REVERSALS OF PREFERENCE BETWEEN BIDS AND CHOICES IN GAMBLING DECISIONS [1]

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The *S*s in three experiments chose their preferred bet from pairs of bets and later bid for each bet separately. In each pair, one bet had a higher probability of winning (P bet); the other offered more to win ($ bet). Bidding method (selling vs. buying) and payoff method (real-play vs. hourly wage) were varied. Results showed that when the P bet was chosen, the $ bet often received a higher bid. These inconsistencies violate every risky decision model, but can be understood via information-processing considerations. In bidding, *S* starts with amount to win and adjusts it downward to account for other attributes of the bet. In choosing, there is no natural starting point. Thus amount to win dominates bids but not choices. One need not call this behavior irrational, but it casts doubt on the descriptive validity of expected utility models of risky decision making.

Utility theory, in one form or another, has provided the guiding principle for prescribing and describing gambling decisions since the eighteenth century. The expected utility principle asserts that given a choice among gambles, the decision maker will select the one with the highest expected utility.

There are a number of ways other than choosing by which an individual can express his opinions about the utilities of various gambles. Among these are ratings of attractiveness, bids to buy, and bids to sell:

1. Ratings of attractiveness: On an arbitrary scale, *S* assigns an attractiveness value to each of a set of bets. For any pair, it is assumed that he prefers the one to which he gives the highest rating.

2. Bids to buy (B bids): *E* owns a set of bets. For each bet, *S* indicates the maximum amount of money he would pay in order to be able to play the bet. (See Coombs, Bezembinder, & Goode, 1967;

Lichtenstein, 1965.) For any pair of bets, it is assumed that he prefers the one for which he bids the most money.

3. Bids to sell (S bids): *S* owns a set of bets. For each bet, *S* indicates the minimum amount for which he would sell the right to play the bet (see Becker, DeGroot, & Marschak, 1964; Coombs et al., 1967; Tversky, 1967). For any pair it is assumed that *S* prefers the bet for which he demands the most money.

Since utility theory assumes that these different responses are all determined by the same underlying values, it predicts that *S*s who are asked to choose one of two bets will choose the one for which they would make the higher bid, or to which they would give the higher rating.

In contrast, the view of the present authors is that such decisions do not rely solely on expected utilities. Slovic and Lichtenstein (1968) have demonstrated that a gamble is a multidimensional stimulus whose various attributes have differential effects on individual decision-making behavior. In particular, they presented evidence that choices and attractiveness ratings are determined primarily by a gamble's probabilities, while bids are most influenced by the amount to be won or lost. Specifically, when *S*s found a bet attractive, their bids correlated predominantly with the amount to win; when they disliked a bet, the amount to lose was the primary

determiner. It was argued that these differences between ratings and choices on the one hand and bids on the other demonstrated the influence of information-processing considerations upon the method by which a gamble is judged. In the bidding task, Ss had to evaluate a gamble in monetary units; this requirement apparently led them to attend more to payoffs when bidding than they did when making choices or ratings.

The notion that the information describing a gamble is processed differently for bids than for choices suggested that it might be possible to construct a pair of gambles such that S would choose one of them but bid more for the other. For example, consider the pair consisting of Bet P (.99 to win $4 and .01 to lose $1) and Bet $ (.33 to win $16 and .67 to lose $2). Bet P has a much better probability of winning but Bet $ offers more to win. If choices tend to be determined by probabilities, while bids are most influenced by payoffs, one might expect that Ss would choose Bet P over Bet $, but bid more for Bet $. If such a reversal of orderings were to occur, it would provide dramatic confirmation of the notion that bidding and choice involve two quite different processes, processes that involve more than just the underlying utilities of the gambles. The following three experiments tested this hypothesis.

For all three experiments, the general paradigm was first to present S with a number of pairs of bets. All of the bets had positive expected value and were viewed by Ss as bets they would like to play. Every pair was composed of two bets with the same (or nearly the same) expected value: a "P bet," i.e., a bet with a high probability of winning a modest amount and a low probability of losing an even more modest amount, and a "$ bet," i.e., a bet with a modest probability of winning a large amount and a large probability of losing a modest amount. For each pair, S indicated which bet he would prefer to play. After S had made all his choices, he then made a bid for each of the bets, which this time were presented one at a time.

