Gain, cost, and event probability as determiners of choice behavior¹

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Abstract

Differential gain, cost, and event probability were varied in a two-choice situation. Increases in the gain associated with a correct response, increases in the probability of being correct, and decreases in the cost of an incorrect response all result in increases in the probability of that response. Gain had a greater effect than cost, but both variables became less effective as event probability increased. Changes in these relationships were noted as a function of trials.

Introduction

The present study was designed to investigate the effects of differential gains and costs in a two-choice situation. "Differential" means that the gain resulting from a correct decision was a function of which choice had been made; similarly, the cost of an incorrect choice depended upon the choice. The results of studies of differential gains (Edwards, 1956; Taub & Myers, 1961) and of differential gains and costs (Myers et al., 1961) suggest that the asymptotic probability of making the response with the highest expected value (EV) is correlated with the difference in expected values (ΔEV) associated with the two responses. The acceptance of this conclusion must be qualified by noting that none of these investigations involved more than 150 trials. In a more recent experiment, with more trials and equal event probabilities, Katz (1964) investigated the effects of nine different cost-gain combinations. He concluded that the ΔEV rule does not account for the rank ordering of choice probabilities across conditions. The present study extends Katz's research to two additional levels of event probability, and should therefore test the generality of his findings regarding gain-cost combinations.

Method

The probability of the more frequent event (π), and gain

(G) and cost (C) associated with the A_1 response (prediction of the more frequent event, E_1) were combined factorially. Eight groups of 24 Ss were run, representing all combinations of π 's of .6 and .8, G's of 1 and 4 units, and C's of 1 and 4 units. Gain and cost associated with A_2 were each 1 unit for all experimental groups. All Ss began the experimental session with a stake of 100 units, redeemable at .25¢ per unit. They were informed of their payoff condition and were told to predict which of two lights would occur on each trial, and to record their gains and losses during the session. The Ss were run in groups of three and four (but separated by partitions) for 300 trials, each of 10 sec. duration.

Results and Discussion

Table 1 presents $P(A_1)$, the probability of predicting E_1 , the more frequent event. $P(A_1)$ increases as π , the probability of E_1 , increases, as the gain associated with a correct A_1 response increases, and as the cost of an incorrect A_1 response decreases. Despite the fact that the variation in actual monetary amounts is quite small, the effects of π , G, and C are all highly significant ($df = 1, 184$; F 's = 181.60, 89.69, and 29.33, respectively; $P < .001$). Of greater interest are the first order interactions. Manipulations of either cost or gain are far less effective when π equals .80. The $C \times \pi$ interaction is significant at the .05 level ($df = 1, 184$; $F = 5.32$) and the $G \times \pi$ interaction is significant at the .01 level ($df = 1, 184$; $F = 16.13$). At both π levels, increases in cost have a considerably greater effect on $P(A_1)$ when the gain is only one point than when it is four points. This $G \times C$ interaction is significant at the .05 level ($df = 1, 184$; $F = 4.52$).

Katz's conclusion that ΔEV is of limited value as an index of response probability is supported at the new π levels investigated in the present experiment. Within

Table 1
 $P(A_1)$, the Probability of Predicting E_1 , the More Frequent Event, for Each Block of 50 Trials, and ΔEV

π	Gain	Cost	Trials						ΔEV
			1-50	51-100	101-150	151-200	201-250	251-300	
.6	1	1	.528	.539	.527	.547	.610	.626	.40
.6	1	4	.384	.388	.384	.368	.368	.357	-.80
.6	4	1	.645	.756	.772	.794	.803	.813	2.20
.6	4	4	.593	.673	.654	.690	.683	.717	1.00
.8	1	1	.633	.802	.851	.909	.923	.929	1.20
.8	1	4	.568	.708	.751	.798	.822	.819	.60
.8	4	1	.761	.911	.917	.915	.937	.948	3.60
.8	4	4	.704	.878	.893	.914	.937	.933	3.00

each level of π , Δ EV correctly rank orders the values of $P(A_1)$, but the fact that all .80 groups are above .60 groups is not consistent with the Δ EV values of Table 1.

In one respect, the present findings differ from those of Katz. While Katz found that the variances due to cost and gain were similar, and that the two variables did not interact, in the present study gain has a greater effect than cost, and the variables do interact in the manner noted above. The single and joint effects of the two payoff variables are apparently different at a π value of .5 than at π values of .6 and .8.

The relationships among values of $P(A_1)$ for the four payoff conditions at .8 are quite different after 300 trials than after 100 or 150 trials, as evidenced by the significant $T \times \pi$ ($df = 5, 920$; $F = 15.44$; $P < .001$) and $T \times G \times \pi$ ($df = 5, 920$; $F = 7.40$; $P < .001$) interactions. This provides some explanation of why the earlier studies (Taub & Myers, 1961; Myers et al., 1961) resulted in somewhat different trends, particularly with respect to

Δ EV, than Katz's study or the present one.

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Comment

The paper by Longo, Klempay and Bitterman, "Classical Appetitive Conditioning in the Pigeon" (*Psychon. Sci.*, 1964, 1, 19-20) raises a basic question: What criteria must a conditioning situation meet to qualify as *classical* conditioning? Is the lack of contingency between response and administration of reinforcement adequate to identify a classical conditioning experiment? For reasons developed elsewhere (Kimble, G. A. *Hilgard and Marquis' Conditioning and Learning*, Appleton-Century-Crofts, 1961) I believe that the answer to this question is *no* and that classical conditioning applies only to responses of the sort which Skinner called elicited and the layman calls involuntary.

On this basis it seems unlikely that the study by Longo et al., involved a classical conditioning experiment. The responses conditioned were not described in detail, but the authors themselves note that "much of the activity that develops in the appetitive situation may be instrumental in character—a product of adventitious reinforcement." This point is convincing. Indeed it cannot be ruled out that everything *recorded* in the experiment

was behavior of this "superstitious" variety.

This interpretation raises a second basic question: Do experiments on instrumental conditioning have any relevance to the CS-US interval function which was the object of investigation in the study in question? It seems to me that there is probably no connection except indirectly. A two process theory of such learning would posit the development of (largely unmeasured) classical CRs simultaneously with the establishment of the superstitious instrumental responses actually observed. Even if one chooses to make this assumption, however, there is no evidence that the instrumental behavior measured in such experiments provides a good index of the measured classical CR.

These considerations urge caution in referring to an experiment as classical conditioning just because there is a non-contingent relationship between CR and reinforcement. Especially in the titles of articles it seems to be important to reserve the expression, "classical conditioning" for experiments where that designation is less open to question.

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