps were never lit simultaneously, and presses on the button beneath an unlit lamp had no scheduled consequences. After 1.5 min of each schedule (3-min schedule cycle), both blue lamps were turned off and a buzz replaced the white noise in the headphones; this marked the beginning of the guess period.

Guesses. An ample supply of guess sheets was available next to the console. Each guess sheet had six sentences to be completed. For guess sheets requiring descriptions of contingencies, the sentences were "The computer will let your press turn on the green lights depending on:"; the first three followed the heading "Left button:" and the last three the heading "Right button:". Guess sheets requiring descriptions of performance (used for some students) were identical to those used by Catania et al. (1982), with sentences

for each button of the form: "The way to turn the green lights on with the left [right] button is to:". Students were instructed to pass each completed guess sheet through an 8-cm hole in the wall next to the console.

To shape guesses, an experimenter assigned each guess 0, 1, 2, or 3 points, writing point values next to each guess and passing the sheet to the student through the hole in the wall; the guess period ended when the student returned the graded guess sheet. In shaping, both the ratio-interval distinction and the variability of outcomes were taken into account in awarding points to guesses, but no distinction was made between technical and colloquial vocabularies. For example, both "variable ratios" and "a changing number of presses" were typically awarded the maximum of 3 points in the shaping of RR contingency descriptions. The decision to shape a particular schedule description for a particular button was always made in advance of the shaping session. In all but one case (see D, Figure 2), RR guesses were initially shaped for the left button and RI guesses for the right button, corresponding to actual contingencies.

At the end of the guess period, the buzz was replaced by white noise and the light above the left button was again lit. Points earned by guessing did not appear on the point counter, but at the end of each session students were given a card showing total session earnings; they were paid at the end of their final sessions. Sessions lasted about 50 min, and, depending on writing time for guesses, included 8 to 12 schedule cycles and guess periods.

Instructions. The following instructions were mounted on the wall above the console:

> Each point you earn is worth 1 cent. For example, if you earn 300 points, you will be paid $3.00.
>
> You have two ways to earn points: (1) by pressing the RED BUTTONS, and (2) by GUESSING.
>
> RED BUTTONS. At the lower center of the console are two red push buttons. At any time, only one of the two red buttons will work (the blue lights above the buttons will tell you which one is working).
>
> If you press in the right way: (1) The GREEN LIGHTS next to the counter will light up, and (2) when the green lights come on, you can add 1 point to your total by pressing the small BLACK BUTTON next to the counter.
>
> GUESSING. Every few minutes, the console will shut off for about 2 minutes. During this time, you may fill in as many blanks as you wish on the GUESS SHEET.
>
> When you have written as many guesses as you wish (don't take longer than about 2 minutes altogether), roll up the guess sheet and SLIDE IT THROUGH THE HOLE IN THE WALL just to the left of the console.
>
> The sheet will come back with your point earnings written in red. Each guess can earn 0, 1, 2, or 3 points.
>
> After you have seen your points for guessing, PASS THE SHEET BACK AGAIN, and the console will come on.
>
> Do not remove your headphones once the experiment is under way.

RESULTS

Figure 2 presents data from three students, B, C, and D, for whom button-pressing rates followed descriptions of contingencies; also included are data from Student E, an equivocal case. Rates of point delivery are not shown, but were consistent with the respective schedules. Those produced by RR responding can be estimated by dividing RR response rates by 20; those produced by RI responding averaged nine per component. Consistent with earlier findings (Catania et al., 1982), the shaping of verbal behavior was a more important determinant of response rates than were schedule differences or reinforcement rates (e.g., see discussion below of Student C, Figure 2).

For Student B, rate differences appeared early in the first session; by the end of that

