MAGNITUDES OF SCORE DIFFERENCES PRODUCED WITHIN SESSIONS IN A COOPERATIVE EXCHANGE PROCEDURE¹

BYRON A. MATTHEWS

UNIVERSITY OF MARYLAND BALTIMORE COUNTY

Interest centered on maximal score differences produced within sessions during two-party exchange. Subjects chose between earning money independently or through potentially higher-paying exchange. In the exchange option, only one person could produce points for the other on a trial. Because each exchange response ("give") required the giver to forego earning points independently, the larger the score difference produced (*i.e.*, the further ahead in earnings the other person was put), the greater the reduction in the giver's earnings if the other person did not reciprocate. Results showed that scores were usually equal at the end of each session, and that subjects maintained close equality of scores throughout each session. When a response-cost contingency that punished the alternation of giving was introduced, however, large within-session score differences developed. These large differences continued to be produced after the response-cost contingency was removed. Finally, when subjects were told that the session could end at any moment, score differences were sharply reduced, indicating that production of score differences remained under the control of discriminative stimuli associated with the likelihood of reciprocation. The study suggests that with appropriate procedures, an experimental analysis of behavioral phenomena associated with the concept of "trust" may be possible.

Key words: score correspondence, equity, cooperation, exchange, response cost, response preference, dyads, pushbuttons, humans

Large deviations from an equitable distribution of reinforcers may be possible in a response-exchange cooperation procedure (Hake and Vukelich, 1972). For example, if only one of a pair of subjects can produce a reinforcer for the other on each trial, and if such "giving" need not be alternated, the possible divergence between subjects' total earnings will be a function of the number of trials. Large deviations from equity are typically not observed, however. In a study of "score correspondence" in an exchange procedure, Hake, Vukelich, and Olvera (1975) found that subjects in most pairs responded so as to come out about even each session. Studies of the effects of payoff inequity on response choice (Schmitt and Marwell, 1972; Shimoff and Matthews, 1975) have found that most subjects will respond to avoid unequal pay, even when doing so results in an absolute reduction in earnings. Such findings

suggest that most subjects would produce an unfavorable earnings difference during a session only to the extent that reciprocation (*i.e.*, an eventual equalization of earnings) is likely. Although Hake *et al.* (1975) did not present within-session score data, they reported that most pairs strictly alternated responses, which would have maintained close equality of scores from trial to trial.

The purpose of the present research was to begin investigating variables that may determine the magnitude of the difference between subjects' cumulative earnings maintained from trial to trial during cooperative exchange. In this procedure, subjects could emit exchange responses ("gives") to produce unfavorable differences in accumulated session earnings (*i.e.*, to put the other person ahead). If the give(s) were reciprocated, both subjects' earnings were greater than those available from an alternative independent-work option. If the other person switched to independent work, rather than reciprocating, however, the giver's earnings were reduced. An important characteristic of the procedure was that the magnitude of the

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earnings reduction risked was a function of the size of the earnings difference produced. That is, because each give required the giver to forego earning points independently, the further the other person was put ahead in earnings, the greater was the possible reduction in the giver's session total.

The concern here, *i.e.*, behavior that produces unfavorable inequity, which may or may not be eliminated depending on the subsequent behavior of another person, is closely related to the topics of "trust" and the expansion of social exchange. Most discussions of trust have been based on work by Deutsch (1958; 1968 *a, b*; 1962), in which a trusting response was defined as one by which the individual commits himself to profit or loss according to the behavior of another person when the possible loss exceeds the possible gain. In the present procedure, gives that created or increased an unfavorable earnings difference were trusting responses by Deutsch's definition. Similarly, gives that decreased the difference between scores (*i.e.*, reciprocal gives) were "trustworthy" responses. As greater deviations from equity are produced by one or both persons, exchange is said to "expand" (Blau, 1964). According to theories of social exchange (especially Blau, 1964; see also Thibaut and Kelley, 1959; Emerson, 1969; Homans, 1974), expansion of exchange is gradual and depends on consistent reciprocation. Because expanded exchange is not restricted to "safe", single-alternation giving, but can be maintained when larger and more prolonged deviations from equity are required, the degree of expansion of exchange may be important for the stability of exchange in changing circumstances.