EXPERIMENT I

Experiment I was a group study comparing choices with S bids. The Ss were 173 male undergraduates who were paid for participating; there was no actual gambling. The stimuli were 13 two-outcome bets, 6 bets with excellent odds (the P bets), and 7 bets with large winning payoffs (the $ bets). All bets had positive expected values, ranging from $1.40 to $4.45. First these bets were combined into 12 pairs, each of which had one P bet and one $ bet; no bet occurred more than twice. The Ss were asked to pick, for each pair, the bet they would prefer to play. After each choice, Ss indicated how strongly they preferred their chosen bet by marking one of four lines on their answer sheet; the first line was labeled "slight" preference and the fourth was labeled "very strong" preference. The instructions suggested that the two intermediate lines might be labeled "moderate" and "strong." After about 1 hr. of intervening work, Ss then made bidding responses to 19 singly presented bets. The first 6 bets were intended as practice bets and differed from those used in the paired comparisons. The responses to these bets were not analyzed. The next 13 bets were the same as those used earlier. In the bidding instructions, S was told he owned a ticket to play the bet and was asked to name a minimum selling price for the ticket such that he would be indifferent to playing the bet or receiving the selling price. For both the bidding and choice tasks, Ss knew their decisions were "just imagine."

Since the 12 pairs contained several repetitions of single bets, only the results of a subset of 6 pairs of bets, which contained no bets in common, are presented here; these bets are shown in Table 1. The results for the other 6 pairs were virtually identical to these.

Results.—The first column of Fig. 1 shows the results of Exp. I. The top histogram indicates that most Ss varied their choices across bets, choosing the P bet over the

TABLE 1

BETS USED IN EXPERIMENT I

Pair	P bet	Expected value	$ bet	Expected value
1	.99 Win $4.00 .01 Lose 1.00	$3.95	.33 Win $16.00 .67 Lose 2.00	$3.94
2	.95 Win $2.50 .05 Lose .75	$2.34	.40 Win $ 8.50 .60 Lose 1.50	$2.50
3	.95 Win $3.00 .05 Lose 2.00	$2.75	.50 Win $ 6.50 .50 Lose 1.00	$2.75
4	.90 Win $2.00 .10 Lose 2.00	$1.60	.50 Win $ 5.25 .50 Lose 1.50	$1.88
5	.80 Win $2.00 .20 Lose 1.00	$1.40	.20 Win $ 9.00 .80 Lose .50	$1.40
6	.80 Win $4.00 .20 Lose .50	$3.10	.10 Win $40.00 .90 Lose 1.00	$3.10

$ bet about half the time. This does not mean, however, that the Ss felt indifferent about their choices. The mean strength of preference, when coded 1 ("slight"), 2, 3, or 4 ("very strong"), was 2.94, with a standard deviation of .95. Most of the Ss (65%) never used the "slight" preference rating.

The second histogram in the first column of Fig. 1 shows that Ss were far more consistent in their bids: 70% of the Ss never bid more for the P bet than for the $ bet with which it had previously been paired.

The proportion of times that the bid for the $ bet exceeded the bid for the P bet, given that the P bet had been chosen from the pair, is called the "proportion of conditional predicted reversals" in Fig. 1. Of the 173 Ss, 127 (73%) always made this reversal: for every pair in which the P bet was chosen, the $ bet later received a higher bid.

The histogram labeled "conditional unpredicted reversals" shows the proportion of times in which the bid for the P bet exceeded the bid for the $ bet, given that the $ bet had been previously chosen. This latter behavior was not predicted by the authors and is hard to rationalize under any theory of decision making. It might best be thought of as a result of carelessness or changes in S's strategy during the experiment. Unpredicted reversals were rare in Exp. I; 144 Ss (83%) never made them.

The mean strength of preference rating was as high when Ss made reversals as it

was when Ss were consistent, as shown in Table 2. This finding suggests that reversals could not be attributed to indifference in the choice task.

