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SPREAD OF EFFECT OF REWARD AND PUNISHMENT IN A MULTIPLE CHOICE SITUATION[1]

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It is generally agreed among psychologists that an "empirical" law of effect operates in learning. It is well known that such consequences as the obtaining of food or shock determine to a large extent the final product of the selective and eliminative processes that obtain in the learning situation (2). Just *how* these consequences strengthen or weaken responses has been the subject of much research and even more verbal polemics. But all competent observers in the field will agree on the empirical fact: the consequences of connections between psychological events which satisfy the prevailing motivating condition strengthen directly the connections they follow (4).

In the earlier statements of Thorndike's law of effect, the results of punishment were assumed to be opposite to those of reward. That is, they supposedly weakened the connections they followed. It is now believed, however, that the action of punishment is not the precise converse of that of reward. Indeed, punishment *per se* has little or no effect upon a response. It may lead to an improvement of performance in the learning situation, but only in so far as it forces the subject to vary his response and thus increases his chance of discovering the correct one.

It must not be thought that this formulation has met with universal approval. Instances of disagreement in the psychological literature upon this point are legion. We need not detail them here, but we may strongly urge that "the action of punishment is a subject urgently needing additional research" (3).

Most of the evidence for a law of effect stems from a large number of experiments by Thorndike and his students (1, 6, 7, 8, 9, 10, 11, 12). In pursuing the proof of this law, Thorndike has evolved a methodology which makes the effects of the consequences of responses particularly amenable to experimental analysis. The typical Thorndikean experiment is one in which a situation is presented to the subject to which he has the option of several response. For instance, he may be presented with the word "laugh", and may be told that some number from one to ten constitutes the correct response to that word; he is to discover the

1. This study was carried out under the direction of Professor A. W. Melton of the University of Missouri.

correct response on the basis of the designation of his guesses by the experimenter as "right" or wrong". The subject makes some response, the after-effect follows, and then another situation is presented—in this instance, another word—and the same procedure is repeated. The number of the situations is usually large enough to preclude the learning of the correct response to every situation in a single repetition. After all the situations have been presented, the subject starts over. Learning is measured by a trial-to-trial comparison of the responses to each situation.

Among the phenomena adduced by the experimental attack on the law of effect has been the so-called "spread of effect." In interpreting this phenomenon, Thorndike has formulated the hypothesis that a satisfying after-effect strengthens not only the connections leading to it, but also other punished connections which are contiguous to the rewarded one. This gradient of the reinforcing effect of reward extends in both directions temporally from the moment of reward. Thus, responses occurring both before and after a reward are strengthened in inverse proportion to their distance in the series from that reward.

There has been at least one study (5) whose results argue a comparable spread of the effect of punishment upon contiguous responses. And the study reported in this paper represents, in part, an experimental attack upon that problem as well as upon certain other problems implied in the above discussion.

The experimental situation was a punchboard maze. It consisted of thirty-five groups of holes arranged in a spiral pattern on a piece of bakelite a foot square. Each group was in the form of a hexagon, with a hole at each of its vertices. The thirty-five groups of holes were analogous to thirty-five items in a verbal multiple-choice test, to each of which there were six possible responses. The subjects were instructed to learn which of the six holes in each group was the correct one. Their responses consisted of the insertion of a stylus into the selected hole.

The signals "right" and "wrong" following the subject's response were given according to a prearranged pattern. Thus, any response in a particular group was always "right" or "wrong", regardless of the particular hole punched. In this manner, it was possible to distribute the successful and unsuccessful responses in a definite order. It was this pattern of designation of the responses which differentiated the two conditions of the experiment: the "spread of reward" condition contained five successful responses, each of which was preceded and followed by several un-

successful ones; and the "spread of punishment" condition contained five unsuccessful responses, each one preceded and followed by several successful responses. The entire series was repeated six times for both conditions. Thirty-six subjects were run under each condition; and the equality of the two groups was demonstrated by their average performance on a preliminary practice-day problem.