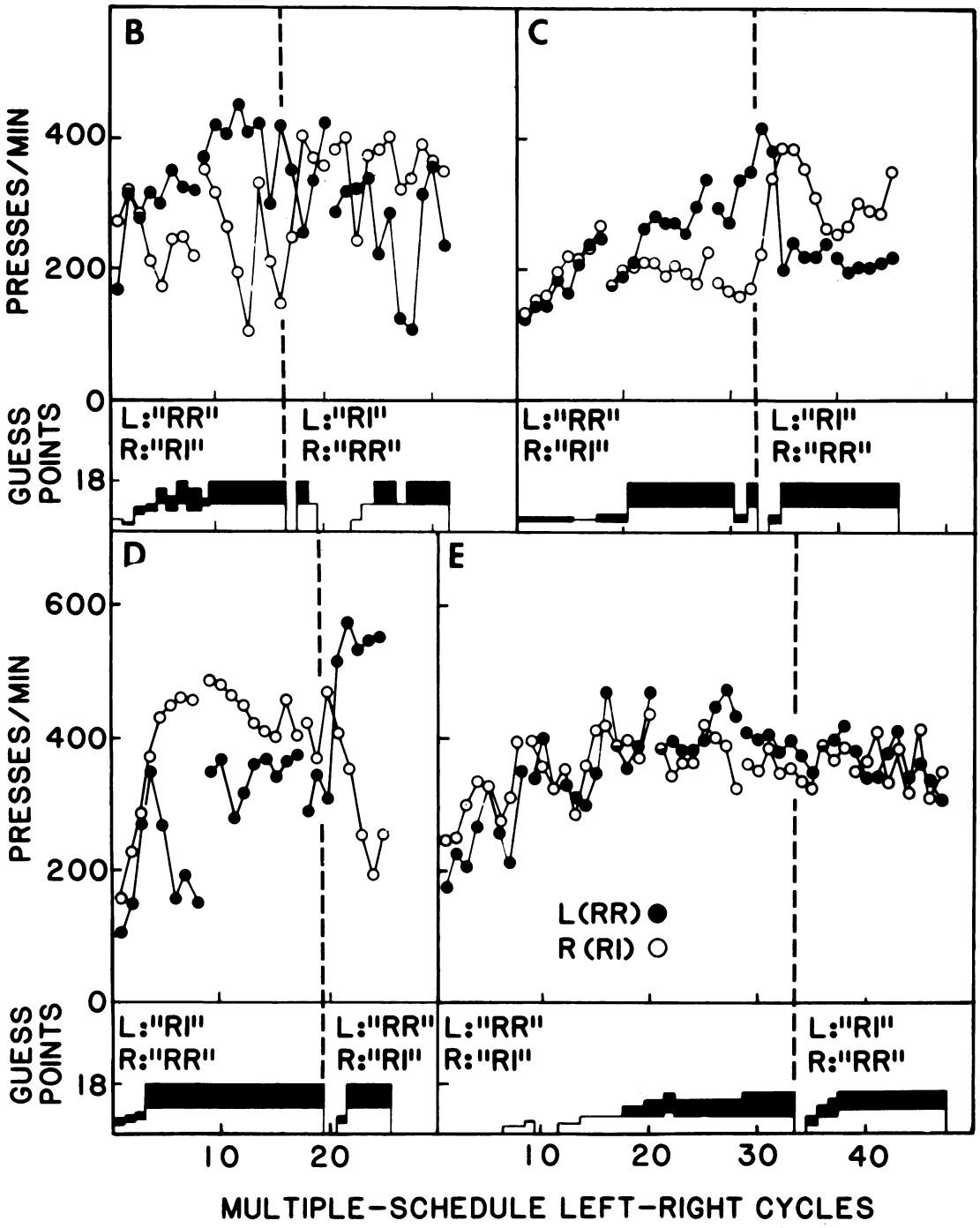

Fig. 2. The button-pressing rates of and guess-points earned by Students B through E. Each case involved the shaping and then the reversal of contingency descriptions. Except perhaps for E, contingency descriptions were accompanied by correlated changes in button-pressing rates. Details as in Figure 1.

session, B described the left- and right-button contingencies as "variable ratio" and "variable interval," respectively, and left-button rates were consistently higher than right-button rates. Toward the end of the second session (dashed lines), guess contin-

gencies were reversed, so that maximum guess points were assigned for describing the left-button (RR) contingency as RI and the right-button (RI) contingency as RR; guesses conformed to the reversed contingency by the fifth guess period of the third session, and pressing rates corresponded to the contingencies described, with left-button rates systematically lower than right-button rates.

A similar pattern was observed for Student C, who described the left-button contingency as "# of times button is pushed" and the right-button contingency as "time interval between green lights"; rate differences appeared at about the same time as the guesses became consistent. In the third session (dashed line), the contingencies on guesses were reversed, and points were assigned for describing the left- and right-button contingencies as RI and RR, respectively. With the reversal of guesses (dashed line), button-pressing rates also reversed, conforming to the guesses rather than to the contingencies on the presses themselves. The reversal occurred even though RI reinforcement rate did not increase with the increased RI response rate, whereas a roughly halved RR reinforcement rate accompanied the decreased RR rate.

