

*INTERPERSONAL CONTINGENCIES: PERFORMANCE DIFFERENCES AND COST-EFFECTIVENESS*

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Three reinforcement contingencies were compared with regard to performance differences and cost-effectiveness (i.e., responses per unit reinforcer). Pairs of college students were studied under individual, cooperative, or competitive contingencies using a concurrent setting that included one of these three contingencies as one alternative and a lower paying individual contingency as the other alternative. With the individual and the cooperative contingencies, overall response rates were typically high; under competitive contingencies the overall response rates were substantially lower. Subjects responded at very high rates when competing, but chose not to compete most of the time. Competition and cooperation produced the most cost-effective responding, assessed as the number of responses made per \$.01 of reinforcer. High overall rates of competitive responding were obtained when the contests were longer and the lower paying alternative contingency was not available.

*Key words:* interpersonal relations, reinforcement contingencies, competition, cooperation, individual contingency, cost-effectiveness, variable-interval schedule, concurrent schedule, college students

Cooperative, competitive, and individual contingencies have been prime alternatives for reinforcing behavior of people in groups. The key element in a cooperative contingency is mutual reinforcement (Marwell & Schmitt, 1975), whereby all participants receive a reinforcer if their responses collectively meet a specified performance criterion. In a competitive contingency, reinforcers are distributed unequally based on relative performance. In an individual contingency, a person receives a reinforcer when an individual performance criterion is met. Both cooperative and competitive contingencies are distinguished by reinforcement interdependence—each person's reinforcers are partly determined by the behavior of others in the group.

Research in social and educational psychology has compared these three contingencies (most often cooperation and competition) with regard to task performance (for reviews see Johnson, Maruyama, Johnson, Nelson, & Skon, 1981; Miller & Hamblin, 1963; Rosenbaum, 1980; Schmitt, 1984; Slavin, 1977, 1983). Conclusions typically emphasize the

advantages of cooperation. In particular, cooperation has been found to produce performance of superior quality or quantity across a range of tasks, with competition producing superior performance only where responses can be made independently by each person and little or no collaboration is required.

However, studies comparing these types of contingencies have had major limitations (Schmitt, 1984). First, in most previous research the behavior observed may not have related to the scheduled consequences (Scott & Cherrington, 1974). In studies conducted in a single session, behavior was typically preceded by instructions describing the consequences and followed by the consequences themselves. Thus, the behavior was likely to have resulted mainly from instructions rather than from experienced consequences. Although both types may sometimes produce similar behavior patterns, this is not necessarily true (Baron, Kaufman, & Stauber, 1969). In everyday, longer lasting situations, instructions are likely to control mainly initial task responses, after which the consequences may exert increasing control.

Second, previous studies provide no evidence that cooperative and individual contingencies used reinforcement criteria that produced optimal performance for the type of contingency. For example, if criteria are set too high to be achieved very often, persons may perform poorly or quit; or if they are set too low and can be achieved easily, persons may respond

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less often than they might if the criteria were set higher.

Third, the performance differences found across contingencies in previous research might have resulted from differing reinforcer amounts. The typical procedure has been to equate scheduled reinforcer amounts across contingencies and then observe the resulting performances (e.g., Miller & Hamblin, 1963; Rosenbaum et al., 1980), but the reinforcer amounts received can be very different depending on the contingency. In a simple competitive contest the total amount received by the competitors is fixed. Only the distribution among them is in question. In an episode of cooperative or individual responding, however, the total reinforcer amount received varies, depending on whether or not (and the degree to which) the participants' performance meets the reinforcement criteria. The question of which contingency produces the most responding per unit reinforcer (i.e., cost-effectiveness) has not been investigated (Schmitt, 1984). In applied settings this question is important because reinforcer amounts are often limited (e.g., the number of high grades awarded in education or bonus money available in business).

The present study addressed these important issues. Three contingencies—individual, cooperative, and competitive—were compared with regard to performance and cost-effectiveness. These three contingencies were based on a procedure used by Church (1962, 1968) in studies of competition. In the competitive procedure, reinforcement occurred on a variable-interval (VI) 30-s schedule in which, after each interval, only the first response by either subject was reinforced. Because the availability of a scheduled reinforcer was unsigned and unpredictable, a response rate higher than that of one's opponent was effective for frequent reinforcement.

The individual contingency used the same VI 30-s reinforcement schedule, but with an unsigned limited hold that was set by the experimenter. The length of the limited hold determined the response rate required for reinforcement. For example, with a limited hold set at 1 s, approximately 60 responses per minute were required to receive all of the scheduled reinforcers. The cooperative contingency was identical except that reinforcement required responses by both subjects during the limited hold.

Similar reinforcer amounts were scheduled under each contingency. Under competition, subjects were exposed to a condition until stable response patterns developed. Under the individual and cooperative contingencies, the limited hold was adjusted to produce the highest response rates. The length of the limited hold was reduced in steps. With a reduction from 1 s to 0.4 s, for example, approximately 90 additional responses were needed to receive all of the scheduled reinforcers. Stable competitive response rates and highest cooperative and individual response rates were compared with regard to cost-effectiveness.

Each type of contingency was investigated in a concurrent arrangement in which an alternative response was reinforced on a VI 30-s schedule with a 1-s limited hold and with the duration of that limited hold signaled by a light. Thus, under this schedule the response rate needed to produce all of the scheduled reinforcers was low—approximately two responses per minute. The reinforcer amount was lower than that for the other contingencies, but was sufficient to maintain participation in the study. Choice settings employing a lower paying alternative have numerous applied analogs and have been used extensively in previous studies of cooperative and competitive operant behavior (cf. Marwell & Schmitt, 1975; Schmitt, 1976).

Four experiments were conducted. Experiments 1 and 2 compared individual versus cooperative contingencies, and Experiments 3 and 4 compared individual versus competitive contingencies. Because a cooperative history might affect competitive responding, and vice versa, a given subject was exposed to only one type of contingency or the other.

