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ACQUISITION OF A DISCRETE-TRIAL-OPERANT APPETITIVE RESPONSE IN RATS AFTER EXPOSURE TO RESPONSE-INDEPENDENT FOOD

by

ROBERT PHILIP PALESE

A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

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This manuscript has been read and accepted for the Graduate Faculty in Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

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ABSTRACT

ACQUISITION OF A DISCRETE-TRIAL-OPERANT APPETITIVE RESPONSE IN RATS AFTER EXPOSURE TO RESPONSE-INDEPENDENT FOOD

by

ROBERT PHILIP PALESE

Adviser: Professor William F. Oakes

Maier and Seligman (1976) have asserted that the presentation of uncontrollable (response-independent) aversive events produces the behavioral phenomenon "learned helplessness". According to Seligman (1975), the state of helplessness manifests itself as a reduced ability on the part of an organism subsequently to learn that purposive responses can produce favorable outcomes.

Although the authors proposed that the learned helplessness phenomenon was a general effect encompassing both uncontrollable noxious as well as non-noxious events, the plethora of learned helplessness experiments conducted using aversive stimulus outcomes (e.g., shock) has not been nearly matched by those carried out with positive stimulus outcomes (e.g., food). In fact, there is not a single study cited in the rat learning literature that employed a positive stimulus outcome in an experimental procedure like that of the typical learned helplessness research projects.

It was for the foregoing reasons that the present experiment, which is the appetitive analogue to the learned helplessness studies, was conducted. Three groups of subjects received a series of either response-dependent food, response-independent food or mere food-hopper training, respectively. Following these pretreatment procedures, all animals were tested for acquisition of a discrete-trial operant

response for food reinforcement.

The results of the present experiment indicated that in each instance in which statistical significance was established (e.g., five out of a possible nine times) the bar-pressing response levels of the subjects that had previously received response-independent food pellets was depressed when compared with the response levels of those subjects trained to make a different active response (head-poking) in order to procure nourishment. However, in contrast with the usual learned helplessness results, the bar-pressing response levels of the control group were indistinguishable from the performance of the response-independent animals but significantly different from the performance of the response-dependent subjects on all occasions for which statistical significance was obtained. An explanation based upon contingency theory was advanced to account for these seemingly anomolous findings.

The findings of the current experiment were consistent with the thesis presented by MacKintosh (1973), which asserted that animals learn to "ignore" independently presented events and attend to contingently presented events. Further, the results of the current experiment were inconsistent with the position set forth by Rescorla (1967), which suggested that independence between two events is a neutral condition which leads to no conditioning between the two events.

The present findings, together with the relevant findings reported in the literature, were interpreted as being compatible with the hypotheses which suggests that the experience of a non-predictive relationship between behavior and the delivery of a reinforcer, positive or negative, results in a retardation in later learning when a response does become predictive of the reinforcer.

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I wish to express a special thank you to Rose A. Tichio for being my dearest and closest friend during this period in my life.

Finally, I wish to dedicate this thesis to all those persons who at some time in their lives have been afflicted with the belief that they surely could no longer endure, and then endured.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

Seligman (1975) has asserted that the presentation of uncontrollable (response-independent) aversive events produces the behavioral phenomenon "learned helplessness". According to Seligman, the state of helplessness, owing to the development of motivational, cognitive, and emotional deficits, manifests itself as an inability on the part of an organism subsequently to learn that purposive responses can produce favorable outcomes. For example, after receiving a series of inecsapable shocks, an organism may later have difficulty learning that a response is now available with which to terminate shock. In the words of the major proponents of the theory:

> We assume that the incentive to initiate voluntary responses in a traumatic situation is partly produced by the expectation that responding produces relief. In the absence of this incentive, voluntary responding will decrease in liklihood. When a person or animal has learned that relief is independent of responding, the expectation that responding produces relief is negated, and therefore response initiation is reduced. Most generally put, the incentive to initiate voluntary responses to control any outcome (e.g., food, sex, shock termination) comes, in part, from the expectation that responding produces that outcome. (Maier and Seligman, 1976, p. 18)

