

Reduction of instrumental discrimination performance by post-conditioning devaluation of discriminative stimulus: The effects of novelty in reinforcing outcome and extended training[☆]

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Abstract

In three experiments the effects of post-conditioning pairings of a discriminative stimulus (Sd) with an illness-inducing agent (lithium chloride, LiCl) on subsequent discrimination performance in extinction and consumption of reinforcing outcome were investigated. Rats were trained to choose a correct lever to obtain food pellets, with a light presented on a bulb just above the correct lever serving for the Sd on each trial. After achievement of a criterion of the discrimination, animals received paired or unpaired presentations of the Sds and LiCl injection. In Experiment 1, in which a familiar outcome was given throughout the discrimination training, Sd–LiCl pairings did not reduce either lever-press performance during presentation of the Sds or amount of consumption of outcomes. On the other hand, in Experiment 2 where a novel outcome was introduced in the final two sessions of the discrimination training, subsequent Sd devaluation reduced lever-press performance during presentations of the Sds. Similar findings were obtained in Experiment 3, in which animals were given extended discrimination training with introduction of novel outcomes in the final two sessions. These findings suggest that a representation of the outcome, evoked by presentation of the Sd, and illness were associated in the course of Sd–LiCl pairings but only when a novel outcome was used.

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1. Introduction

Many researchers have attempted to understand the associative structures that mediate responses acquired in the course of instrumental conditioning. According to [Adams and Dickinson \(1981a\)](#), for example, animals learn a descriptive relationship between events in the environment (which includes the animal's own behavior) in the form of response–outcome (R–O) associations, whereas the condition under which a behavior is to be performed is acquired as stimulus–response (S–R) association. The possibility of R–O associations in instrumental learning has received a lot of attention for at least two reasons. First of all, some authors have suggested that animals, like humans, can acquire the declarative knowledge of contingencies between

events ([Adams and Dickinson, 1981a](#); [Dickinson, 1980](#)). Secondly, R–O associations allow animals to control their environment in the service of their needs ([Dickinson and Balleine, 1994](#); [Balleine, 2001](#)).

One of the main sources of evidence for R–O associations comes from outcome revaluation studies. Typically, these experiments consist of three phases: (a) training of instrumental responses; (b) manipulations to change the value of one of the outcome events contingent on the instrumental responses (by means of a conditioned food aversion: e.g. [Adams, 1982](#); [Adams and Dickinson, 1981b](#); [Colwill and Rescorla, 1985a,b](#), or a conditioned flavor preference: [Rescorla, 1990](#), Experiment 2); (c) testing the effect of the second phase treatment on performance of the instrumental responses in extinction. Recent findings from these works have shown that instrumental responses in testing were modified in the direction proportional to the new value recreated for the outcome, suggesting that R–O associations are formed during initial training and mediate instrumental performances (see [Colwill and Rescorla, 1986](#); [Dickinson and Balleine, 1994](#), for reviews). It is worthwhile to note that these

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experiments demonstrate that animals can integrate two separate, but elemental-sharing associative structures established in the course of phases 1 and 2 (Adams and Dickinson, 1981a; Dickinson, 1980; but see also Balleine, 2001).

Early experiments that addressed these issues shared a feature that the recent studies do not possess, and now this feature could be seen as one of the causes of the contradictory results of these early works. These pioneers devalued the significance of *the stimuli correlated with the occurrence of the outcome*, whereas more recent studies have devalued that of primary reinforcing outcome itself. Original instrumental training given to subject animals in these early works varied from experimenter to experimenter: although Miller (1935) trained his rats to run in a simple straight alleyway, Tolman and Gleitman (1949) applied discrimination training in a T maze. Tolman (1933) also trained rats on a simultaneous black–white discrimination task in a runway. Lever pressing reinforced by water in an operant chamber was administered by Rozeboom (1957). Then, the stimuli that correlated with the occurrence of the outcome were subsequently devalued by presenting these stimuli alone or paired with electric shock; this was the goal box context in the studies of Miller (1935), Tolman (1933), and Tolman and Gleitman (1949), and a dipper operation for delivery of a reinforcing outcome in the experiments reported by Rozeboom (1957). Only in the studies including those of Miller (1935) and Tolman and Gleitman (1949) did devaluation of the stimulus correlated with outcome result in a decrease in performance of the instrumental response, thus providing evidence for integration of the associative structure established during the devaluation episode with the associative knowledge acquired during initial instrumental training.