## EXPERIMENT 1: RESPONDING UNDER INDIVIDUAL AND COOPERATIVE CONTINGENCIES

### METHOD

#### *Subjects*

Thirteen college students (11 female, 2 male) were recruited to participate in a laboratory study through notices read in undergraduate classes and posted on bulletin boards. Notices stated that the study would consist of approximately 15 daily 1-hr sessions, and that sub-

jects would typically earn at least \$4 per hour working on a simple laboratory task. Subjects signed consent forms agreeing to be available for the required sessions. Earnings were paid after each session.

### Apparatus

Each of the two experimental rooms contained a table-mounted panel (24 by 43 cm) with stimulus lights, two counters, and a switch for choosing between two contingencies. A plunger with a return spring (Lindsley knob) mounted below the panel required a pull of approximately 600 g. A red light in the upper right corner of the panel (labeled "Panel On") was lighted when the contingencies were available. Two counters mounted vertically on the left side of the panel, labeled "Your Counts" and "Others' Counts," respectively, showed the subject's and partner's earnings during the current session. Whenever the subject or partner pulled the plunger, a white light to the right of his or her counter was illuminated for 0.1 s. The switch for choosing between two contingencies was located in the lower left corner of the panel. An amber light located to the left of the switch was illuminated when the subject's switch was up. A second amber light located to the right of the switch was illuminated when the partner's switch was up. A green light in the center of the panel was illuminated for 1 s when reinforcement was available on the alternative contingency. A computer in an adjacent room programmed contingencies and recorded the data.

### Procedure

In this and subsequent experiments, subjects reported to separate waiting rooms and were not introduced to each other during the experiment.

The experiment consisted of two parts. First, subjects worked separately with a choice between the individual and alternative contingencies. Second, 10 of the 13 subjects worked in pairs with a choice between the cooperative and alternative contingencies.

Table 1 shows the sequence of conditions for the individual contingency. Each session consisted of three 20-min segments. In this part of the experiment, the counter labeled "Other's Counts" and the lights indicating partner's plunger pulls and switch position were inoperative.

Table 1  
Conditions for individual contingency.

Session	Segment <sup>a</sup>	Individual	Alternative	Limited hold (s)
1	1	none	\$.04	
	2	\$.06	none	10.0
	3	.06	none	5.0
2	4	.06	none	2.0
	5	.06	none	1.0
	6	.06	.04	1.0
3	7-8 <sup>b</sup>	.06	.04	1.0
Other segments (three per session):				
	9-11 <sup>b</sup>	\$.06	\$.04	0.4
	12-14 <sup>b</sup>	.06	.04	0.25
	15-17 <sup>b</sup>	.06	.04	0.18
	18-20 <sup>b</sup>	.06	.04	0.14
	21-23 <sup>b</sup>	.06	.04	0.12
	24-26	.06	.04	0.10

<sup>a</sup> All segments lasted 20 min.

<sup>b</sup> Time spent on individual contingency in each of the last two segments was assessed using the following criteria. (a) If time was at least 75%, limited hold was reduced one step during the next three segments. (b) If time was less than 75%, no more segments were run. If neither criterion was met, additional segments were run under the same condition until (a) or (b) was reached during the last two segments.

*Training (Segments 1 through 5).* Subjects were first shown how to earn money on the alternative contingency (Segment 1). All instructions were written and handed to subjects at the appropriate times. Initial instructions stated:

The way you make money is by pulling the brass knob below the panel. Every few seconds the green light next to your counter will go on for 1 second. If you pull the knob during this time, 4 cents will be added to your counter. The switch below the counters must be down.

Reinforcers were available on a constant-probability VI 30-s schedule; for each segment, one of eight schedules was randomly assigned. All schedules used 20 intervals with a range of 1 to 108 s (derived from the VI 100-s schedule described by Catania & Reynolds, 1968, p. 381).

Next, subjects were shown how to earn money on the individual contingency (Segment 2). Instructions stated:

The green light will not go on to show you when you can make money. As before you can still make money every few seconds if you pull the knob within 10 seconds of the right time.

This time 6 cents will be added to your counter. The switch below the counters must be up.

With a limited hold of 10 s, most of the scheduled reinforcers would be received if a subject responded intermittently at least six times per minute. The limited hold was reduced to 5 s in Segment 3, 2 s in Segment 4, and 1 s in Segment 5 if subjects received at least half of the reinforcers in the previous segment. Instructions stated the new limited-hold lengths. If fewer than half of the reinforcers were received, the segment was repeated.

*Choice between individual and alternative contingencies.* Subjects were shown how to choose between the individual and alternative contingencies (Segment 6). Instructions stated:

You have a choice in earning money. You use the switch to make the choice. 1. *SWITCH DOWN*: Pull the knob during the 1-second green light and earn 4 CENTS. 2. *SWITCH UP*: Pull the knob within 1 second of the right time and earn 6 CENTS. You can switch back and forth anytime.

In this and later conditions in which contingencies were available concurrently, a single VI 30-s reinforcement schedule was used for both alternatives. Thus, contingency choice altered reinforcement requirements and reinforcer size, but not schedule.

Segments 7 and 8 repeated the conditions of Segment 6. After these three segments, behavior during the last two segments was examined to assess whether the limited hold should be reduced. This decision was based on the proportion of time spent on the individual contingency. When the individual contingency was chosen at least 75% of the time in each segment, the limited hold was reduced to 0.4 s for the next three segments. When the individual contingency was chosen less than 75% of the time in each segment, no more segments were run, because highest response rates would be unlikely to occur with reduced time on that choice. If neither criterion was met, additional segments were run with the limited hold at 1 s until one of the two criteria described above was reached. The same procedure was followed for the 0.4-s limited hold and all shorter intervals (0.25, 0.18, 0.14, 0.12, and 0.10 s). With each shorter interval, approximately 90 additional responses were required to produce all of the scheduled reinforcers.

This part of the experiment concluded for each subject when less than 75% of the time was spent on the individual contingency. Three subjects (female) quit during this part of the experiment (completing Sessions 5, 6, and 7, respectively). These, and other subjects who failed to complete later experiments, typically appealed to external schedule conflicts (e.g., another job, exams, illness, etc.) as reasons for terminating.