In addition to investigating specific determinants of expansion of exchange, a more general purpose of the present research was to develop and demonstrate a procedure that would make an experimental analysis possible by allowing the expansion of on-going exchange to be monitored over a wide range of values as conditions were altered. In the basic procedure, the alternation of giving, and thus the degree of expansion of exchange, was subject-determined through "exchange control" buttons. In the baseline (free-exchange) condition, there were no restrictions on the use of the exchange control buttons. Pretest results showed a tendency for exchange to ex-

pand slightly over time for some pairs in the free-exchange procedure. A possible account is that there are coordination "costs" involved in exchange (*e.g.*, vigilance, timing, and sequencing of responses) that are reduced when subjects trade longer sequences of consecutive gives. This suggested that exchange might be expanded through differential reinforcement. A coordination-cost procedure was therefore introduced in which maintaining close equality of scores (*e.g.*, strictly alternating gives) was punished by a point-cost contingency on the use of the exchange control buttons. In that procedure, subjects could avoid point losses by giving a larger number of times in succession (with the attendant risk of reduced earnings) or by switching to independent work. Finally, exchange was observed when it was uncertain whether reciprocation would be possible. On the assumption that altruistic behavior is rare in experimental settings, it was anticipated that the degree of expansion of exchange would be sharply reduced when a "temporary" earnings difference was likely to become permanent. In all conditions, independent work was available as a reinforced alternative to exchange, and subjects' relative preference for exchange could be assessed.

METHOD

Subjects

Fourteen undergraduate volunteers, recruited through the campus newspaper, were assembled into seven same-sex dyads (six female, one male) by time of availability. Precautions were taken to ensure that no subject ever discovered the identity of his partner. Subjects were seated in individual, sound-attenuating cubicles, and could communicate only through their responses on the apparatus. Each pair was scheduled for 1 hr on Mondays, Wednesdays, and Fridays. To minimize missed sessions, earnings were paid one day late (*e.g.*, Monday's earnings were paid when subjects arrived on Wednesday).

Apparatus

Each member of a pair was seated before an identical table-mounted control console (Figure 1). The console contained two add-subtract counters for displaying the subject's and the other person's current session earnings, and a third that counted down the minutes in

the session. In the lower center of the console was a two-position toggle switch for choosing between the independent-work ("SELF") and exchange ("EXCHG") options. This task switch was always operable. Directly above and below the task switch were indicator lights showing the switch position of the subject and the other person, respectively. At the lower right were three lights labelled "SELF", "GIVE", and "GET". The SELF light was lit for both subjects on any trial on which either or both persons' task switches were in the independent-work (SELF) position. On trials on which both person's task switches were in the exchange (EXCHG) position, one person's GIVE light and the other's GET light were illuminated. At the lower left were two response

buttons. A press on the left (unlabelled) button when the subject's SELF light was lit added four points to his total ("MY EARNINGS"). Both subjects could earn points on each independent-work trial. A press on this "points" button when the subject's GIVE light was lit added 10 points to the other person's total ("OTHER'S EARNINGS"). If a subject pressed the points button while his GET light was lit, nothing happened. Only one person could produce points for the other on each exchange trial. The right button was an "exchange control" button, which was operable only on exchange trials. A press on the exchange control button by the pair member whose GIVE light was lit reversed the direction of potential giving; a press by the subject whose

Fig. 1. Subject's console.

GET light was lit had no effect.² Thus, a press turned off the subject's GIVE light and illuminated his GET light; at the same time his partner's lights changed from GET to GIVE. The partner could then re-establish the original situation by pressing his own exchange control button. There was no restriction on such back-and-forth use of the exchange control buttons. On the other hand, one person could remain the giver trial after trial, as long as he did not operate his exchange control button. The exchange control buttons thus allowed a pair to coordinate their exchange behavior and to determine the difference between their session totals from trial to trial.