> Response-outcome independence is an active form of learning, and like any other active form of learning, it can proactively interfere with contravening forms of learning. (Maier and Seligman, 1976, p. 18)

The typical learned helplessness experiment employs a triadic design in which three groups of subjects receive either a series of escapable noxious events, a series of inescapable noxious events, or no noxious events, respectively. The aversive event is usually shock of a fixed duration and intensity; inescapability is achieved by restraining the organism in some manner; finally, the animals assigned to the inescapable condition receive events at the same time and for the same duration (i.e., yoked) as that of their matched subjects exposed to the escapable treatment. Some time after this pretreatment, all subjects are then exposed to a task in which escape from the noxious stimulus is possible via the execution of a designated response.

The typical results obtained under these circumstances are as follows: while subjects who were administered either the escapable noxious stimulus or the no noxious stimulus pretreatments subsequently display equally reliable escape behavior, the subjects assigned to the inescapable aversive event condition demonstrate significantly low levels of escape behavior. These very same effects of inescapable noxious stimuli have been demonstrated with dogs (Overmeir and Seligman, 1967; Seligman and Groves, 1970), rats (Maier, Albin and Testa, 1973; Seligman and Beagley, 1975; Seligman, Rosellini and Kovak, 1975), cats (Thomas and Balter cited by Seligman, 1975, p. 28), fish (Padilla, Padilla, Ketterer and Giacalone, 1970), and man (Gampel, 1976; Hiroto, 1974; Thorton and Jacobs, 1971).

Theoretically, the propositions surrounding the helplessness literature are much related to the early research with Pavlovian contingency learning theory conducted by Rescorla (1967), as well as to the more contemporary and advanced approach to both classical and instrumental conditioning contingencies of Gibbon, Berryman and Thompson (1974). In 1967 Rescorla proposed a "truly random" procedure as the proper and single control for experimentation dealing with classical conditioning phenomenon. The truly random control was achieved by eliminating all temporal contingencies between conditioned and unconditioned stimuli. This could be achieved in either of two ways: by presenting the conditioned stimuli (CS's) in the same temporal periods as in the experimental condition while randomly distributing the occurrences of the unconditioned stimuli (UCS's) throughout the session, or vice versa. The spirit of the immediately preceding statement may be translated into a conditional probability statement of the following form: $\underline{p}(UCS/CS) = \underline{p}(UCS/\overline{CS})$. Translated, this statement suggests that the probability ($\underline{p}$) of the UCS given the CS is equal to the probability of the UCS given no CS. In other words, the presentation of the CS is not predictive of the occurrence of the UCS since the UCS has previously occurred with equal probability when the CS was and was not presented.

Strictly speaking, Rescorla's propositions were confined to classical conditioning situations and the various relationships that could be obtained between CS's and UCS's. However, it may logically be assumed that response-produced stimuli occurring in various temporal arrangements with a reinforcer may duplicate the relationships (e.g., contingent, non-contingent) obtained with conditioned and unconditioned stimuli. Therefore, using the logic of the Rescorla (1967) model, it can be assumed that no conditioning should eventuate when a response (with accompanying response-produced stimuli) and a reinforcer occur independently.

Substituting the term response for CS and reinforcement, or outcome, for the term UCS in the statement discussed above, we have the makings of a new conditional probability expression which deals with similar relationships in the realm of instrumental conditioning.

This new statement may then take the following form: $\underline{p}(RF/R) = \underline{p}(RF/\bar{R})$. Translated, this statement intimates that the probability of reinforcement (outcome) given the execution of a specified response is equal to the probability of reinforcement given the occurrence of no response. In short, the occurrence of a certain response is not predictive of a particular outcome since that outcome has previously occurred with the same probability when the response occurred as when it did not. Seligman, Maier, and Soloman (1971) refer to this latter situation as one of "uncontrollability", i.e., the occurrence of the reinforcer (outcome) is independent of responding.

