Delay of reinforcement gradients in children's learning¹

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Abstract

Ninety Grade 2 children were randomly assigned to one of nine conditions in a study of the effects of concurrent delay of reward and delay of punishment on children's learning. Three levels of delay of reward and three levels of delay of punishment, 0, 10, and 30 sec. in each case, were selected for study. Both increasing delay of reward and increasing delay of punishment significantly increased the number of errors made during learning.

Problem

Experimental studies with children (Hockman & Lipsitt, 1961; Lipsitt & Castaneda, 1958; Lipsitt et al., 1959) have indicated that performance on discrimination and choice tasks becomes increasingly poorer with increasing delay of reward, at least over the brief time intervals that have so far been investigated. Evidence of an analogous delay-of-punishment gradient has so far been obtained only from animal studies in which electric shocks have served as punishments (e.g., Kamin, 1959). In view of the theoretical significance of delay-of-punishment effects (Church, 1963; Mowrer, 1960) and their implications for child-training and educational practice, it seems important to determine whether these effects also characterize human learning.

In many learning situations, in which children must learn to make a correct sequence of responses and avoid alternative incorrect sequences, learning proceeds through the concurrent reward of correct, and punishment of incorrect, responses. In a preliminary study of delay-of-reinforcement effects, Setterington & Walters (1964) simultaneously manipulated both delay of material reward and delay of material punishment in a factorial design employing three levels of delay (0, 10, and 20 sec.) for both reward and punishment. Although the study failed to yield a significant main effect for delay of punishment, there were trends in the data that suggested that a gradient might have been obtained if the number of subjects had been larger or a longer delay interval had been used. This paper reports an approximate replication of the Setterington & Walters study; a 30-sec. delay interval was substituted for the 20-sec. interval, and the number of subjects was slightly increased.

In the child-training literature, "punishment" has been used to cover a variety of disciplinary procedures involving both the presentation of aversive stimuli and the withdrawal or withholding of positive reinforcers. In this study, these "punishment" procedures were combined, with the presentation of a presumably aver-

sive stimulus, a loud unpleasant buzzer, serving as part of the signal for the child to give up a positive reinforcer.

Procedure

Ss were 90 Grade 2 boys, with a mean age of 7 years 11 months. They were divided into nine groups, with ten Ss in each group, in a 3 x 3 factorial design employing three levels of delay of reward and three levels of delay of punishment (0, 10, and 30 sec. in each case).

The apparatus has been described in detail by Setterington and Walters (1964). The front panel, facing S, contained three white lights, numbered 1 to 3 from left to right. Below each light was a toggle switch with a spring return that permitted S to blink the lights immediately above it. A rectangular frosted-glass window, screening two signal lights (one green and one red) had been added to the original apparatus. The rear panel contained three lights (corresponding to the three white lights on S's panel) that informed E of S's response and levers that enabled E to present "correct" or "incorrect" signals at varying delay intervals.

A female E took S to the experimental room, where he was permitted to select a toy, which he was told he would receive if he did well enough at a game he was about to play with E. After S had been shown how to work the equipment, he was told that E would switch on all three lights and that his task was to blink two of the lights, one after the other, in the correct order. S was further told that if he blinked the correct lights in the correct order, he would see a green light and hear a bell sound (demonstrated) and that these were signals for him to take a hockey coin from a box that was placed in front of him. However, if he blinked a wrong light or blinked the lights in the wrong order, he would see a red light and hear a buzzer (demonstrated), which were signals for him to give up one of his coins to E. It was emphasized that S would receive a prize only if he finished the game with a large enough pile of coins. Trials were continued, using a noncorrection procedure, until S had made five successive correct responses or had completed 80 trials. The "correct" sequence of lights was varied from S to S, but was balanced over groups.

Results and Discussion

A summary of results, in terms of mean number of errors on the learning task, is provided in Table 1. An analysis of variance yielded significant main effects for both delay of reward and delay of punishment (F , 4.03 and F , 4.44, respectively; $p < .025$ in each case) and an interaction effect that approached significance (F , 2.05; $p < .10$).²

Table 1. Group Means and SDs for Errors^a

		Delay of Reward Interval					
		0 sec.		10 sec.		30 sec.	
		Mean	SD	Mean	SD	Mean	SD
Delay of Punishment Interval	0 sec.	12.6	10.4	14.6	11.3	27.2	18.6
	10 sec.	17.3	12.3	27.5	20.7	32.9	25.4
	30 sec.	21.9	20.1	51.5	24.8	29.6	26.6

^a For each cell, $n = 10$

The factorial delay-of-reward vs. delay-of-punishment design has one possible disadvantage. Whenever asymmetrical delay-of-reward and delay-of-punishment intervals are paired, knowledge of results may attenuate the effects of delaying material rewards and punishments. For example, when a zero delay interval is used for punishment and a 10- or 30-sec. delay interval is used for reward, the omission of a punishment, at least after the first few punished and rewarded trials, may immediately provide the child with information that he is shortly to be rewarded. However, both the data reported by Setterington & Walters (1964) and those reported in this paper reveal delay effects that appear to be relatively independent of knowledge of results. For example, Table 1 indicates that learning was somewhat poorer under both the asymmetrical 10-30 delay conditions than under the 30-30 delay condition. Moreover, there are indications of rather consistent delay effects across the zero- and 10-sec. delay-of-punishment rows and across the zero- and 10-sec. delay-of-reward columns. One must therefore conclude either that knowledge of results was not the only important determinant of learning or that the omission of a reward or punishment failed to provide adequate knowledge of results.

Although Ss in the 30-30 group performed better than Ss in the 10-30 groups, mean scores for the 30-30 Ss were somewhat larger than those for 10-10 Ss and considerably larger than those for 0-0 Ss. Learning may have been more difficult when asymmetrical delay intervals were employed, possibly on account of the non-coincidence of knowledge of results and the dispensing of material reinforcers. This possibility will be explored in future studies by means of a modified delay-of-reinforcement apparatus that permits independent manipulations of the timing of the occurrence of material rewards and punishments and the timing of knowledge of results.

Church (1963) has classified theories of punishment into two major groups: those not necessarily involving the correlation of response and punishment and those

necessarily involving such a correlation. As Church points out, "if the contiguity between response and punishment is a parameter of consequence, then there should be a delay of punishment gradient" (p. 378). The significant main effect for delay of punishment obtained in this study may be interpreted as supporting theories of punishment that assume that response suppression is most effectively achieved when punishment is contingent on the occurrence of the response.

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Notes

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2. An analysis of variance of trials to criterion yielded a very similar pattern of results.