Procedure

Baseline: free exchange. At the start of each experimental hour, both task switches were thrown to SELF. Depending on the current positions of the task switches, each trial began with illumination of both subject's SELF lights (independent-work trial) or with illumination of one person's GET light and the other's GIVE light (exchange trial). In the latter case, initial position of the lights was that of the previous exchange trial. On independent-work trials, each subject could press his points button to add four points to his total and initiate a 10-sec intertrial interval. Each point was worth 0.5¢; all console lights were extinguished during intertrial intervals. Subjects' point deliveries and intertrial intervals were not yoked in any way during independent work. On exchange trials, the subject whose GIVE light was lit could press his points button to add 10 points to the other person's total; alternatively, he could press his exchange control button. Each give initiated a 10-sec intertrial interval for both subjects.

Coordination cost. The costs of coordinating exchange were increased by a response-cost contingency on the use of the exchange control buttons. Each time either person operated his exchange control button, a fixed number of points was subtracted from both person's totals. The cost contingency itself had no effect on the difference between subjects' scores because an equal number of points was subtracted from both totals. The coordination-cost contingency

was introduced by the following note: "Each time either person presses the EXCHANGE CONTROL button, two points will be subtracted from both persons' totals." For Pair 7, the cost contingency was initially set at one point (Session 3) and later raised to three points (Session 4). The free-exchange procedure could be re-instated at any time by a note reading "... 0 points will be subtracted. ..."

Time uncertainty. Reciprocation was made uncertain by setting subjects' clocks at 10 rather than 20 min at the beginning of a session and providing the following written instructions: "Note that there are only 10 minutes showing on the clock. The session will actually last longer than 10 minutes, but you have no way of knowing how much longer. That is, the session may shut off at any time once the clock has reached zero." The session actually shut off after 15 min, providing 5 min of time uncertainty.

The scheduled sequence of procedures was: free exchange (Sessions 1 and 2), coordination cost (Sessions 3 and 4), free exchange (Session 5 and first 10 min of Session 6), time uncertainty (final 5 min of Session 6). Subjects' earnings counters were zeroed at the start of every session.

In the instruction period preceding the first session, subjects were provided with printed instructions presented concurrently by a tape recorder. The instructions (1) indicated that there would usually be two 20-min sessions per day; (2) indicated that each point was worth 0.5¢ and that payment would always occur one day late; (3) described the operation of the control console; (4) indicated that the experiment could end without warning after any session, depending on factors beyond the control of the subjects, and that the pair's final session was as likely to be the first session of the day as the second; (5) told the subjects that they were free to behave as they wished during experimental sessions, as long as they did not damage the equipment. Subjects were given a brief (approximately 5 min) period of experimenter-guided practice operating the console, including practice on both the independent and exchange tasks. Finally, any remaining questions about console operation or method of payment were answered, and subjects signed forms certifying their informed consent to participate.

Sessions were 20 min in length, except for the final (sixth) session, which lasted 15 min.

²In Pairs 1 and 2, both subjects' exchange control buttons were operable; in both dyads, however, only the giver ever pressed his exchange control button.

A single session was scheduled for Days 1 and 4, with two sessions each on Days 2 and 3.

RESULTS

Development of Stable Exchange

Table 1 shows the number of points earned in the independent and exchange options by subjects and sessions. Absolute numbers of responses can be readily computed from Table 1, since each independent response produced four points for the subject and each give produced 10 points for his partner. The proportion of time the exchange option was in effect in each session was also measured for each pair.

The table shows that stable exchange developed quickly in Pairs 1, 2 (the only male dyad), 5, and 7. Pairs 1 and 2 responded in the exchange mode exclusively, beginning with Session 1. In Pairs 5 and 7, the proportion of responses and time spent in exchange both reached 100% by Session 2. Introducing the coordination-cost contingency in Sessions 3 and 4 briefly disrupted exchange in Pairs 2, 5, and 7. The complete response record for Pair 1 is shown in Figure 2; the records for Pairs 2, 5, and 7 were essentially similar.