Based on the results of these previous studies as well as their original findings, Wilson et al. (1981) argued that the discrepancy in the results of these “latent extinction” studies depends on the role of the outcome-correlating-stimuli to be devalued. According to them only if these stimuli have acted as a conditioned reinforcer in training stage before they are devalued, and presented again contingently on instrumental responses in the extinction test, successful reduction or attenuation of responses would be observed. It was Rozeboom (1957) who reported that post-conditioning devaluation of the stimulus had no effect on the instrumental performance in the extinction test unless the stimulus was presented contingently on lever pressing. On the other hand, devaluation of the stimuli that function only as a cue for discrimination (discriminative stimulus, Sd) in training would cause reduction of instrumental responses independently of whether or not the stimuli were presented contingently on the responses in testing. It was the case reported by Miller (1935) and Tolman and Gleitman (1949).

A study reported by Pearce and Hall (1979) would also relate to the prediction by Wilson et al. (1981). They showed that simple exposure to the operant chamber after training of lever pressing reduced its rate of the rats in comparison with a condition in which food outcome was made available during the exposure phase or no explicit treatment was given. Since no explicit Sds were presented in their study, the operant chamber context could be seen as functioning as the Sd. Then Pearce

and Hall’s (1979) findings suggest that Sd devaluation by means of simple exposure to it resulted in the reduction in instrumental responses. And now, further systematic assessment would be required which investigates the effects of devaluation of discrete Sd, which is explicitly established to set the occasion in which an instrumental response reinforced by an outcome (cf. Skinner, 1938), by means of paired presentations of it with an aversive event similar to the integration tests mentioned above.

The research reported here was aimed at investigating the effects of post-conditioning Sd devaluation with nausea induced by lithium chloride (LiCl) injection as a devaluating agent, which is often used in recent studies. In the first stage of the experiments, rats were trained to solve a simultaneous discrimination task with light stimuli signaling whose response would be rewarded by a food pellet on each trial. After the animals had reached a criterion level of performance, the Sds were paired with LiCl injection in the absence of the levers and the outcomes. Experiment 1 examined whether or not such devaluation resulted in reduction in instrumental discrimination performance in an extinction test, when compared with a condition in which Sd–LiCl unpaired presentations were given. In addition, consumption of the outcome pellets in animal’s home cage was monitored.

In Experiments 2 and 3, two factors that could possibly influence the results of the extinction and the consumption tests were investigated: the novelty of the outcome in Experiment 2 and the extensiveness of instrumental discrimination training in Experiment 3.

2. Experiment 1

2.1. Materials and methods

2.1.1. Subjects

The subjects were 16 naive male Wistar strain rats from the colony of Nagoya University, about 120 days of age at the start of the experiment. They were housed in individual cages and maintained on a food-deprivation regime that kept them at 85% of their ad libitum body weights throughout the experiment. They had free access to water in their home cages.

2.1.2. Apparatus

The apparatus was an operant chamber measuring 30.0 cm × 31.0 cm × 25.0 cm, located in a sound- and light-resistant experimental room. The two end walls of the chamber were made of aluminum, and the sidewalls and ceiling were made of clear acrylic plastic. The floor consisted of stainless steel rods, 0.5 cm in diameter and spaced 1.0 cm apart. On one end wall, three retractable levers, spaced 5.0 cm apart from each other, were mounted 6.0 cm above the grid floor. Located 6.0 cm directly above each lever were three lights (of the same, white color), each 1.5 cm in diameter, the illumination of which served as Sds. Throughout experimental sessions, this chamber was illuminated by a house light mounted 13.0 cm above the center Sd light. A metal feeder cup was situated in the center of the opposite end wall, 2.5 cm above the grid floor. Food pellets stored in an adjacent food dispenser were delivered to the cup via

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