*Choice between cooperative and alternative contingencies.* Each subject was paired with a partner whose response rate had been similar on the individual procedure. Subjects were first given instructions showing how to earn money on the cooperative contingency with the alternative absent. Because all subjects had continued to respond on the individual contingency when the limited hold was reduced to 0.4 s in the first part of the experiment, 0.4 s was the first limited-hold value in the sequence used for study of cooperation. The counter labeled "Other's Counts" and the lights showing the partner's switch position and plunger pulls were now operative. Instructions stated:

You will be able to make money every few seconds, but you will be cooperating with another person. If both of you pull the knobs within 2/5 second of the right time, each of you will get 6 CENTS.

Following one segment with only the cooperative contingency available, pairs then were exposed to three segments with a choice between the cooperative and alternative contingencies. The cooperative contingency was in effect only when chosen by both subjects. If either subject chose the alternative, that schedule was in effect for both subjects. Instructions stated:

You have a choice in earning money. You use the switch to make the choice. 1. *SWITCH DOWN*: Pull the knob during the 1-second green light and earn 4 CENTS. 2. *SWITCH UP*: Pull the knob within 2/5 second of the right time and earn 6 CENTS. *NOTE*: To cooperate both of you must have your switches up. You can switch back and forth anytime.

After three segments, the behavior was examined to determine if the limited hold should be reduced. The criteria for reducing the length of the limited hold and the sequence of intervals were identical to those used for the individual contingency.

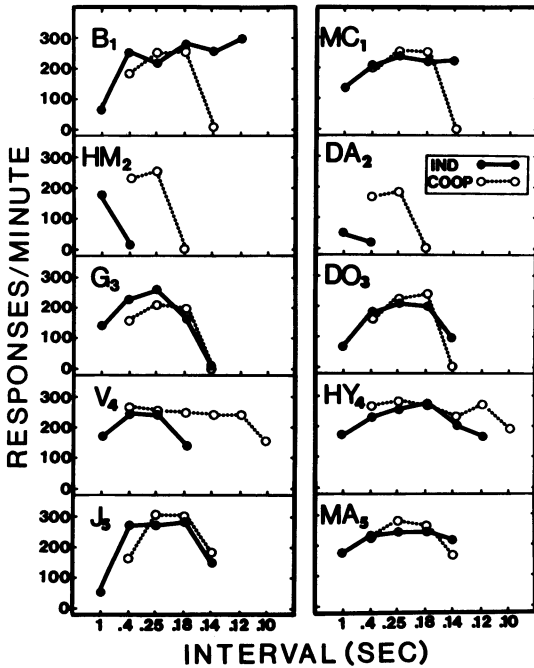


Fig. 1. Overall response rates under individual (filled symbols) and cooperative (open symbols) contingencies as a function of limited-hold intervals for each subject. The data shown for each interval are from the two 20-min segments that met the criterion for continuation or termination of that limited-hold condition. Subjects who worked as a pair have the same subscript. Subjects MC, DA, G, DO, V, HY, B, and MA are female; D and HM are male.

RESULTS AND DISCUSSION

Figure 1 compares overall individual and cooperative response rates during all limited-hold conditions for the 10 subjects who completed both parts of the experiment. The data shown for each condition are from the two 20-min segments in which the criterion for continuation or termination was met. As the limited hold was reduced, both individual and cooperative response rates typically increased gradually and then decreased sharply, indicating that subjects then spent most of their time on the alternative response. This pattern illustrates the dependence of cooperative and individual response rates on the stringency of the requirements for reinforcement, and thus the importance of adjusting the requirements to obtain highest performance when comparing performances on, and preferences for, the

two types of procedures. For 8 subjects, highest cooperative response rates ( $M = 256$ ) exceeded the highest individual rates ( $M = 227$ ), although most differences were small. Increases ranged from 5% to 253% with all but two being less than 21%. The two largest increases occurred for subjects in pair HM-DA whose individual rates were the lowest of all subjects. The two decreases were 11% and 19%.

When the alternative contingency was chosen, response rates (not shown) were very low—approximately two responses per minute. Each signaled limited hold was typically followed by a single response.

If subjects received all of the scheduled reinforcers under the various conditions, response rates would also be a measure of cost-effectiveness (i.e., number of responses per \$.01 of reinforcer). This did not occur, particularly with the shorter limited-hold intervals under the cooperative contingency. Table 2 shows, for each subject, the overall individual and cooperative response rates and the number of responses made per \$.01 of reinforcer during all limited-hold conditions. In the conditions in which the individual and cooperative response rates of each subject were highest (shown in italics), number of responses per \$.01 was at least 19% greater under the cooperative contingency for 7 of the subjects. Differences in cost-effectiveness between performances on individual and on cooperative contingencies were typically larger than comparable differences in response rates, because the response requirements for reinforcement were met less often under the cooperative than under the individual contingency.

The conditions resulting in the most cost-effective responding were not always those that produced the highest response rates. Cost-effectiveness was typically highest in conditions with the shortest limited holds, where response rates were high and fewer of the scheduled reinforcers were received. Excluding the final limited-hold condition where the alternative contingency was chosen more than 25% of the time, the most cost-effective condition for 8 of the 10 subjects was cooperative.

Thus, for most subjects response rates were slightly higher under the cooperative than under the individual contingency, and a given reinforcer amount typically produced more cooperative than individual responses.

Table 2

Overall response rates and number of responses per \$.01 of reinforcer (in parentheses) during individual and cooperative contingencies. Data for each limited-hold interval are from the two 20-min segments that met the criterion for continuation or termination of the experimental condition. Highest response rates for each subject are shown in italics. Subjects with the same subscript worked as a pair under the cooperative contingency.

