RESPONSE COST AND THE AVERSIVE CONTROL OF HUMAN OPERANT BEHAVIOR[1]

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The effects of cost (point-loss per response) upon human avoidance, escape, and avoidance-escape behavior maintained by PLPs (point-loss periods) were investigated. Cost had a marked but differentially suppressive effect upon responding under all schedules. The greatest number of PLPs taken under cost occurred on the escape schedule. In most instances PLPs were more frequent on the avoidance-escape schedule than on the avoidance schedule under cost. Inferior avoidance performance appeared only under cost conditions. Under no-cost, all subjects (*Ss*) successfully avoided all PLPs after the first hour of conditioning. These results indicate that the development and maintenance of human avoidance and escape behavior may, in part, be dependent upon response cost conditions. Aversive control of human operant behavior may be limited without an adequate specification of response-cost conditions.

In a previous study (Weiner, 1962a), response cost (point-loss per response) was found to be an important determiner of "characteristic" and "deviant" performance under a fixed-interval (FI) schedule of positive reinforcement (acquisition of points via critical signal detections). The present study was concerned with the effects of response cost upon human avoidance, escape, and avoidance-escape behavior maintained by a fixed temporal aversive event (point-loss periods). An avoidance response may be defined as a response emitted in the absence of an aversive event which *postpones* the aversive event for a period of time. A response emitted in the presence of an aversive event which *terminates* the aversive event for a period of time is called an escape response.

METHOD

Subjects

Subjects S9, S11, and S13 were three male humans (aged 34, 18, and 19 respectively); subjects S10 and S12 were two female humans (21 and 18 years old respectively). The *Ss* were paid $4.00 for the first hour of testing and $1.50 for each additional testing hour of each day.

Apparatus and Task

The *Ss* were seated alone in an experimental room facing a display mounted on a Par Metal Triple Assembly Console. This display consisted of two rows of In-Line Digital readouts. The top row contained five readouts which were employed as an electronic counter. The counter could add or subtract any number from 1 to 99,999. The bottom row consisted of two readouts which presented S^Ds for the avoidance, escape, and avoidance-escape schedules under the different cost conditions and an S^D during the aversive events.

The *Ss* began each 1-hr session with a maximum score (*i.e.*, 99,999) showing on the counter. Their task was to keep this score as high as possible by pressing a microswitch key (with a force of approximately 20 g through a distance of 1 cm). Continuous depression of the key had no effect on the programmed experimental contingencies. Repeated responses required repeated closures of the microswitch key.

Transistorized digital elements and networks (Weiner, 1963) were used to program the aversive contingencies and response cost

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conditions. Responses were recorded continuously on a Gerbrands cumulative recorder.

Procedure

The key presses of the *S*s were conditioned initially on a three-ply multiple schedule without cost (no point-loss per response). The components of the three-ply schedule were as follows: a 20-min avoidance schedule presented in the presence of a solid red circle; a 20-min escape schedule presented in the presence of a solid green circle; a 20-min avoidance-escape schedule presented in the presence of a solid orange circle. The presentation order of each component was randomized from session to session.

Under the avoidance schedule, a 20-sec "point-loss period" (designated PLP), during which 86 points were subtracted one at a time from the score on the counter, was scheduled every 10 sec (PLP-PLP interval = 10 sec) unless the *S* pressed the key. Key presses emitted within 10 sec, from either a previous key press or the termination of a PLP, postponed the next PLP for 10 sec. (Using Sidman-type terminology, where a key press is designated R, the avoidance contingency can be specified as follows: R-PLP = PLP-PLP = 10 sec.) Key presses emitted during a PLP had no effect on the PLP. Thus, *S*s could avoid (postpone) the PLP but could not escape (terminate) it once it had been initiated. A large red square (S^D) remained on during PLPs in addition to the S^Ds associated with the aversive schedules and cost conditions. It was extinguished when the PLP terminated.