Pairs 4 and 6 failed to develop stable exchange during the first two sessions and were terminated. Person B in Pair 4 consistently

failed to reciprocate A's gives during Session 1, and only independent responding occurred in Session 2. In Pair 6, some alternated giving occurred early in Session 1. However, on every trial on which it was B's "turn" to produce points for A, Person B used her exchange control button one or more times to re-illuminate her GET light. The result was much back-and-forth use of the exchange control buttons. The standoff that developed in Pair 6 is reflected in the low numbers of gives in Session 2 (Table 1), even though the exchange option was in effect during 42% of that session. There were no gives by either member of Pair 6 during the final 42 trials of Session 2.

The response record for Pair 3 is shown in Figure 3. The pattern of responding observed for this pair during Sessions 1 and 2 was a milder version of that described for Pairs 4 and 6, with Person B continually attempting to receive points more often than she produced them for A. Stable exchange was achieved by the middle of Session 1, however, and no independent responding occurred during Session 2. Exchange remained rather inefficient, however, as reflected in Pair 3's relatively low earnings for Session 2 (Table 1), due to intermittent contention about the direction of giving. Exchange was briefly disrupted in Session 3 after the coordination-cost contingency was introduced (Trials 212 to 213, Figure 3).

Table 1

Numbers of points earned in the independent (Ind) and exchange (Exg) options, by subject and session. Numbers in parentheses are net of point subtractions for use of the exchange control buttons (coordination-cost procedure). Session 6 lasted 15 min; all other sessions were 20 min.

Subject	Session									
	1		2		3		4		5	
	(Free Exchg)		(Free Exchg)		(Coord Cost)		(Coord Cost)		(Free Exchg)	
	Ind	Exg	Ind	Exg	Ind	Exg	Ind	Exg	Ind	Exg
A1	0	490	0	500	0	510 (490)	0	520 (518)	0	500
B1	0	480	0	510	0	510 (490)	0	520 (518)	0	500
A2	0	480	0	500	0	500 (482)	0	520 (514)	0	520
B2	0	490	0	490	0	500 (482)	0	520 (514)	0	520
A3	100	320	0	430	8	440 (360)	0	500 (464)	0	500
B3	100	330	0	440	8	470 (390)	0	500 (464)	0	510
A4	204	10	376	0						
B4	208	160	404	0						
A5	24	440	0	490	8	490 (480)	0	520 (514)	0	520
B5	24	440	0	490	8	500 (490)	0	510 (504)	0	520
A6	52	200	260	40						
B6	48	240	260	50						
A7	8	460	0	490	0	490 (472)	24	490 (484)	0	520
B7	8	460	0	480	0	510 (492)	24	490 (484)	0	520

EARNINGS DIFFERENCE

Table 2

Maximum earnings difference in favor of each subject during each session. Sessions 1 through 5 were 20 min in length. For Session 6, the slash separates data for the first 10 min (free-exchange procedure) and the final 5 min (time-uncertainty procedure).

Subject	Session					
	1 (Free Exchg)	2 (Free Exchg)	3 (Coord Cost)	4 (Coord Cost)	5 (Free Exchg)	6 (Free Exchg/ Time Uncert)
A1	10	10	170	0	480	0/20
B1	20	30	100	520	10	260/20
A2	0	10	50	500	480	260/10
B2	10	0	160	20	40	0/10
A3	0	10	10	20	10	0/0
B3	30	20	70	90	130	200/70
A4	10					
B4	150					
A5	10	10	190	40	250	30/50
B5	30	20	100	480	200	230/50
A6	0	0				
B6	40	10				
A7	10	10	20	0	150	170/0
B7	0	0	100	490	90	50/10

Score Differences

Table 1 shows, consistent with the findings of Hake *et al.* (1975), that subject's earnings were about equal by the end of each session. Among the five pairs that developed stable exchange, in only one was an end-of-session earnings difference as large as 30 points (\$0.15) ever observed (Pair 3, Sessions 3 and 6). The mean earnings difference for all pairs and sessions (excluding Pairs 4 and 6, which were terminated following Session 2) was less than four cents (\$0.37); the modal difference in session earnings was zero cents.