Subject	Contingency	Limited-hold interval (s)						
		1.0	0.4	0.25	0.18	0.14	0.12	0.10
B <sub>(1)</sub>	Ind	76 (7)	254 (22)	214 (20)	289 (26)	268 (30)	97 (28)	
	Coop		193 (19)	241 (22)	256 (31)	3 (0)		
MC <sub>(1)</sub>	Ind	135 (12)	204 (18)	240 (22)	222 (26)	222 (32)		
	Coop		198 (19)	260 (24)	262 (32)	3 (0)		
HM <sub>(2)</sub>	Ind	189 (16)	15 (25)					
	Coop		235 (21)	259 (25)	0			
DA <sub>(2)</sub>	Ind	55 (5)	12 (15)					
	Coop		165 (15)	194 (19)	0			
G <sub>(3)</sub>	Ind	141 (12)	225 (19)	254 (22)	168 (24)	10 (33)		
	Coop		160 (15)	207 (19)	190 (29)	0		
DO <sub>(3)</sub>	Ind	82 (7)	183 (16)	208 (18)	100 (26)			
	Coop		150 (14)	227 (21)	243 (38)	0		
V <sub>(4)</sub>	Ind	189 (16)	236 (20)	238 (23)	132 (26)			
	Coop		263 (22)	253 (25)	248 (31)	236 (43)	236 (49)	161 (89)
HY <sub>(4)</sub>	Ind	175 (15)	226 (20)	254 (24)	268 (24)	199 (32)	166 (40)	
	Coop		265 (23)	281 (29)	264 (33)	225 (44)	269 (57)	191 (106)
T <sub>(5)</sub>	Ind	67 (6)	279 (24)	272 (23)	291 (27)	145 (34)		
	Coop		161 (14)	308 (27)	300 (27)	180 (40)		
MA <sub>(5)</sub>	Ind	184 (16)	224 (21)	233 (20)	232 (28)	206 (31)		
	Coop		221 (19)	281 (24)	273 (25)	174 (39)		

## EXPERIMENT 2: EFFECTS OF STIMULI INDICATING PARTNER'S PERFORMANCE

The cooperative and individual contingencies in Experiment 1 differed not only in reinforcement interdependence but also in the stimuli provided each subject. Under cooperation, subjects saw their partners' earnings, contingency choices, and responses. It is possible that these stimuli, an integral part of most cooperative contingencies, caused the higher cooperative response rates. An extensive social psychological literature on social facilitation indicates that a person's performance on simple tasks is improved when observed by another person (for reviews see Bond & Titus, 1983; Guerin, 1986). Experiment 2 was conducted to investigate the effects of stimuli showing another's responding and to replicate the findings from Experiment 1 using a different procedure. Three conditions were compared: the individual and cooperative contingencies used in Experiment 1 and an individual contingency in which the subject was shown the partner's

counter total, switch choices, and knob pulls (as in the cooperative contingency).

## METHOD

### Subjects and Apparatus

Thirteen college students (10 female, 3 male) were recruited as for Experiment 1 to work as paid participants for 11 1-hr sessions. The apparatus from Experiment 1 was used.

### Procedure

The procedure consisted of two parts. The first four sessions used the procedure for the individual contingency shown in Table 1 of Experiment 1. Subjects were first exposed to the alternative contingency, then to the individual contingency, and finally to a procedure that allowed choice between the two contingencies. Unlike the procedure in Experiment 1, however, the limited hold was not reduced below 0.4 s, in order to allow a greater increase in response rates. This same limited hold was also used for the other contingencies. Three subjects (1 male, 2 female) quit during this

Table 3

Overall response rates and number of responses per \$.01 of reinforcer (in parentheses) for the initial exposure to the individual and cooperative contingencies (Sessions 4 and 5), and for the final exposures to the individual, cooperative, and individual contingencies with the partner's stimuli displayed (Sessions 9 through 11). Data are from the last two 20-min segments in each condition. Subjects who worked as a pair have the same subscript. The limited-hold interval was 1.0 s for J and V and 0.4 s for all other subjects. Subjects B, Y, D, M, G, and L are female; E and R are male.

Subject	Contingency				
	Individual (Session 4)	Cooperative (Session 5)	Individual (Session 9)	Cooperative (Session 10)	Individual + stimuli (Session 11)
L <sub>(1)</sub>	192 (17)	212 (18)	232 (20)	220 (19)	215 (18)
G <sub>(1)</sub>	182 (17)	214 (18)	130 (12)	184 (16)	147 (13)
E <sub>(2)</sub>	228 (19)	229 (20)	245 (20)	256 (22)	249 (20)
R <sub>(2)</sub>	105 (12)	190 (16)	163 (14)	172 (15)	167 (14)
Y <sub>(3)</sub>	228 (20)	247 (22)	265 (23)	243 (21)	267 (23)
B <sub>(3)</sub>	229 (20)	249 (22)	218 (19)	236 (20)	259 (22)
D <sub>(4)</sub>	222 (21)	240 (21)	234 (20)	215 (20)	233 (20)
M <sub>(4)</sub>	176 (18)	223 (20)	159 (19)	230 (21)	173 (17)
J <sub>(5)</sub>	69 (19)	133 (11)	153 (13)	130 (11)	157 (13)
V <sub>(5)</sub>	32 (6)	132 (11)	120 (10)	130 (11)	142 (12)
Means:	166 (17)	207 (18)	192 (17)	202 (18)	201 (17)

part of the experiment (completing Sessions 1, 3, and 4, respectively).

In the second part of the experiment, each subject was paired with a partner who had been working under the same limited hold (1 s or 0.4 s). Each pair then worked seven additional sessions. Sessions 5, 7, and 10 investigated the cooperative contingency (introduced as in Experiment 1), Sessions 6 and 8 the individual contingency, and Sessions 9 and 11 the individual contingency with added display of the partner's knob pulls, switch choices, and counter totals. Instructions indicated the changes in contingencies and stimuli for each session.

## RESULTS AND DISCUSSION

Table 3 shows the response rates for the last two segments of the first and final sessions under the individual and cooperative contingencies and for the final session under the individual contingency with the partner's stimuli displayed. Data are for the 10 subjects who completed both parts of the experiment. For subjects J and V, the limited hold was 1 s; for all others it was 0.4 s.

The results of the initial comparison of the individual and cooperative contingencies (Sessions 4 and 5) closely match those from Experiment 1. Cooperative response rates were higher ( $M = 207$ ) than individual rates ( $M =$

166) for 9 of the 10 subjects. Again, most of these increases were small. Unlike the comparison in Experiment 1, this difference occurred with comparatively long limited-hold intervals (0.4 s or 1 s), which produced lower response rates for both contingencies. Consequently it is unlikely that the small differences between response rates in the two conditions were a result of physical limits on maximum response rates. With reversal of the cooperative and individual conditions, these differences diminished further, being only slight in the third and final comparison (Sessions 9 and 10), where cooperative response rates were higher ( $M = 202$ ) than individual rates ( $M = 192$ ) for 6 subjects. Consequently, little difference remained to be explained by the effects of stimuli showing the other's responding.