For Student D, guesses opposed to the contingencies on presses (i.e., describing the left-button contingency as RI and the right-button contingency as RR) were shaped in the first session; substantial rate differences developed at about the same time as the guesses became consistent. The left-button contingency was described as "time elapsed since the last lite," and the right-button contingency as "presses since last lite." In the third session (dashed line), the contingencies on guesses were reversed and guesses became consistent with the left-button RR and right-button RI contingencies; as in the previous cases, pressing rates also reversed, conforming to the verbal descriptions of the contingencies. Thus, for these three students, the effects of contingency guesses were equivalent to those reported by Catania et al. (1982) for performance descriptions.

For Student E, accurate guesses, describing the left- and right-button contingencies as "number of presses" and "amount of time since lite came on," respectively, did not develop until the end of the third session; a small corresponding difference in rates emerged somewhat later. In the middle of the fourth session (dashed line), the contingencies on guesses were reversed; although the guesses changed appropriately, consistent differences in pressing rates were not evident. This student was unable to return for additional sessions. Even if a rate difference had appeared with continued sessions, the long lag between the change in verbal behavior and the change in pressing rates would not have been consistent with the data from the other students.

Figure 3 shows data from Students F and G, for whom pressing rates were unrelated to descriptions of contingencies but varied systematically with descriptions of high-rate and low-rate performances. For Student F, guesses describing the contingencies as "variable ratios" and "variable interval" developed at the beginning of the third session, but there were no consistent differences in pressing rates. In the fourth session (dashed line), guess sheets appropriate to performance descriptions were introduced, and descriptions of "fast" (for left-button presses) and "slow" (for right-button presses) were shaped; when performance descriptions were established, pressing rates conformed to them: Substantial rate differences developed immediately.

For Student G, guesses describing left- and right-button contingencies as "changing ratio of presses" and "changing time since previous point" developed by the sixth guess period of the second session, but there were no correlated differences in pressing rates. In the middle of the third session, guess sheets appropriate to performance descriptions were introduced. The shaping of performance descriptions took longer than for F. Toward the end of the fourth session, pressing "rapidly" and pressing "slowly" had developed as the respective left- and right-button descriptions, and pressing rates

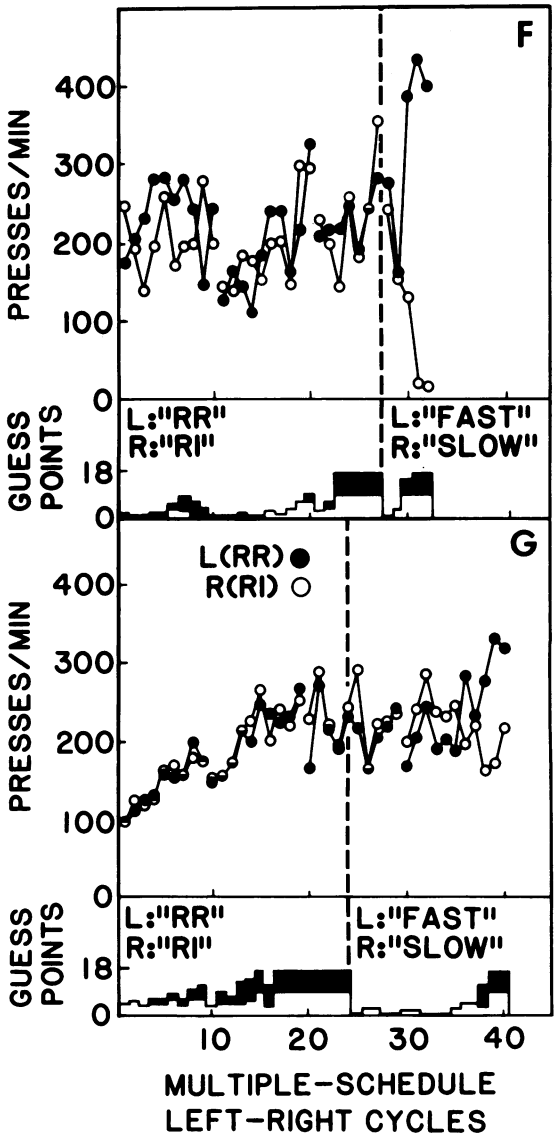

Fig. 3. The button-pressing rates of and guess-points earned by Students F and G. In these cases, the shaping of contingency descriptions was not accompanied by correlated changes in button-pressing rates; such changes emerged when descriptions of performance were subsequently shaped. Details as in Figure 1.