It is clear that when S bids are compared with choices, reversals occur as predicted. Would the effect also hold for comparisons of choices with B bids? There are certain considerations suggesting that the reversal effect might be diminished, since the effect seems to be largely attributable to a tendency to overbid for $ bets but not for P bets. For example, with the P bet, .99 to win $4 and .01 to lose $1, it is hard to imagine a bid much beyond the expected value of $3.95; while with the $ bet, .33 to win $16 and .67 to lose $2, bids greatly exceeding the expected value of $3.94 are common. Since Ss ask to be paid more when selling a bet than they pay to play when buying, the S bid method leads to higher bids than the B bid method (Coombs et al., 1967; Slovic & Lichtenstein, 1968). Therefore, S bidding should act to enhance the amount of differential overbidding and thereby lead to more reversals than B bidding.
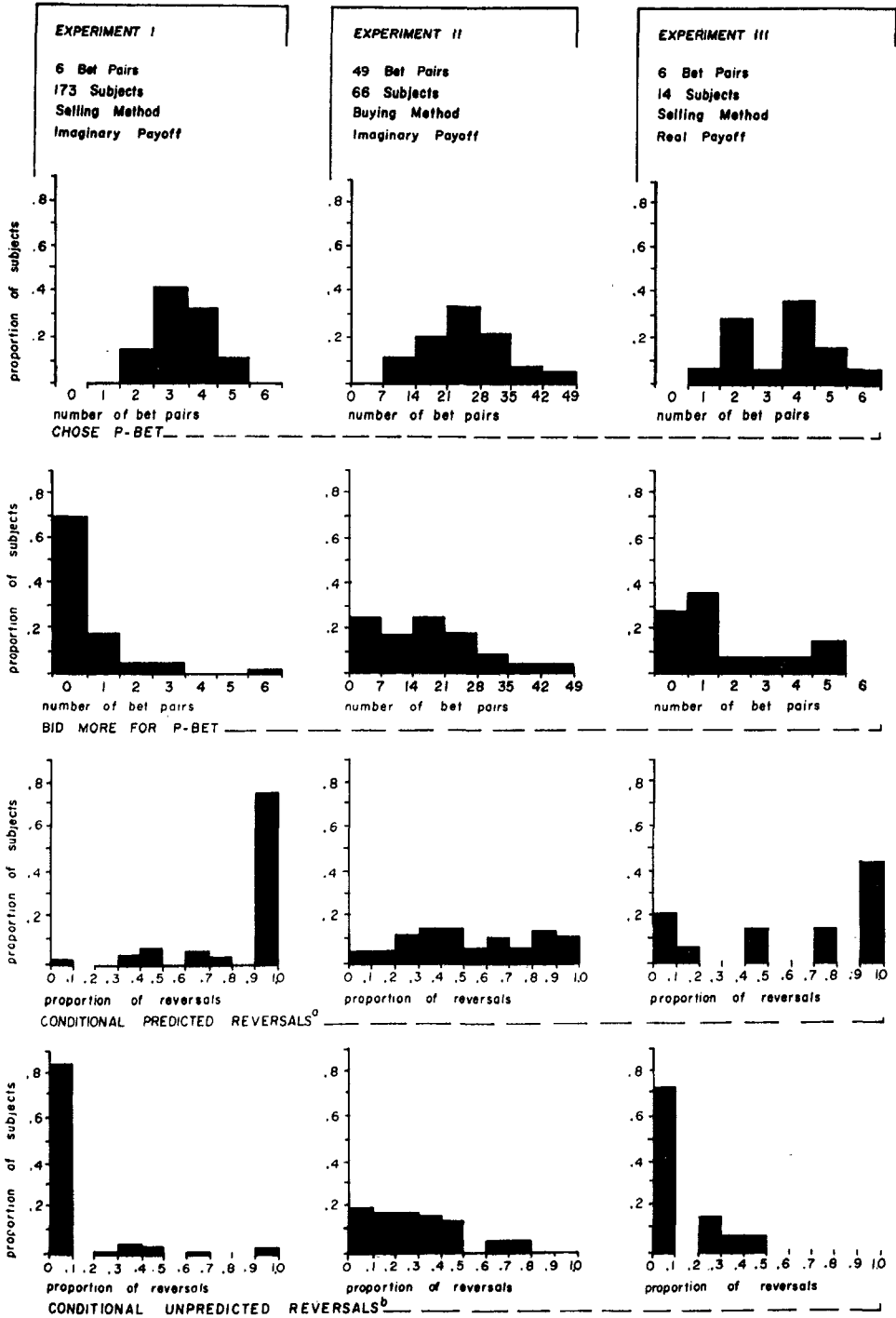
EXPERIMENT II