Response rates under the individual contingency with the partner's stimuli displayed (Segment 11) were slightly higher ( $M = 201$ ) than those during the individual contingency ( $M = 192$ ) for 9 of 10 subjects. Both the direction and small magnitude of these differences are in accord with previous findings on the effects of social facilitation in social psychology.

Number of responses per \$.01 of reinforcer was marginally higher for the cooperative contingency—a difference smaller than in Experiment 1. With the longer limited-hold in-

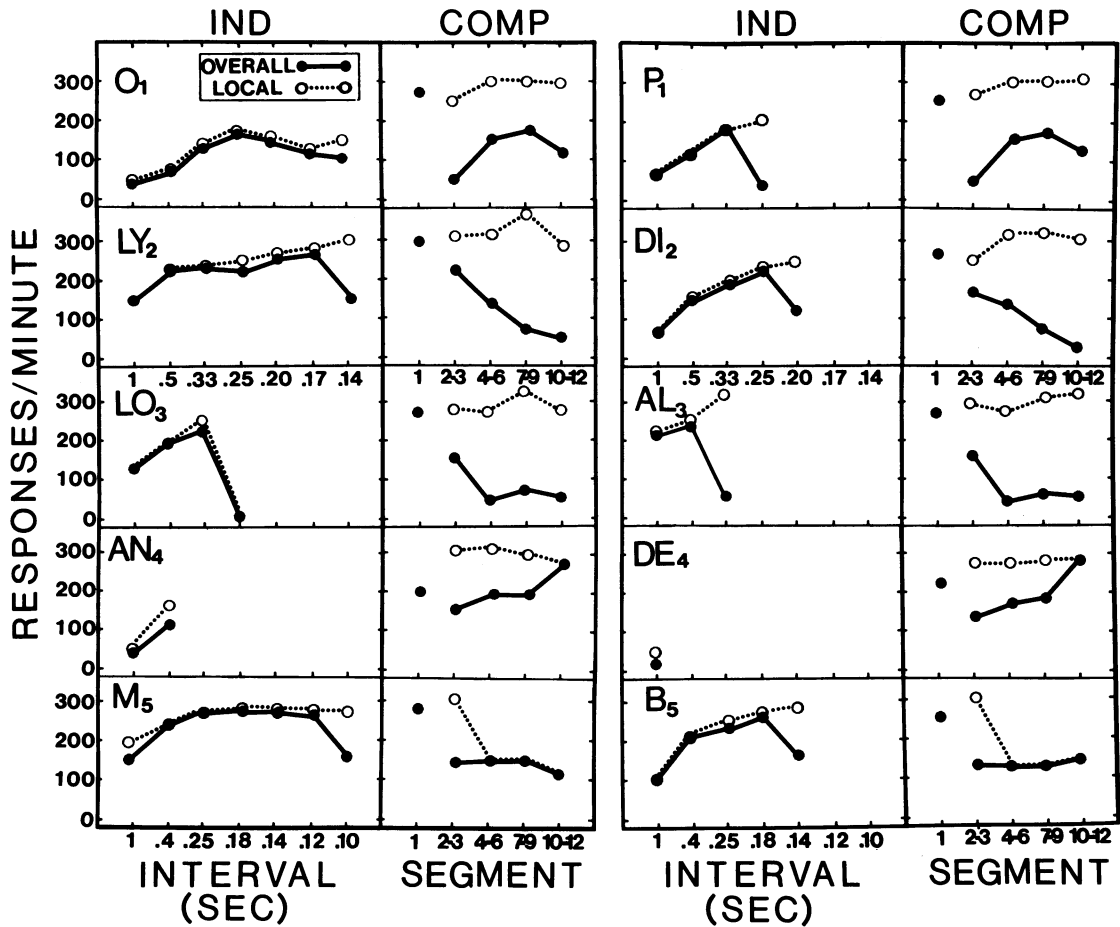


Fig. 2. Overall (filled symbols) and local (open symbols) response rates for each subject under individual and competitive contingencies. For the individual contingency the data shown are from the two 20-min segments that met the criterion for continuation or termination. With the exception of the first session, the time periods for the competitive contingency are the three-segment sessions. In Segment 1, shown separately, only competition was possible. Subjects who worked as a pair have the same subscript. Subjects LO, AN, DE, B, M, DI, LY, O, and P are female; AL is male.

intervals, there were few failures to meet the requirement for reinforcement under cooperation. Hence, cost-effectiveness was not differentially affected as in Experiment 1.

### EXPERIMENT 3: RESPONDING UNDER INDIVIDUAL AND COMPETITIVE CONTINGENCIES

#### METHOD

##### *Subjects and Apparatus*

Twelve college students (9 female, 3 male) were recruited as described for Experiment 1 to work as paid participants. The apparatus from the previous experiments was used.

##### *Procedure*

The experiment consisted of two parts. With one exception, the first part was identical to that shown in Table 1 of Experiment 1. Subjects were exposed first to the alternative contingency, then to the individual contingency, and finally to a choice between the two contingencies. For 9 subjects, the sequence of limited-hold intervals was 0.4, 0.25, 0.18, 0.14, 0.12, and 0.10 s as in Experiment 1. For 4 subjects, the sequence was 0.5, 0.33, 0.25, 0.20, 0.17, 0.14, 0.12, and 0.10 s. With each shorter interval in this second sequence, approximately 60 additional responses were required to produce all of the scheduled reinforcers. This sequence was used to examine whether smaller



Table 4

Overall response rates, local response rates, and number of responses per \$.01 of reinforcer (in parentheses) during individual and competitive conditions. Data shown for the individual condition are the final two 20-min segments of the limited-hold interval in which response rates were highest. With the exception of Segments 1 through 3, periods for the competitive contingency are three-segment sessions. In Segment 1, only competition was possible. Subjects who worked as a pair have the same subscript.