For the escape and avoidance-escape schedules, the interval between PLPs was also 10 sec (PLP-PLP = 10 sec). Under the escape schedule, key presses emitted in the absence of a PLP did not postpone the next PLP. However, key presses made by the *S*s during a PLP terminated the PLP for 10 sec. Thus, under the escape schedule *S*s could not avoid PLPs but could escape them. In the avoidance-escape schedule, *S*s could either avoid (postpone for 10 sec) or escape (terminate for 10 sec) the PLPs. The amount of points lost during PLPs under the escape and avoidance-escape schedules depended upon the latency of the escape response (*i.e.*, the time interval between the onset of a PLP and the escape response). A rapid escape response could occasionally terminate a PLP without point-loss

After 4 hr of conditioning under no-cost, the three-ply schedule was subdivided into a six-ply schedule by introducing a 10-min cost period, in which one point was subtracted for each key press, during each 20-min component. The components of the six-ply multiple schedule were therefore as follows: a 10-min no-cost avoidance schedule; a 10-min cost avoidance schedule; a 10-min no-cost escape schedule; a 10-min cost-escape schedule; a 10-min no-cost avoidance-escape schedule; a 10-min cost avoidance-escape schedule. The presentation order of the avoidance, escape, and avoidance-escape schedules was randomized from session to session. The no-cost condition preceded the cost condition under all schedules.

The S^Ds presented for the no-cost three-ply schedule were associated with the same no-cost schedules under the six-ply schedule. The 10-min cost components of the six-ply schedule were also associated with particular S^Ds as follows: avoidance-cost was presented in the presence of a solid white circle; escape-cost was presented in the presence of a solid yellow circle; avoidance-escape cost was presented in the presence of a solid blue circle.

The *S*s were conditioned for 5 hr on the six-ply multiple schedule (except for S11 who quit the program after the fourth hour). All *S*s were tested for three 1-hr experimental sessions daily.

Instructions

At the beginning of the first hour of conditioning the following instructions were read:

"Your task is to keep the score on the counter as high as you possibly can. This can be accomplished only by pressing and releasing this key (Experimenter indicates) in some fashion. Holding down this key will not enable you to get a high score. You must immediately release the key each time you press it. You will start this session with the highest score you can get, that is, 99,999 points. Try to keep as many of these points as possible. Remember, the higher your score, the better your performance.

"From time to time there will be different conditions. Do not think that the machine is broken or not functioning properly. If the machine does break, I will know about it and will tell you that such is the case.

Under some conditions, you will do better, that is, get a higher score, than under others. In fact, under some conditions you may be below zero in your score. This means that you have lost *more* than the 99,999 points given to you at the start of the session. Just try to get the highest score you can under all conditions."

At the beginning of each session, *S*s were told to "keep the score as high as possible." They received no other instructions.

RESULTS

Figures 1 through 3 show the effects of cost upon avoidance, escape, and avoidance-escape behavior conditioned under no-cost. These figures present the cumulative response curves for S9 and S12 during the fifth hour of six-ply conditioning and for S11 during the fourth hour of six-ply conditioning. The response curves of the other two *S*s tested were similar to S9 and S12. The average response rates for all five *S*s during the last two sessions