The goals of Exp. II were to test the generality of the reversal phenomenon by using the B bid technique, as well as to study the relationships between various attributes of the bets and the reversal phenomenon by using a larger and more varied set of stimuli.

Method.—The Ss were 74 college students run in four groups. No bets were actually played; Ss were paid by the hour. The stimuli were 49 pairs of bets following 11 practice pairs. Contained in

TABLE 2

STRENGTH OF PREFERENCE RATING GIVEN TO CHOICES IN EXPERIMENT I

Bet chosen	Bid more for:			
	P bet		$ bet	
	$\bar{X}$	SD	$\bar{X}$	SD
P	3.06	.93	3.10	.91
$	2.78	.94	2.78	.91

FIG. 1. Summary of results for three experiments.

these pairs were 88 different single bets. These 88 bets, following 10 practice bets, constituted the bidding stimuli. Results from the practice stimuli were excluded from the analyses. The bets in each pair were equated in expected value. Each P bet had a winning probability from $\frac{8}{12}$ to $\frac{11}{12}$; the probability of winning for the $ bet ranged from $\frac{1}{12}$ to $\frac{5}{12}$. The $ bet always had a larger amount to win than the P bet. With few exceptions, the win exceeded the loss in a given bet.

The bets were expressed in dollars and cents; the winning amount ranged from 10¢ to $10; the losing amount from 10¢ to $3.70; the expected value ranged from 10¢ to $3. A typical bet pair looked like this: P bet, $\frac{11}{12}$ to win $1.00 and $\frac{1}{12}$ to lose $0.20; $ bet, $\frac{1}{12}$ to win $9.00 and $\frac{11}{12}$ to lose $2.00.

The bets were chosen in an attempt to represent a variety of P bets and $ bets. Thus, the winning amount in the $ bet always exceeded the winning amount in the P bet, but the ratio of the former to the latter ranged from 1.3 to 100. The difference between the amount to lose in the $ bet and the amount to lose in the P bet varied from $-$3.00 to $2.80.

The Ss were first briefly instructed in the choice task. They were asked to choose, from each pair, which bet they would prefer to play. After choosing, the Ss turned to the bidding task. Instructions for the buying method of bidding emphasized "the *highest* price you would pay to play it. . . . Ask yourself each time, 'Is that the *most* money I would pay to play that bet?'"

Results.—Comparison of the second column with the first column of Fig. 1 shows there were fewer predicted reversals (Kruskal-Wallis analysis of variance by ranks, $x^2 = 82.73$, $p < .01$) and more unpredicted reversals (Kruskal-Wallis analysis of variance by ranks, $x^2 = 87.66$, $p < .01$) for B bids (Exp. II) than for S bids (Exp. I). As expected, the B bids in Exp. II were lower, relative to the expected values of the bets, than the S bids in Exp. I. Bids for the P bets averaged 7¢ below expected value in Exp. I, but 44¢ below expected value in Exp. II, $t = 5.97$, $p < .01$. Bids for the $ bets were $3.56 *higher* than expected value in Exp. I, but 4¢ below expected value in Exp. II, $t = 12.98$, $p < .01$. These results indicate that the B-bid technique serves to dampen the tendency towards gross overbidding for $ bets, and hence to reduce the rate of predicted reversals. In addition, since bids for $ bets are closer in range to bids for P bets in Exp. II, even fairly small fluctuations in bidding could more easily produce

an increase in the occurrence of unpredicted reversals, as observed. Nevertheless, 46 of the 66 Ss ($p < .01$) had a higher rate of conditional predicted reversals than conditional unpredicted reversals.