Subject	Ind limited-hold interval	Individual		Competitive									
		Overall	Local	Seg. 1		Seg. 2-3		Seg. 4-6		Seg. 7-9		Seg. 10-12	
				Overall	Local	Overall	Local	Overall	Local	Overall	Local	Overall	Local
O <sub>(1)</sub>	0.25	160 (19)	163	275 (24)	50 (84)	261	157 (27)	290	172 (20)	296	120 (31)	293	
P <sub>(1)</sub>	0.33	173 (16)	173	257 (21)	54 (23)	282	164 (25)	304	180 (33)	309	130 (20)	318	
LY <sub>(2)</sub>	0.17	259 (27)	276	297 (24)	223 (23)	313	130 (23)	316	101 (23)	388	34 (24)	291	
DI <sub>(2)</sub>	0.25	220 (20)	228	265 (25)	173 (24)	243	129 (20)	314	84 (32)	322	35 (58)	302	
LO <sub>(3)</sub>	0.25	224 (23)	254	274 (21)	158 (26)	277	53 (53)	271	83 (21)	326	67 (32)	290	
AL <sub>(3)</sub>	0.4	236 (23)	266	284 (28)	169 (23)	295	56 (21)	283	79 (26)	310	76 (29)	326	
AN <sub>(4)</sub>	0.4	102 (16)	165	206 (21)	153 (32)	305	201 (30)	309	202 (26)	296	277 (21)	277	
DE <sub>(4)</sub>	1.0	26 (5)	53	227 (16)	140 (22)	278	179 (24)	276	194 (25)	284	283 (27)	283	
M <sub>(5)</sub>	0.25	270 (24)	271	285 (25)	138 (23)	305	141 (12)	143	142 (12)	142	128 (11)	128	
B <sub>(5)</sub>	0.18	250 (25)	265	256 (21)	135 (24)	298	128 (11)	130	130 (11)	130	149 (13)	149	
Means:		192 (20)	211	263 (23)	139 (30)	286	134 (25)	264	137 (23)	280	130 (27)	266	

reductions in the length of the limited hold would increase the likelihood of subjects' continuing to choose the individual contingency. Two subjects (1 female, 1 male) quit during this part of the experiment (completing Sessions 1 and 3, respectively).

Each subject who completed the first part of the experiment was paired with a partner who had responded at a similar rate on the individual procedure. Subjects were first shown how to earn money on the competitive contingency with the alternative absent. Instructions stated:

You will be able to make money every few seconds, but you will be competing with another person. The person who pulls *first* will get 12 cents. The other person will get *nothing*.

They were then exposed to a 20-min segment in which this competitive contingency was imposed. Then for the remaining two segments of that session and for three additional three-segment sessions, the procedure allowed choice between the competitive and alternative contingencies. Instructions stated:

You have a choice in earning money. You use the switch to make the choice. 1. *SWITCH DOWN*: Pull the knob during the 1-second green light and earn 4 CENTS. 2. *SWITCH UP*: Compete and earn either 12 CENTS or *NOTHING*. *NOTE*: To compete both of you must have

your switches up. You can switch back and forth anytime.

RESULTS AND DISCUSSION

Figure 2 shows the individual and competitive response rates for the 10 subjects. Because most subjects spent substantial amounts of time on the alternative response when the alternative was competition, two response rates are shown: overall rates are based on the total session time, and local rates are based on the time the individual or competitive contingency was in effect. Segment 1 from the first session under competition is shown separately because only competition was possible. Table 4 shows overall and local response rates for the individual condition with the highest rate and for the four sessions with competition.

Overall competitive response rates during the final session were lower ( $M = 130$ ) than the highest individual rates ( $M = 192$ ) for 8 of the 10 subjects. Decreases ranged from 25% to 87%. In Segment 1 of competition, shown in Figure 2, subjects could only compete. The competitive response rates during this segment illustrate the rates that subjects were capable of sustaining over a segment. For 8 of the 10 subjects, rates were markedly higher than the rates in subsequent segments in which the alternative contingency was available. For all 10

subjects rates were higher than response rates on the individual contingency as well.

Six subjects (Pairs O-P, LY-DI, and LO-AL) responded at very high rates when competition was chosen, with these rates being higher than local individual rates. But because subjects spent most of their time on the alternative contingencies, the overall rates on the competitive contingencies were low. A subject who was losing during a competitive episode typically ended the competition by switching to the alternative contingency.

For the remaining 2 subjects with relatively low overall competitive rates, reinforcers were shared under competitive contingencies. Beginning in Segment 4, Pair M-B consistently chose the competitive contingency. However, only 1 subject responded at a time, until a reinforcer was received. As a result overall and local response rates were identical and low. When questioned at the conclusion of the study, both subjects said they were unacquainted and had made no verbal agreement to share. In Segments 2 and 3, prior to sharing, Pair M-B's response rates were similar to those of the other pairs with low competitive response rates (i.e., periodic competition with high local rates).

Competitive response rates for one pair, AN-DE, were much higher than their individual rates. These subjects had the lowest individual response rates, but their competitive response rates were the highest of all subjects. Competitive rates increased over time, unlike the pattern for other subjects.

As in Experiment 1, overall response rates under the individual contingency first increased gradually and then decreased sharply as the limited hold was reduced. The pattern is similar for both sequences of intervals. Because subjects continued only if they chose the individual contingency at least 75% of the time, overall and local response rates were similar, with the exception of the last interval when the 75% criterion was not met.

Table 4 also shows the number of responses made by each subject per \$.01 reinforcer during the individual condition with the highest response rate and the four sessions with competition. Cost-effectiveness was typically higher for competition. A comparison of the individual condition with highest response rate and the final competitive session (Segments 10 through 12) shows that the number of competitive responses per \$.01 was at least 25%

greater for 7 of the subjects. Two of the 3 subjects with fewer competitive responses per \$.01 were the ones who shared reinforcers working alternately.

To investigate additional regularities between competitive responding and reinforcement over the four sessions, Pearson correlation coefficients were calculated for each subject for the relation between overall competitive response rates during 5-min intervals and (a) number of reinforcements during the same interval, (b) number of reinforcements during the previous interval, (c) difference between partners' reinforcements during the same interval, (d) difference between partners' reinforcements during the previous interval, and (e) cumulative difference between partners' reinforcements during the current session. The only substantial and significant correlation was a positive relation between overall competitive response rate and number of reinforcements during the same interval. With the exception of Subjects M and B (who shared reinforcers), this correlation ranged from .43 to .84 ( $M = .71$ ).