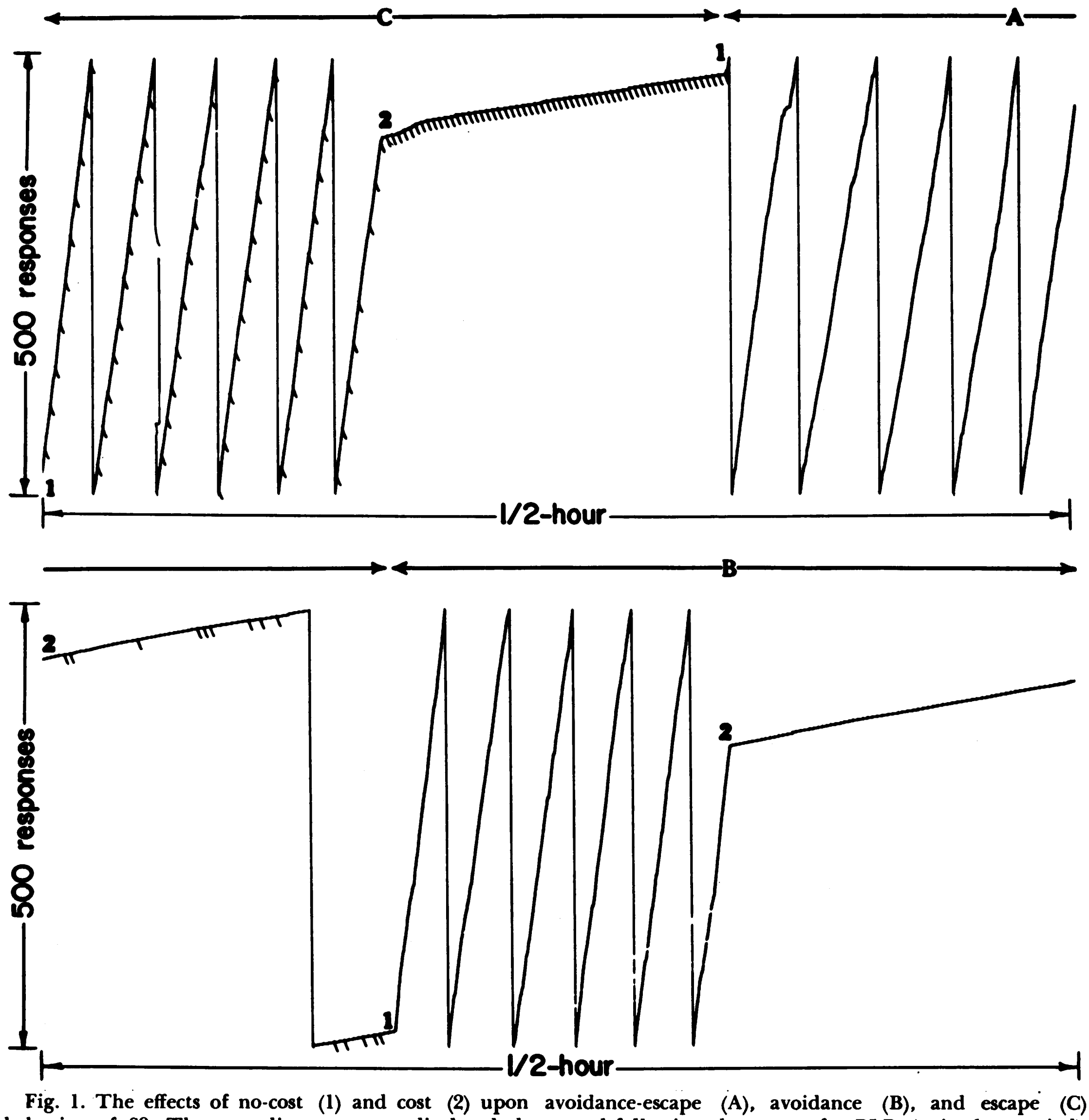

Fig. 1. The effects of no-cost (1) and cost (2) upon avoidance-escape (A), avoidance (B), and escape (C) behavior of S9. The recording pen was displaced downward following the onset of a PLP (point-loss period). While displaced, the pen continued to make a cumulative record of responses. The pen reset following termination, either by the subject or the programing equipment, of the PLP.