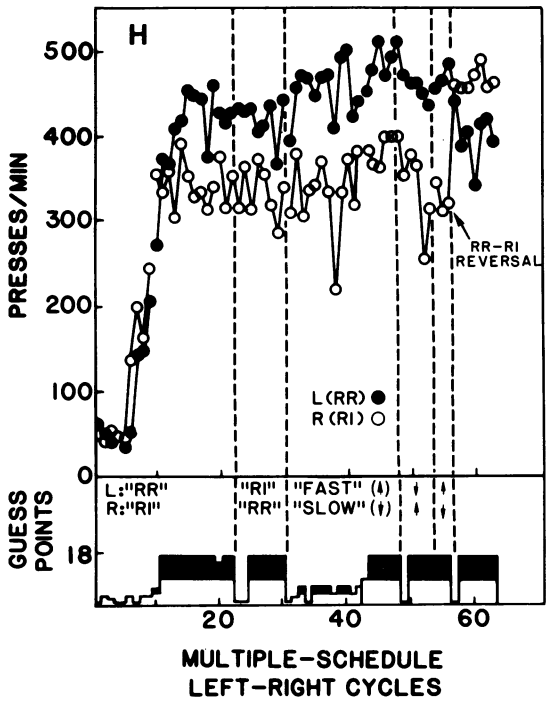

Fig. 4. The button-pressing rates of and guess-points earned by Student H. In this case, neither changes from contingency descriptions to performance descriptions nor guess reversals were accompanied by corresponding changes in button-pressing rates. The reversal of the RR and RI schedules showed that this student's button-pressing rates were determined by the contingencies arranged for button-pressing rather than by the verbal behavior that had been shaped. Details as in Figure 1.

immediately conformed to these descriptions.

For Student H, shown in Figure 4, contingency descriptions of "number of pushes" and "timed spaces since last green light" developed in the second session, and left-button rates became consistently higher than right-button rates. But reversing the guesses in the third session (first dashed line) did not affect pressing rates. Guess sheets for performance descriptions were introduced in the fourth session (second dashed line), and descriptions of responding as pressing "quickly" and "slowly" were shaped. When performance descriptions were twice reversed in the fifth session (third and fourth dashed lines), however, pressing rates remained unchanged. This suggested the possibility that the pressing was sensitive to contingencies and independent of the verbal performance. In the sixth session (last dashed line), this was confirmed; performance descriptions continued to specify "quickly" and "slowly" for the left and right buttons, respectively, but when schedules were reversed (so that left and right buttons operated according to RI and RR schedules, respectively), pressing rates conformed to the contingencies and

opposed the verbal descriptions (i.e., H pressed slowly on the button described as "rapidly" and vice versa). Thus, for H, nonverbal responding was sensitive to contingencies and was independent of verbal descriptions.

An appendix presents the complete protocols for Students B, D, and F, illustrating the range of verbal behavior that occurred on these procedures. Sessions are designated by roman numerals, and components within sessions by arabic numerals. The three verbal responses for each button during each guess period are coded by letter and are followed by the respective points assigned for each; omissions of verbal responses are shown by dashes. For example, B's verbal responses relating to the left button after Component 4 of the first session were c, k, and f, resulting in 3, 3, and 0 points, respectively. Some lettered items, such as c and f in this example, include variant verbal responses that were treated as equivalent during shaping and in the presentation of the data. No attempt will be made here to present rules for the shaping of verbal behavior. The specific assignment of points to particular verbal responses can be debated, but the main consideration is that the shaping produced appropriate classes of verbal responses.

DISCUSSION

In summary, only three—or at best four—of the seven students in this study showed correspondences between response rates and descriptions of contingencies equivalent to those demonstrated between response rates and descriptions of performance in Catania et al. (1982): Nonverbal responding conformed to contingency descriptions for B, C, D, and perhaps for E, but they did not do so for F, G, and H. In the earlier research, correspondences between response rates and descriptions of performance were observed without exception. A correspondence between response rates and descriptions of performance was not obtained for H in the present study, but H's history by the time the performance description was shaped was substantially different from that at the time of shaping in the previous study.

The distinction between performance descriptions and contingency descriptions is difficult to draw clearly. For example, Skinner (1969) defines rules sometimes as describing consequences (e.g., p. 163), sometimes as including responses (e.g., p. 140), and sometimes as encompassing occasions, responses, and consequences (e.g., p. 160). The distinction may be difficult in practice, as illustrated by the preliminary findings in Figure 1, but it is important because only performance descriptions had consistent effects on nonverbal responding.

It is tempting to appeal to students' prior knowledge of reinforcement schedules in accounting for the variation between performances that accompanied contingency descriptions, but the data raise questions about the criteria that might be used to assess such knowledge. If verbally "knowing" the schedules is in some way related to performances appropriate to the schedules, it is nonetheless evident that accurately describing the contingencies is insufficient. Descriptions of the respective ratio and interval contingencies are not reliably accompanied by systematic rate differences. Furthermore, contact with the technical vocabulary of schedules, as might occur in a psychology classroom, does not guarantee performances appropriate to schedules. Of the two students whose guesses included formal schedule names, B but not F showed corresponding rate differences, and rate differences were obtained from students such as D, whose verbal responses did not include the vocabulary of schedules (see Appendix).