Competition was more profitable than the alternative response when more than 34% of the competitive reinforcers were received. Subjects in the three pairs that spent more than half of their time on the alternative response when competition was available (O-P, LY-DI, LO-AL) received at least 46% of the reinforcers under competition. Thus these subjects received substantially less money than they would have if they had competed exclusively, assuming that the proportion of wins during competition would have continued. The additional earnings, however, would have required continuation of the high response rates.

#### EXPERIMENT 4: EFFECT OF THE PRESENCE OR ABSENCE OF AN ALTERNATIVE RESPONSE ON COMPETITIVE RESPONDING

Although the data from Experiment 3 clearly show that subjects typically choose not to compete despite its potential profitability, the reason for this choice is not clear. Episodes of competition had two distinctive characteristics: very high rates of responding which might not be sustainable over a 60-min session and a short-term difference in subjects' wins and losses. Either or both of these could contribute

to subjects' choosing the alternative response. Using a different response, Buskist, Barry, Morgan, and Rossi (1984) showed that high rates of competition could occur for periods of 30 min or more, but their procedure also included rest periods. High competitive rates were also found over a 20-min period in the present Experiment 3 when subjects could only compete, but the result might be different over longer periods or over additional sessions. This possibility was explored in Experiment 4.

Three competitive conditions were compared. One allowed a choice between the competitive and alternative responses identical to that in Experiment 3. The other two allowed only competition, and differed in contest length. In one condition, the contests were 20 min long—the duration of segments in the preceding experiments. In the other, they were 60 min long—the duration of a session. The two lengths were included to examine the possibility that longer contests might sustain less responding from subjects who fell increasingly behind over the course of the contest. Under the competitive contingency, 12 counts were given to the subject who responded first after the VI 30-s schedule elapsed (as in Experiment 3), but the counts did not equal cents. The count totals at the end of 20 or 60 min were used only to determine contest winners. To prevent consistent losers from withdrawing from the experiment because of low earnings, all subjects in these two conditions received a minimum payment per session for participating and an additional amount for winning the competitive contests.

Thus, if competition in Experiment 3 was infrequent because the high competitive response rates were unsustainable, rates in the 20-min and 60-min contests should be lower than those in which subjects competed in the choice condition.

## METHOD

### *Subjects and Apparatus*

Twelve college students (8 male and 4 female) were recruited as described for Experiment 1, and the apparatus from the previous experiments was used.

### *Procedure*

Subjects were scheduled in same-gender pairs. In Session 1, subjects were introduced to the alternative contingency (Segment 1), the

competitive contingency (Segment 2), and the choice between contingencies (Segment 3). Segments 2 and 3 used instructions from the similar conditions in Experiment 3. One male pair quit following Session 1. With one exception, the remaining pairs then worked for three (nonconsecutive) sessions under each of the three competitive conditions. In Session 2, the 20-min contests were introduced. Instructions stated:

You will receive \$5.50 for participating for one hour in this experiment. Each 20 minutes you will be able to earn an additional \$1.00 if you meet the following criterion: Earn more counts than the other person. You will be able to earn counts every few seconds by competing with the other person. The person who pulls first will get 12 counts. The other person will get nothing.

The instruction sheet contained a section for registering earnings, and after each 20-min contest the experimenter went to the subjects' rooms and entered either \$1.00 or \$.00 on the sheet. The 20-min contests were repeated in Sessions 5 and 8.

In Session 3, the 60-min contest was introduced. Instructions stated that the subject earning more counts than the other person by the end of the hour would get \$3. Every 20 min the panel was turned off for approximately 1 min while the data were recorded. The 60-min contests were repeated in Sessions 6 and 9.

In Session 4, the choice between competition and the alternative response (identical to that in Segment 3) was available for the hour. The choice procedures were repeated in Sessions 7 and 10.

One pair of subjects, BE-CO, completed two instead of three sessions under each condition. These data are included in the results.

## RESULTS AND DISCUSSION

Figure 3 shows the response rates for the final session under each of the three competitive conditions. For all 10 subjects, response rates in the 20-min contests ( $M = 224$ ) and 60-min contests ( $M = 240$ ) were higher than those in the choice condition ( $M = 61$ ). Rates in the longer contests were similar. The low overall rates for most subjects during the choice condition replicate the findings from Experiment 3. Local rates in the choice condition typically approached overall rates in the longer

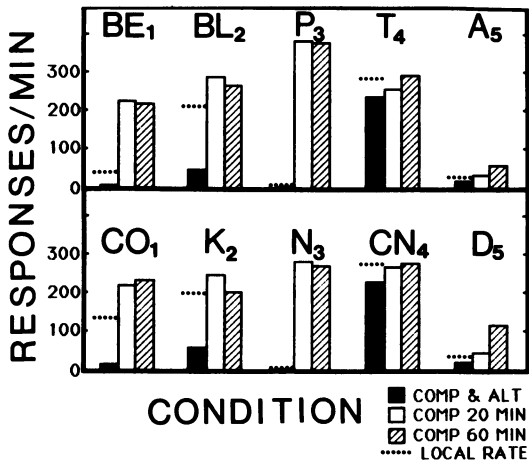


Fig. 3. Overall response rates for the final 60-min sessions (Sessions 8 through 10) of exposure to three competitive conditions: choice between the competitive and alternative responses; three imposed 20-min contests; and one imposed 60-min contest. Local response rate for the choice condition is also shown. Subjects who worked as a pair have the same subscript. Subjects CN, T, D, and A are female; BE, K, CO, BL, N, and P are male.

contests (excluding Pair P–N who did not respond in the choice condition).

The response rates of Pair A–D were markedly lower than those of other subjects during the 20-min and 60-min contests. Subject D was able to respond at a higher rate than A and responded at a rate just sufficient to stay ahead.

The results thus indicate that very high response rates are sustainable for at least the length of a 60-min session. Hence, the low competitive response rates observed when an alternative response was present appear to be caused by the differences in earnings produced by competition. For competitive responding, then, the presence or absence of a concurrent response has a very substantial effect on overall response rates.