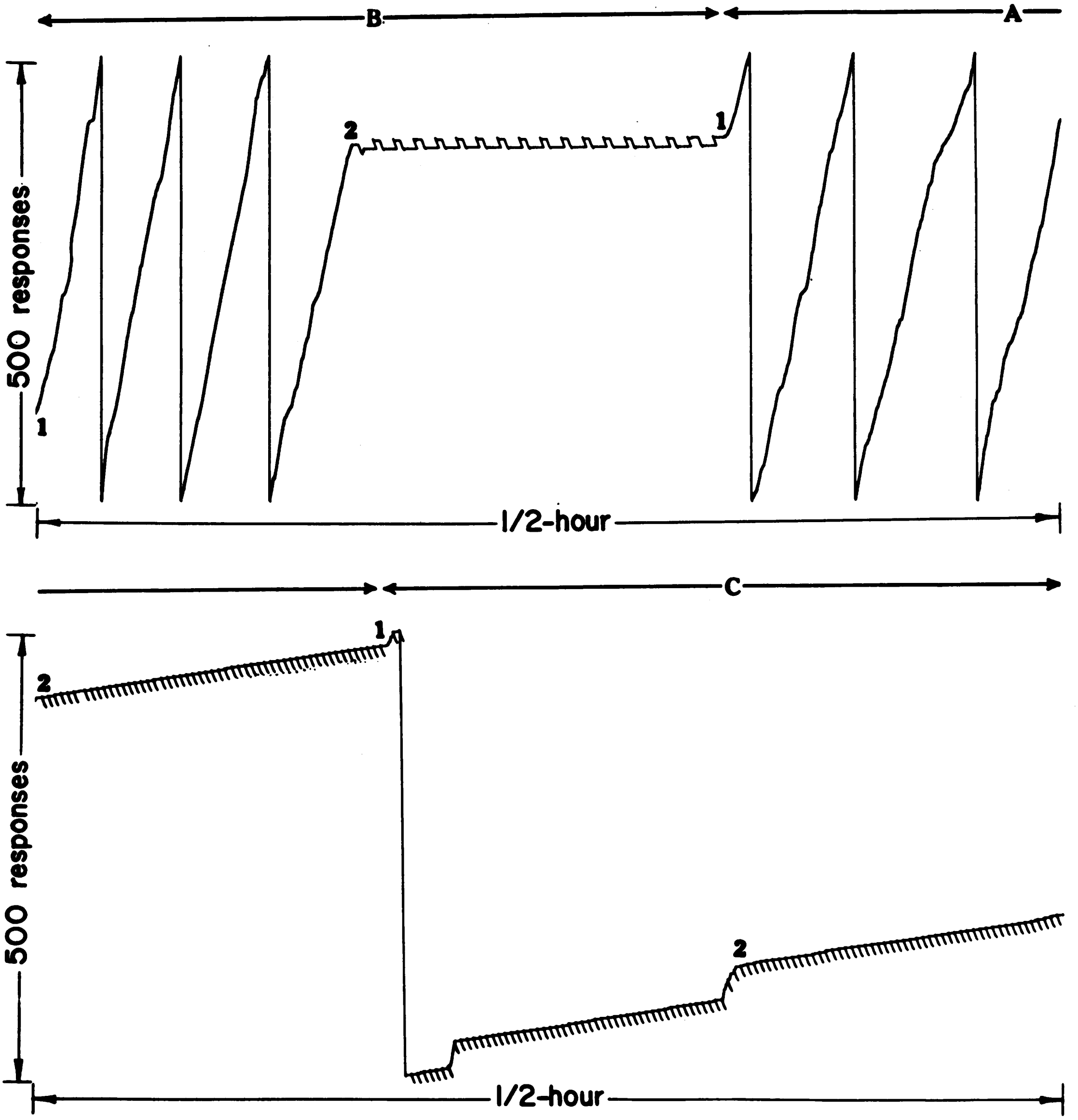

Fig. 2. The effects of no-cost (1) and cost (2) upon avoidance-escape (A), avoidance (B), and escape (C) behavior of S11. See Fig. 1 for details of the recording technique.

on the six-ply schedule are presented in Table 1.

All *S*s successfully avoided all PLPs under no-cost on the avoidance and avoidance-escape schedules. Successful avoidance was attained usually by the end of the first hour of three-ply (no-cost) conditioning. Intra-subject avoidance rates under the avoidance and avoidance-escape schedules were remarkably similar despite differences in the aversive contingencies. An "unnecessarily" high steady avoidance rate characterized no-cost performance under both schedules.

No-cost escape performance varied across *S*s. Inter-PLP responding was characterized by high constant rates which were similar to their respective no-cost avoidance and avoidance-escape rates (Fig. 1), relatively low rates and flat scalloping patterns (Fig. 2), and intermediate rates and deep scalloping (Fig. 3). All *S*s, however, emitted some responses between PLPs on the escape schedule under no-cost