Of primary interest here, however, was the degree of expansion of exchange, *i.e.*, the magnitude of earnings differences produced during sessions. Table 2 shows the maximum earnings difference in favor of each subject during each session. Except for Pair 4, in which exchange ceased during the first session, close equality of scores was maintained in all pairs throughout Sessions 1 and 2 (free-exchange procedure); no earnings difference larger than 40 points was observed in any pair during the first two ses-

sions. The most common pattern of exchange was a strict alternation of giving, which produced minimum possible deviations from equity. Only in Pair 1 was any tendency observed for exchange to expand in the free-exchange procedure (Figure 2). Pairs 4 and 6 were the only pairs in which earnings diverged during independent work (Table 1).

Introduction of the coordination-cost contingency (Session 3) progressively expanded exchange in Pairs 1, 2, 5, and 7, with a smaller effect for Pair 3 (Table 2 and Figures 2 and 3). In Pairs 1, 2, 5, and 7, earnings differences during Session 4 approached the maximum possible, consistent with the opportunity for pair-members to complete the session with approximately equal earnings; that is, one subject gave throughout most or all of the first 10 min of the session, and the other gave throughout most or all of the final 10 min.

When the free-exchange procedure was reinstated in Session 5, deviations from equity remained maximal in Pairs 1 and 2, decreased to more moderate levels in Pairs 5 and 7, and continued to increase in Pair 3 (Table 2 and

Fig. 2. Response record for Pair 1. The horizontal broken line represents a zero difference between the accumulated session earnings of Person A and Person B. Each division on the vertical axis represents a one-give (10-point) difference in A's favor (above the equal-earnings line) or in B's favor (below the line). Successive trials are shown along the horizontal axis. Sessions are separated by triangles, experimental procedures by vertical broken lines.

EARNINGS DIFFERENCE

Fig. 3. Response record for Pair 3.

Figures 2 and 3). In Session 6, earnings differences that were maximal or near-maximal, consistent with the possibility of reciprocation, were observed in all pairs during the first 10 min of the session but were sharply reduced during the last 5 min when the subjects' clocks had reached zero and reciprocation was uncertain.

DISCUSSION

Interest in the present experiment centered on the magnitude of earnings differences maintained during two-party exchange. The results, like those of Hake *et al.* (1975), showed that dyad members achieved close equality of scores by the end of each session. However, it was to

determinants of score differences during sessions (*i.e.*, of the degree of expansion of exchange) that this research was primarily addressed. In the procedure used here, the larger the earnings difference produced by a subject, the greater the reduction in his earnings if the other person did not reciprocate. A concurrently available independent response provided a reinforced alternative to reciprocal giving.

Results showed that exchange tended not to expand in the absence of reinforcement contingencies favoring such expansion, that is, subjects usually minimized trial-to-trial score differences when they could do so without penalty (free-exchange procedure). Introduction of a coordination-cost procedure, however, in which point-losses could be avoided if subjects produced larger deviations from equity, resulted in progressive and typically maximal expansion of exchange. Large within-session score differences continued to be produced after the cost contingency was removed, but decreased sharply when it became uncertain whether reciprocation could occur before the session ended (time-uncertainty procedure).