The 49 pairs of bets used in this experiment were constrained by the requirements that all P bets had high probability of winning a modest amount, while all $ bets had low to moderate probability of winning a large amount. Nevertheless, there were differences in the degree to which individual pairs of these bets elicited predicted reversals. Despite the constraints, there was sufficient variability within some of the characteristics of the bets to permit analysis of their relationship to Ss' bids and choices. This analysis indicated that the difference between the amount to lose in the $ bet and the amount to lose in the P bet correlated .82 across the 49 bet pairs with the number of Ss who chose the P bet. Thus, when the amount to lose in the $ bet was larger than the amount to lose in the P bet, Ss chose the P bet 73% of the time. But when the reverse was true, the P bet was chosen only 34% of the time. This loss variable had no differential effect upon bids.

Variations in amount to win, on the other hand, affected bids but not choices. The amount to win in the $ bet was always larger than the amount to win in the P bet, but the ratio of the two winning amounts varied. This win ratio correlated .55 across the 49 bet pairs with the number of Ss who bid more for the $ bet than for its previously paired P bet. The win ratio did not correlate ($r = -.03$) with the number of Ss who chose the P bet.

These results, that variations in amount to lose affected choices but not bids, while variations in amount to win affected bids but not choices, are further evidence that different modes of information processing are used in bidding and choosing.

The probabilities of winning across the 49 bet pairs in Exp. II had very narrow ranges ($\frac{8}{12}$ to $\frac{11}{12}$ in the P bets, $\frac{1}{12}$ to $\frac{5}{12}$ in the $ bets) and had no differential effects on the frequency of reversals.

The probability of observing a predicted reversal increases both when the probability

of S choosing the P bet increases and when the probability of S bidding more for the $ bet increases. This, together with the correlational information presented above, implies that the ideal bet pair for observing reversals would have a larger $ bet loss than a P bet loss (facilitating choice of the P bet), and a large $ bet win relative to the P bet win (facilitating a larger bid for the $ bet). In fact, in this experiment, the bet pair which had the most predicted reversals (40 of 66 Ss reversed) had just these characteristics: P bet, $\frac{9}{12}$ to win $1.10 and $\frac{3}{12}$ to lose $ .10; $ bet, $\frac{3}{12}$ to win $9.20 and $\frac{9}{12}$ to lose $2.00.

EXPERIMENT III

The purpose of Exp. III was to test whether the predicted reversals would occur under conditions designed to maximize motivation and minimize indifference and carelessness. Lengthy and careful instructions were individually administered to 14 male undergraduates. The bets were actually played, and Ss were paid their winnings.

The stimuli were the 12 bets, 6 P bets and 6 $ bets, shown in Table 3. The probabilities were expressed in thirty-sixths, so that a roulette wheel could be used to play the bets. The amounts to win and lose were shown as points (ranging from 50 to 4,000), and a conversion to money was established such that the minimum win was 80¢ (even for Ss who had a net loss of points), while the maximum win was $8.00. The concept of converting points to money, and the minimum and maximum win, were explained to Ss at the beginning of the experiment. However, the actual conversion curve was not revealed until the experiment was over.

Each S was run individually. After six practice pairs, S chose his preferred bet from each of the six critical pairs three consecutive times, with a different order of presentation and top–bottom alignment each time. The E kept a record of S's choices. After S had responded to each pair twice, this fact was pointed out to him. The E told S that he would see these

TABLE 3

BETS USED IN EXPERIMENT III

Pair	P bet	Expected value	$ bet	Expected value
1	35/36 Win 400 1/36 Lose 100	386	11/36 Win 1600 25/36 Lose 150	385
2	34/36 Win 250 2/36 Lose 50	233	14/36 Win 850 22/36 Lose 150	239
3	34/36 Win 300 2/36 Lose 200	272	18/36 Win 650 18/36 Lose 100	275
4	33/36 Win 200 3/36 Lose 200	178	18/36 Win 500 18/36 Lose 150	175
5	29/36 Win 200 7/36 Lose 100	142	7/36 Win 900 29/36 Lose 50	135
6	32/36 Win 400 4/36 Lose 50	350	4/36 Win 4000 32/36 Lose 100	356

same six pairs one last time, that E would remind S of which bet he had preferred on each of the first two times and ask S for his final, binding decision. The E emphasized that his interest was in obtaining S's careful and considered judgments and that S should feel free to change his decision if, by so doing, he would reflect his true feelings of preference for one bet over the other. Then, as S looked at each pair, E would report either "The first two times, you said you would prefer to play Bet A (Bet B); do you still prefer that bet?" or "You chose Bet A once and Bet B once. Which bet do you really want to play?" It was emphasized that this final choice would determine which bet S would actually play.