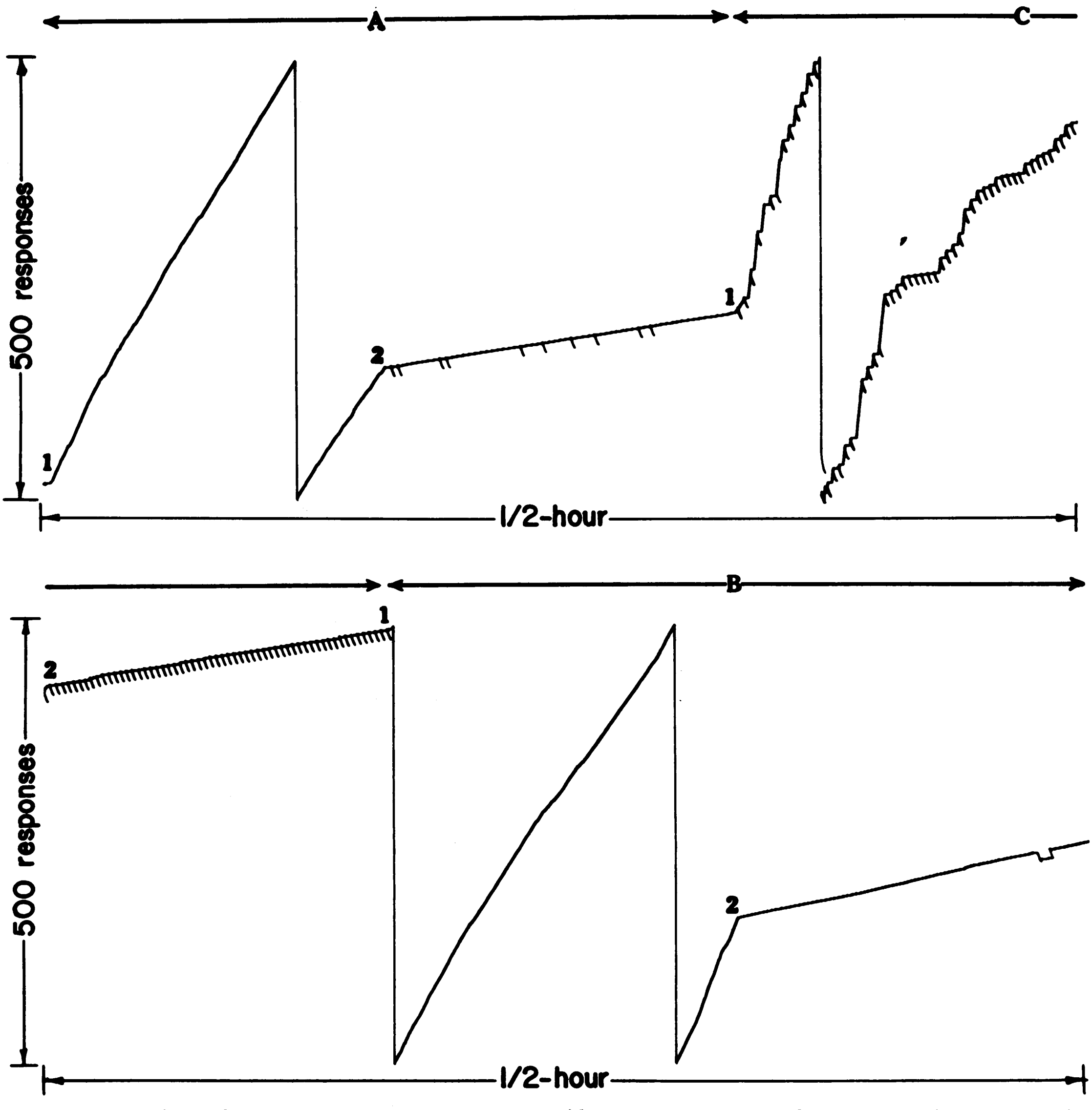

Fig. 3. The effects of no-cost (1) and cost (2) upon avoidance-escape (A), avoidance (B), and escape (C) behavior of S12. See Fig. 1 for the details of the recording technique.

despite the fact that these responses did not affect the occurrence of PLPs (*i.e.*, went unreinforced).

In all cases, cost response rates were lower than their respective no-cost rates. Exposure to cost did not apparently affect the previously established no-cost rates. Reversibility of no-cost and cost performances was obtained under all schedules.