The high degree of expansion of exchange in the coordination-cost procedure was surprising, given the risk involved and the availability of a "safe" independent-work alternative. For example, in Session 4, had the initial recipient failed to reciprocate, the giver would have suffered an earnings reduction of at least \$0.98 (Pair 7, Table 3). The expansion of exchange was gradual in every pair, however, suggesting both that give responses continued to depend on reciprocation from the other person and that subjects' reinforcement histories had prepared them to behave cautiously in such situations. Thus, in Pair 3, in which reciprocation by one person was not consistent, smaller score differences were produced during coordination-cost sessions (*cf.* Figures 3 and 2). Even in Pair 3, however, score differences progressively increased in size, continuing to do so even after the cost contingency was removed. Additional research is necessary to determine whether highly expanded exchange may be a terminal pattern of performance in very long-term, steady-state exchange. If that were the case, the effect of a coordination-cost contingency would be one of accelerating, rather than uniquely producing, the transition to an eventual performance.

The continuation of large within-session deviations from equity after the coordination-cost contingency was removed may be analogous to similarly "unnecessary" exchange behavior sometimes observed among preliterate peoples. Anthropologists argue that such behavior is maintained so that the parties may continually demonstrate and test their mutual trustworthiness (Sahlins, 1965). A much simpler account, however, would be that subjects continued to produce large score differences as they discovered the reduced effort of exchange when each person gives more times in succession. In any case, the sharp reduction in earnings differences after it became uncertain when the session would end indicates that production of such differences remained under the control of discriminative stimuli concerning the probability of reciprocation.

The present study, although preliminary in scope, indicates that it may be possible to provide an experimental analysis of behavioral phenomena traditionally associated with the concept of "trust". Further research should continue to investigate determinants of the expansion of exchange, as well as investigating the properties of expanded exchange itself. For example, if, as exchange theories indicate, expansion of exchange must occur gradually, then high coordination cost introduced gradually could have very different effects than the same contingency introduced abruptly. It is also possible that discriminative stimuli concerning the future utility of expanded exchange (*e.g.*, warning of future inequity requirements) could affect the expansion of exchange. Finally, information is needed about the relative stability of expanded exchange under various conditions. All of these questions bear on the important problem of specifying the general conditions under which cooperative exchange will be maintained.

REFERENCES

- Blau, P. *Exchange and power in social life*. New York: John Wiley & Sons, 1964.
- Deutsch, M. Trust and suspicion. *Journal of Conflict Resolution*, 1958, 2, 265-279.
- Deutsch, M. The effect of motivational orientation upon trust and suspicion. *Human Relations*, 1960, 13, 123-139. (a)
- Deutsch, M. Trust, trustworthiness, and the F scale. *Journal of Abnormal and Social Psychology*, 1960, 61, 138-140. (b)
- Deutsch, M. Cooperation and trust: some theoretical

- notes. *Nebraska symposium on motivation*. Lincoln: University of Nebraska Press, 1962.
- Emerson, R. M. Operant psychology and exchange theory. In R. L. Burgess and D. Bushell (Eds), *Behavioral sociology*. New York: Columbia University Press, 1969. Pp. 379-405.
- Homans, G. G. *Social behavior: its elementary forms*. Revised Edition. New York: Harcourt Brace Jovanovich, 1974.
- Hake, D. F. and Vukelich, R. A classification and review of cooperation procedures. *Journal of the Experimental Analysis of Behavior*, 1972, 18, 333-343.
- Hake, D. F., Vukelich, R., and Olvera, D. The measurement of sharing and cooperation as equity effects and some relationships between them. *Journal of the Experimental Analysis of Behavior*, 1975, 23, 63-79.
- Sahlins, M. On the sociology of primitive exchange. In M. Banton (Ed), *The relevance of models for social anthropology*. London: Tavistock Publications, 1975. Pp. 139-237.
- Schmitt, D. R. and Marwell, G. Withdrawal and reward reallocation as responses to inequity. *Journal of Experimental Social Psychology*, 1972, 8, 207-221.
- Shimoff, E. and Matthews, B. A. Unequal reinforcer magnitudes and relative preference for cooperation in the dyad. *Journal of the Experimental Analysis of Behavior*, 1975, 24, 1-16.
- Thibaut, J. W. and Kelley, H. H. *The social psychology of groups*. New York: John Wiley & Sons, 1959.

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