Following this final round of choices, S was instructed in making S bids. This explanation was far more complex than that used in Exp. I and included all the persuasions discussed by Becker et al. (1964). These instructions were designed to convince S that it was in his best interest to bid for a bet exactly what that bet was worth to him. The S was told that E would choose a counteroffer against which to compare S's price by spinning the roulette wheel and entering the number so obtained in a conversion table specially designed for each bet. The conversion table was a list of the 36 roulette numbers with a counteroffer associated with each number. If the counteroffer was equal to, or greater than, S's previously stated bid, E would buy the bet from S, paying S the

TABLE 4

PROPORTIONS OF CHOOSING AND
BIDDING RESPONSES

Bet chosen	Expected under the "null model": bid more for:		
	P bet	$ bet	
P	$pr's' + p'rs$ [a]	$pr's + p'rs'$ [b]	$pr' + p'r$
$	$prs' + p'r's$ [c]	$prs + p'r's'$ [d]	$pr + p'r'$
	$ps' + p's$	$ps + p's'$	1

Observed

Exp. I			Exp. II			Exp. III		
.085 [a]	.425 [b]	.510	.261 [a]	.271 [b]	.532	.250 [a]	.321 [b]	.571
.031 [c]	.459 [d]	.490	.127 [c]	.341 [d]	.468	.048 [c]	.381 [d]	.429
.116	.884	1	.388	.612	1	.298	.702	1

amount of the counteroffer. If the counteroffer was smaller than S's price, no sale would be made and S would play the bet. The counteroffer tables were constructed on the basis of previous bids for similar bets, with a range chosen to include most of the anticipated bids. The values of the counteroffers can influence the expected value of the game as a whole, but they do not affect the optimal response strategy, a fact which was pointed out to Ss.

Further discussion of the technique emphasized two points: (a) The strategy that S should follow in order to maximize his gain from the game was always to name as his price exactly what he thought the bet was worth to him. (b) A good test of whether S's price was right for him was to ask himself whether he would rather play the bet or get that price by selling it. The price was right when S was indifferent between these two events. The E then presented several (up to 12) practice trials. These practice trials included the complete routine: S stated his selling price, E obtained a counteroffer, and the bet was either sold or played.

The 12 critical bets were then presented three times successively. However, the playing of the critical bets (including selection of a counteroffer) was deferred until S had stated his price for all bets. On the third presentation, while S was studying a particular bet, but before S had stated his price, E told S what his price had been for the first two times and urged him now to reconsider and name the final, binding price to be used later in playing the game.

After these decisions, S played the game. First, he played his preferred bet for each of the six pairs of bets. Then the bids were played, starting with the selection by E of a counteroffer and ending with either sale or play of the bet for all 12 bets. The S kept track of his own winnings or losses of points, which were, at the end, converted to money.

Results.—All data analyses were based only on the third, final choices and bids Ss made. Results from these carefully trained and financially motivated Ss give further credence to the reversal phenomenon. As shown in Column 3 of Fig. 1, six Ss always made conditional predicted reversals and five Ss sometimes made them. Unpredicted reversals were rare.

Is it possible that the reversals in all three experiments resulted solely from the unreliability of Ss' responses? This hypothesis can be examined by assuming that the probability that S truly prefers the P bet in the choice task is equal to the probability that he truly values the P bet more in the bidding task. Call this single parameter p, and let $p' = 1 - p$. Suppose further that because of unreliability of response, S will report the opposite of his true preference with a probability of r ($r' = 1 - r$) in the choice task and will reverse the true order of his bids with a probability of s ($s' = 1 - s$) in the bidding task.