The degree of response suppression under cost appeared to depend upon the particular schedule involved. Under the escape schedule, cost removed almost all responses prior to the occurrence of a PLP. Under the avoidance and avoidance-escape schedules, cost attenuated responding (*i.e.*, avoidance responding) between PLPs, but did not (except for S11 on the avoidance schedule) eliminate it entirely. In most instances, more PLPs occurred (*i.e.*, there were more pauses longer than the inter-PLP interval) on the avoidance-escape schedule than on the avoidance schedule under cost. In other words, the *S*s tended to avoid PLPs more successfully on the avoidance schedule than on the avoidance-escape schedule under cost.

Table 1
Average Response Rates in Responses Per Min During Each Component of the Six-Ply Schedule

	Avoidance		*Escape*		*Avoidance-escape*	
	No-Cost	*Cost*	*No-Cost*	*Cost*	*No-Cost*	*Cost*
S9	287	8	290	7	253	7
S10	107	10	7	6	111	7
S11	192	1	44	6	150	6
S12	70	8	77	6	69	7
S13	325	8	280	7	301	8

NOTE: Each entry represents the mean rate (in responses per min) of the last two sessions on the condition indicated. The means have been rounded to the nearest whole number.

The majority of *S*s successfully avoided most of the 20 PLPs programmed during the 10-min cost period under the avoidance schedule. In contrast, S11 (See Fig. 2) failed to avoid almost all of the 20 PLPs programmed under cost on the avoidance schedule. Most of S11's responses throughout six-ply conditioning were made *during* the PLPs. Post-task interviews revealed that these responses represented attempts on the part of S11 to terminate (escape) the PLPs. These non-reinforced "escape" attempts diminished as six-ply conditioning continued, but did not extinguish entirely.

DISCUSSION

Under no-cost conditions, responding on all schedules was generally in excess of that required by the aversive contingencies. These excessive no-cost response rates were reduced to more appropriate levels under cost. Similar effects of no-cost and cost were reported previously for VI and FI schedules of positive reinforcement (Weiner, 1962a).

It is problematical whether or not the unnecessarily high no-cost response rates observed in this experiment are analogous to the high response rates typically found during the early stages of aversive conditioning with animals (Sidman, 1954). At present, it is merely possible to point out that: (1) no-cost avoidance and avoidance-escape performances remained relatively invariant after the first hour of conditioning, and (2) despite intersubject differences in response rates and patterns, no-cost escape performances did not show much intra-subject variation during the course of the experiment.

The rapid acquisition of avoidance responding under no-cost is consistent with the findings of Ader and Tatum (1961), who employed a brief electric shock as the aversive event in avoidance (no escape) schedules with human subjects. Contrary to the findings of these investigators, however, there were no failures to acquire effective avoidance responding under no-cost in the present study.

In this experiment, an avoidance "failure" appeared only under cost conditions. S11 failed to learn avoidance responding under cost on the avoidance schedule. This finding taken together with the high frequency of PLPs under cost on the avoidance-escape schedule suggests the possibility that response cost may be an important factor in the substantial number of *S*s who fail to acquire an instrumental avoidance response (Ader and Tatum, 1961) and in the extensive training often required for even ultimately "successful" avoiders (Meyer, Cho, and Wesemann, 1960). It may be, for example, that the frequently observed freezing-crouching patterns of animals, when electric shock is used to shape avoidance responding (Meyers, 1959), adds "physical costs" to responding which interfere with the development of avoidance behavior.

As a final point, the present study has demonstrated that the loss of points can be made an effective aversive event to maintain human avoidance and escape behavior. The frequency and amount (total or per-instance of loss) of point-loss can be specified precisely and made comparable both quantitatively and qualitatively to response cost conditions. Unlike electric shock or intense noise, point-loss does not have to be restricted in its intensity or duration because of the potential injury to the *S*s. Thus, for example, extended temporal analyses of "escape" responding when escape is impossible (as in an avoidance schedule) can be effected. Finally, the symbolic nature of point-loss makes it readily adaptable as a generalized reinforcer. Various types of reinforcers and/or amounts of reinforcement can, if necessary, be made contingent upon particular point scores.

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