In the spread of reward condition it was found that following a single occurrence of a reward the rewarded response was repeated most often. However, punished responses proximal to the reward were also repeated, in inverse proportion to the number of steps they were removed from the reward. Furthermore, additional rewards progressively strengthened the response they followed, though at a negatively accelerated pace. Thus two rewards were not twice as efficacious as one, and so on.

The proportion of repetitions of rewarded responses and that of proximal responses one, two, three, and four steps removed in the series from a reward are given in Table 1.

Table 1. Proportional Frequency of Rewarded Responses and of Punished Responses Before and After a Reward When When They Are Repeated One, Two, and Three Times.

	Punished Connections Preceding			Rewarded Connections	Punished Connections Following			
	-3	-2	-1		+1	+2	+3	±4
Connections Repeated Once								
N	144	144	180	180	180	180	180	36
%	13.2	16.0	20.0	45.6	21.1	15.6	15.6	13.9
Connections Repeated Twice								
N	19	23	36	81	38	28	28	5
%	26.3	8.7	33.3	55.6	15.8	7.1	17.9	60.0
Connections Repeated Three Times								
N	5	0	12	45	6	0	5	0
%	20.0	0	25.0	73.3	50.0	0	20.0	0

These data reveal, besides the empirical fact of spread, the fact of the progressive strengthening of the rewarded response with successive occurrences of the reward. Rewarded responses which occurred four times were repeated 87.9% of the time on the fifth trial; and these, in turn, were repeated 93.1% of the time on the sixth and last trial.

Table 2 reveals the percentage of repetition of punished responses, and of the rewarded responses proximal to them, on successive trials under the spread of punishment condition.

Table 2. Proportional Frequency of Punished Responses and of Rewarded Responses Before and After Punishment When They Are Repeated One, Two, Three, Four, and Five Times.

	Rewarded Connections Preceding				Rewarded Connections Following			
	-3	-2	-1	Punished Connection	+1	+2	+3	±4
1 Repetition								
N	143	144	180	180	180	180	178	38
%	46.2	36.8	45.6	37.2	45.0	50.6	45.5	39.5
2 Repetitions								
N	66	53	82	67	80	91	81	15
%	68.2	75.5	72.0	52.2	62.5	68.1	69.1	73.3
3 Repetitions								
N	45	40	59	34	50	62	56	11
%	84.4	85.0	83.1	76.5	86.0	80.6	89.3	81.8
4 Repetitions								
N	38	34	49	26	42	50	50	9
%	94.7	88.2	87.6	69.2	85.7	90.0	94.0	100.0
5 Repetitions								
N	36	30	42	17	35	45	46	9
%	97.2	96.7	97.6	82.4	88.6	97.8	97.8	100.0

These results, it is evident, do not clearly reveal the fact of the spread of the effect of punishment. Thus rewarded responses closer to a punished response were not thereby unambiguously depressed more than those further away from such punishment. Nor was the punished response itself depressed as a result of the punishment. On the contrary, the punished response, as well as the rewarded responses proximal to it, actually gained strength with successive trials, and, of course, successive punishment.

One further aspect of these results deserves mention. This study has demonstrated the fact of spread of effect of reward, that is, a tendency to repeat the *same* response less often, as a function of its increased distance from the reward. Further analysis revealed that there was, in fact, a positive tendency to respond to holes spatially more removed from those responded to previously, as a function of the distance between the specified situation and the removed one. In other words, spread of effect of reward involved not only a greater variability of response in an all-or-none fashion with greater distance from a reward, but the actual extent of that

change, interms of spatial difference, was greater. The comparable analysis for the spread of effect of punishment revealed no such unequivocal tendency.

Conclusion

The theoretical formulation which denies comparable and opposite functions to punishment and reward was substantiated in this study. The phenomenon known as spread of effect obtains for reward, but the weakening effect of a punishment upon the response preceding it or upon contiguous rewarded responses is not demonstrated to be an empirical fact.

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