Under this "null model," S will choose the P bet while bidding more for the $ bet if he truly prefers the P bet and responds with his true preference in the choice task but responds with error in the bidding task, or if he truly prefers the $ bet and responds with error in the choice task but truly in the bidding task. The probability of observing this response is thus: $pr's + p'rs'$. The probabilities of all possible responses, constructed in similar fashion, are shown in Table 4.

These expected probabilities can be compared with the proportions actually obtained. For each experiment, three of these proportions are independent and yield three equations in the three unknowns, p, r, and s; these equations may be solved for p. In general, if the actual cell proportions are a, b, c, and d as shown in Table 4, solving for p yields the equation:

$$pp' = \frac{ad - bc}{(b + c) - (a + d)}.$$

For the three experiments here reported, the obtained values for pp' were .295, .315, and .270 respectively. All of these yield only imaginary solutions for p. However, they are all close to the maximum possible real value for pp', .25, which would imply that $p = .5$. When $p = .5$ is substituted into the expressions in Table 4, then regardless of the rates of unreliability, r and s, all the following conditions must hold: (*a*) All marginals must be equal to .5; (*b*) Cell a must equal Cell d; (*c*) Cell b must equal Cell c.

These three conditions are not independent; only the last, that Cell b must equal Cell c, was subjected to statistical test. For the data shown in Table 4, McNemar's test for correlated proportions yielded $\chi^2 = 338.27$ for Exp. I, $\chi^2 = 167.29$ for Exp. II, and $\chi^2 = 15.61$ for Exp. III; for all, $p < .01$. Since the "null model" can in no way account for the data, it is reasonable to reject the notion that unreliability of response is the sole determiner of the reversal effects.

Postexperimental interviews.—The Ss in Exp. III who gave predicted reversals were interviewed at the end of the experiment in an effort to persuade them to change their responses. The inconsistency of the responses was explained to S. If S was initially unwilling to change any responses, E's interview comments became more and more directive. If pointing out that S's pattern of responses could be called *inconsistent* and *irrational* did not persuade S, E explained to S a money-pump game by means of which E could systematically and continuously get S to give E points without ever playing the bets.[3] This was intended to illustrate to S the consequences of his responses. After S understood the nature of the money-pump game, he was again urged to resolve the reversal.

Eleven of the 14 Ss were interviewed. Of these, 6 Ss changed one or more responses after only a little persuasion, 3 changed only after the money-pump game was presented to them, and 2 Ss refused to change their responses at all, insisting throughout the interview that their original responses *did* reflect their true feelings about the bets.[4]

Comments by Ss supported the authors' contention that Ss process the bet information differently in the two tasks. Some Ss showed this indirectly, by mentioning only the probabilities when discussing choices while focusing on the amount to win and entirely disregarding the amount to lose when discussing bids.

Other Ss explicitly stated they were using different processing methods in choosing and bidding. For example, one S, L. H., tried to justify his bid for the $ bet of Pair 5 by noting that his bid was less than half of the amount to win. When E pointed out to him that his chance of winning was much less than one-half, he replied,

7 against 29 . . . I'm afraid I wasn't thinking of the 7 to 29 [the winning odds]. I was thinking of it in terms of relative point value . . . In other words, I looked at the 29 and the 7 [when I was choosing] but as for bidding, I was looking at the relative point value, which gave me two different perspectives on the problem.

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[3] Paraphrased:

Suppose I own both bets and you own some points. You have said that the $ bet is worth X points to you. Are you willing then to buy the $ bet from me for X points? OK, now you own the $ bet and I have X of your points. But you said you really would rather play the P bet than the $ bet. So would you like to trade me the $ bet for the P bet which you like better? OK, now are you willing to sell me the P bet for Y points, which is what *you* told me it is worth? OK, now I have both bets back again and also I now have (X − Y) of your points. We are ready to repeat the game by my selling you the $ bet again for X points.

[4] An edited transcript of one of these Ss is available from the authors.

Subject L. F. said,

I don't arrive at the evaluation . . . quite the same way that I arrive at the preferable bet. And there's some inconsistency there. Now, whether in a particular case this leads to an inconsistency maybe's not too important. It's just that they're two different models . . . I imagine that shows that the models aren't really accurate, but in terms of just betting, they're sound enough. I wouldn't change them.