The argument here for distinguishing between performance descriptions and contingency descriptions, in other words, is based upon the consistent effects of the former and the variable effects of the latter. That variability, a subject for future study, presumably depends in part on the varied verbal repertoires brought to the experimental situation by different students. One student

who has described random-ratio contingencies by saying that "the machine works after a random number of presses" might go on to say "the more often you press, the more points you will get"; another might not. An important component of educational instruction is establishing a repertoire that makes such verbal derivations more likely. It is an experimental question whether all students would have shown correspondences between contingency descriptions and rates of responding if they had each entered the experiment with a previously mastered vocabulary of reinforcement schedules.

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APPENDIX

Verbal Responses and Points Assigned to Each.

		Left		*Right*				*Left*		*Right*				*Left*		*Right*	
I	1	abc	003	dae	000	II	1	kck	323	jkk	300	III	1-2	kkk	000	jjj	000
	2	fgh	001	ibf	200		2-8	kkk	333	jjj	333		3	kkk	000	kjj	300
	3	jkc	032	ljk	030		9	kkk	000	jjj	000		4	jjj	333	jjj	000
	4	ckf	330	jmc	300		10	jjj	333	kkk	333		5-6	jjj	333	kkk	333
	5	ckc	333	njj	033		11	jjj	333	jjj	000		7	jjj	333	jjj	000
	6	ckm	330	jjk	330		12	kkk	000	jjj	000		8-11	jjj	333	kkk	333
	7	kkc	333	jjj	333												
	8	mkc	033	jjj	333												

Student B verbal responses (key):

a. whether you press the red button
b. the pressure applied
c. the number of presses; number of times pressed
d. if the blue light is on
e. if you press the right way
f. how fast; how fast you press
g. when the blue light goes out
h. certain ratios
i. time interval
j. variable intervals
k. variable ratio
l. fixed ratios
m. fixed interval
n. extinction

		Left		*Right*				*Left*		*Right*	
I	1	abc	011	abc	300	III	1-2	eee	333	hhh	333
	2	ade	003	afg	120			(reversal)			
	3	ehf	301	ehf	021		3	eee	000	hhh	000
	4-8	eee	333	hhh	333		4	eeh	003	hhe	003
II	1-9	eee	333	hhh	333		5-8	hhh	333	eee	333

Student D verbal responses (key):

a. how many times push red; how many times red pushed
b. the interval of pushes
c. time elapsed between
d. a series related to # of pts
e. time elapsed after last lite; amount of time since last lite
f. a random assortment of pushes; a random assortment of time and presses; random time and presses
g. the number of presses last time
h. amount of presses since last lite; the number of presses since last lite

		Left		*Right*				*Left*		*Right*				*Left*		*Right*	
I	1	abc	100	bd-	000	II	1	c--	000	ggg	000	III	1	ehj	001	ehj	010
	2	c--	000	dc-	000		2	h--	000	h--	000		2	njj	300	ohh	300
	3	c--	000	c--	000		3	hi-	010	e--	000		3-7	nnn	333	ooo	333
	4	e--	100	d--	000		4	ie-	000	c--	000			(performance guesses)			
	5	edd	100	edd	000		5	ddf	000	ej-	000		8	p--	000	p--	000
	6	eee	111	f--	200		6	jhc	100	jhc	010		9	qrs	003	qrs	000
	7	eef	110	fff	222		7	ekl	000	ehk	010		10	sss	333	tut	232
	8	eee	000	fff	222		8	emh	020	fjh	100		11-12	sss	333	uuu	333
	9	fff	000	fff	111		9	mmm	222	mmm	000						
	10	cc-	000	cc-	000		10	mmm	222	hhh	111						

Student F verbal responses (key):

a. how often I press the button
b. time; what the different times
c. when it feels like it; how often it wants; ?; nothing; the computers choices; when I become disoriented; my moods; how bored I get; my frustration
d. random choices; luck; luck of the draw; chance
e. probability
f. a timed pattern
g. variable ratio
h. a fixed interval; a timed interval
i. random selections
j. ratio; a fixed ratio
k. a fixed variable; a fixed pattern
l. a fixed amount of time
m. chance ratio
n. variable ratio
o. variable intervals
p. in variables of 3; by terms ending in 9
q. firmly
r. with a constant motion
s. quickly
t. infrequently
u. slowly