## GENERAL DISCUSSION

These four experiments show that individual, cooperative, and competitive contingencies produce differing results, in terms of both rate and cost-effectiveness of responding. These differences, however, depend on features of both the procedures and the setting. Highest individual and cooperative response rates required the adjustment of the response criteria for reinforcement, a procedure typically absent in

previous research. Highest competitive rates required the unavailability of a reinforced alternative response.

Because access to choice between alternative tasks typifies many settings outside the laboratory, concurrent contingencies were used for the basic comparisons. Two major response patterns occurred when the three contingencies were juxtaposed with a lower paying alternative contingency: high overall response rates under the individual and cooperative contingencies and substantially lower overall rates under competition. Cooperative rates typically exceeded individual rates, although the small initial differences tended to diminish over time. The higher cooperative rates appear to be partly attributable to stimuli indicating the other's responses and reinforcers, although that conclusion is qualified by the very small differences. Because the response rate-enhancing requirements for the cooperative and individual contingencies were adjusted until subjects chose the alternative response, the highest rates in these comparisons probably approach the optimal for these two contingencies.

Under conditions of competition, subjects typically responded at very high rates when competing, but most of the time chose not to compete. This escape from, or avoidance of, competition is consistent with findings from studies by Steigleder and associates (Steigleder, Weiss, Balling, & Weninger, 1980; Steigleder, Weiss, Cramer, & Feinberg, 1978) in which subjects quickly learned responses that were reinforced by the termination of competition. In those studies, however, winning and losing were not differentially reinforced. In the present study, escape from competition terminated the loss of earnings in the short run, but also resulted in lower earnings for the session.

The contingencies also differed in the number of responses that resulted from each cent of reinforcement, that is, cost-effectiveness. Both the competitive and cooperative contingencies typically produced more responses than did the individual contingency. In applied settings, cost-effectiveness is likely to be considered in conjunction with overall response rates (i.e., total performance) when contingencies are evaluated. Only the cooperative contingency typically produced both higher overall response rates and was more cost-effective than the individual contingency.

High overall rates of competitive responding occurred when the lower paying alternative response was inaccessible. This pattern was found during one 20-min segment (Experiment 3) and over 3 hr with the 20-min and 60-min contests (Experiment 4). The longer contests, however, continued to provide an alternative source of earnings in the form of minimum payments. This limited evidence suggests that competition may be superior with regard to overall response rates and cost-effectiveness when the alternative response is unavailable. Providing an alternative reinforced response or minimum payments for participation represent two among a number of ways of providing alternative reinforcement so that subjects stay in the setting. Different effects of these two means on competition suggest that this variable merits study.

Several features of the contingencies and procedures bear significantly on the generality of the findings. First, the response used throughout the study required minimal dependence between subjects and could be readily made under all contingencies. Common everyday analogs include student assignments in academia, piecework in industry, and selling in business. This response should give the greatest advantage to competition (competitors could not impede each others' responses), and the least advantage to cooperation (the response required no collaboration). In situations where response dependence is higher and partners can impede or facilitate each other's performance, very different response and reinforcement patterns are likely to occur.

Second, the cooperative and competitive contingencies shared a particular choice contingency—they were in effect only if chosen by both subjects. Other choice contingencies are possible, however. For example, the contingencies could be in effect if chosen by either of the 2 subjects or by 1 designated subject. Schmitt (1976) found that when competition between 2 subjects could be dictated by either subject, it was chosen more frequently than when it required mutual choice. That study, however, did not manipulate or compare response rates.

Third, cooperation or competition between two people does not allow contingency variations that are possible in larger groups. For example, in larger cooperative groups the criteria for reinforcement may specify responses

by some instead of all group members, as in some group contingencies in applied settings (Litow & Pumroy, 1975) and in social dilemmas (Messick & Brewer, 1983). Here the problem of "free-riding" (i.e., reinforcers received noncontingently) can occur and significantly affect responding. In larger groups of competitors, a greater variety of reinforcer distributions is possible (Schmitt, 1986). It is likely that different distributions will produce different response rates among competitors and differences in the likelihood of withdrawal from competition.

Fourth, the high cooperative and individual response rates depended on a procedure in which the criterion for reinforcement was made increasingly stringent. In everyday situations, however, such adjustments may be impossible. They are often prevented by work rules, and they cannot be made if reinforcement is scheduled only once. Competition does not share this administrative liability, because competitors set the criteria by their own responses. Thus, in choosing a contingency to implement, attention needs to be paid to the adequacy of the reinforcement criteria for cooperative and individual contingencies.

Finally, contingencies are often arranged in combination as well as singly. For example, people may cooperate on products that are then judged competitively for reinforcement (often termed group competition). Unlike cooperation alone, the criterion for reinforcement is variable instead of fixed. As another example, reinforcement of performance may be divided between an individual and competitive contingency. Here competition might serve to reinforce differentially high response rates, whereas the individual contingency could decrease the likelihood of withdrawal from competition by reducing inequities in earnings.

A preliminary investigation in the present setting studied one variation of a combined individual and competitive contingency. Each subject in a pair received one-third of the total reinforcer for a response within a short limited-hold interval (individual contingency) and an additional one-third for responding more quickly than the other subject (competitive contingency). Providing one-third of the reinforcer independently of competition approaches the most equitable distribution possible using these two contingencies, and should thus decrease the likelihood that subjects will

choose to withdraw from competition. All subjects in the 10 pairs studied under this condition responded at high rates, but neither response rates nor cost-effectiveness were higher than when the individual contingency was present alone. Although these results suggest no advantage of the combined over the individual contingency, it is possible that a variation awarding a higher proportion of the total reinforcer for competition might increase performance further without causing significant withdrawal.

The results of these experiments show that differences among cooperative, competitive, and individual contingencies in performance and cost-effectiveness vary significantly by circumstance. Heretofore, comparative studies have typically used settings that focus on the basic constituents of these contingencies. For everyday task performance, however, the settings that accompany the contingencies are usually far more complex. The effects of the variables that create this complexity, including response alternatives, choice conditions, group size, task type, and the like, constitute a major research agenda with both basic and applied significance.

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