Subject M. K. said,

You see, the difference was, that when I had to pick between [the P bet] and [the $ bet] I picked the bet which was more sure to produce some points for me. When I was faced with [the $ bet alone], my assessment of what it was worth to me, you know, changed because it wasn't being compared with something.

Discussion

In three experiments, Ss frequently chose one bet from a pair of bets and subsequently bid more for the bet they did not choose. The frequency of such reversals varied somewhat as experimental conditions changed, but was always far greater than could be explained by unreliability alone. Similar results have recently been found by Lindman (1971).

These reversals clearly constitute inconsistent behavior and violate every existing theory of decision making. For example, subjectively expected utility theory (Edwards, 1955) postulates both a subjective probability function and a subjective worth function, but does not allow either function to change its shape as the response mode changes. Bids and choices should both be predictable from the same functions; reversals are therefore impossible under the model.[5]

The present results imply that attempts to infer subjective probabilities and utility func-

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[5] This statement is not strictly true for B bids. When S offers a B bid for the bet, the utility of this bid cannot be directly equated to the expected utility of the bet. Rather, when a bid of b is given to a bet with outcomes X and Y, the utilities of the quantities (X − b) and (Y − b) are relevant. In a choice situation, however, the utilities of X and Y are relevant. Thus reversals could occur with suitably chosen utility curves (Raiffa, 1968, pp. 89–91). Utility theory does not, however, help one understand why there were *more* predicted reversals in the present study with S bids (where reversals are normatively impossible) than with B bids (where reversals are normatively permitted).

tions from bids or choices should be regarded with suspicion. Since these subjective factors are not the sole determiners of decisions, inferences about them are likely to vary from one response mode to the next, because of changes in the decision processes used by Ss.

What are the different decision processes that underly bids and choices? The mechanisms determining choices are not clear, but it must be kept in mind that in paired comparisons each attribute of one bet can be directly compared with the same attribute of the other bet. There is no natural starting point, and S may be using any number of strategies to determine his choice. Tversky (1969) has given several examples of such strategies.

In contrast, bidding techniques provide an obvious starting point: the amount to win. Evidence from the present experiments, as well as from the previous study by Slovic and Lichtenstein (1968), indicates that the S who is preparing a bidding response to a bet he sees as favorable starts with the amount to win and adjusts it downwards to take into account the other attributes of the bet. The amount to win translates directly into an amount to bid. However, the probabilities of winning and losing, presented in probability units, are more difficult to translate into monetary units. In trying to adjust his bid to take into account this more complex information, S is not very precise. Some Ss simply subtract a constant from the amount to win. Others multiply·the amount to win by the probability of winning, entirely disregarding the amount to lose. All such schemes produce bids that are highly correlated with amount to win but poorly reflect the variations in probabilities and amount to lose.

The P bets of the present study offered such high probabilities of winning that their modest winning amounts needed to be adjusted downward only slightly to take the other factors into account when bidding. In contrast, the $ bets offered only a modest chance to win a large amount of money. Thus Ss should have made a sizable downward adjustment of the amount to win when bidding for these bets. Their failure to do so led them to bid more for the $ bet than for the corresponding P bet. This, in turn, led to bids which often did not match their choices. Predicted reversals are thus seen as a consequence of the differing evaluation techniques used in the two tasks.

Is the behavior of Ss who exhibit reversals truly irrational? Tversky (1969) posed a similar question about Ss in whom he had induced systematic intransitivities, and for the following reasons answered it in the negative. He noted that *it is impossible to reach any definite conclusion concerning human rationality in the absence of a detailed analysis of the cost of the errors induced by the strategies S follows as compared with the cost to S of evaluating alternative strategies.* The approximations Ss follow in order to simplify the difficult task of bidding might prove to be rather efficient, in the sense that they reduce cognitive effort and lead to outcomes not too different from the results of optimal strategies. In using such approximations, the decision maker assumes that the world, unlike the present experiments, is *not* designed to take advantage of his approximation methods.

In sum, this study speaks to the importance of information-processing considerations too often neglected by decision theorists. The reversal phenomenon is of interest, not because it is irrational, but because of the insights it reveals about the nature of human judgment and decision making.

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