Regarding the effects of uncontrollability upon an organism, Maier and Seligman (1976) had this to say:

> So we believe that the psychological state produced by uncontrollability may undermine response initiation quite generally. Dogs, rats, cats, fish, and people make fewer responses to shock after receiving uncontrollable shock. Furthermore, these motivational deficits may not be limited to shock or even noxious events. Escape from frustration, aggressive behavior, and even the propensity to solve anagrams might be undermined by inescapable events. Conversely, uncontrollable rewards may disrupt escape from noise, learning to procure food, and competitiveness. (pp. 12-13)

It is apparent from the aforementioned quote that the authors believe the learned helplessness phenomenon to be a fairly general effect encompassing both uncontrollable noxious as well as non-noxious events. However, the plethora of learned helplessness experiments conducted using aversive stimulus outcomes (e.g., shock) has not been nearly matched by those carried out with positive stimulus outcomes (e.g., food). As a matter of fact, the only citation in the rat learning literature that did use a positive stimulus outcome did not employ the triadic design indiginous to typical learned helplessness research projects. In that experiment reported by Seligman, Meyer, and Testa (cited by Seligman, 1975, p. 34) different groups of hungry rats demonstrated various levels of difficulty in learning to bar-press for food after they had had different amounts of free food pellets dropped through the roofs of their home cages. In fact, it was reported that some of the rats that had received the largest amounts of free food did not learn to bar-press at all. It is, however, quite clear from the design of this experiment (i.e., nonequivalence of amount of non-contingent food among groups) that it could with greater ease be considered a test of the effects of various degrees of experience with response-reinforcer independence upon food acquisition behavior rather than learned helplessness per se. In the typical learned helplessness situation at least two groups (i.e., contingent and non-contingent) receive equal amounts of the significate (shock). However, in Seligman, Meyer, and Testa's situation described above the groups were not equated for the amounts of food they received. The latter study therefore confounded contingency with degree of experience with food.

A research project which was a closer approximation to a well-controlled, triadically designed, learned helplessness appetitive analogue was one conducted by Welker (1976). Welker trained one group of pigeons during 15 daily sessions to peck a key for food. A second group received the same amount of non-contingent food (i.e., response-independent grain-hopper presentations) yoked to the first group. A third and final group was exposed to only one session of hopper training during which these subjects received 40 grain presentations.

When all the pigeons were later presented with a test situation in which treadle-pressing produced food on a continuous reinforcement schedule, the results showed that the experience with prior response-independent food retarded acquisition.

However, since Welker (1976) utilized the same experimental chamber for both the purposes of training and testing, the results of his experiment may not be interpreted as an appetitive analogue of the learned helplessness situation. This is because Welker's findings can be accounted for by appealing to a model formulated by Rescorla and Wagner (1972). That model would interpret Welker's situation as one in which the animals merely learned to associate a particular response-outcome relationship (i.e., contingent or non-contingent) with stimuli present in the experimental chamber during both training and testing. This interpretation would not be damaging to Seligman's theory. However, it would seriously limit the proposed generality of the hypothesis. A reinspection of the quote from Maier and Seligman (1976, p. 18) reproduced on the first page of the present manuscript should attest to this intended generality.

It was for the foregoing reasons that the present experiment, which is the appetitive analogue to the learned helplessness studies, was conducted. This experiment employed a triadic design, as well as a testing apparatus which was distinctly different from the chamber utilized during training. Based upon the demonstrations and hypotheses of Maier and Seligman (1976) and their colleagues, it was predicted that such an experiment would result in the typical learned helplessness findings (i.e., no significant difference in food-acquisition performance between the control group and those animals trained to make an active response in order to procure nourishment, but a significant retardation in food-acquiring behavior on the part of subjects presented with yoked, response-independent aliment).

Failure to find any group differences in the response-outcome contingency situation outlined above would be predicted by an extension of the seminal stimulus-outcome theory of Rescorla (1967), which maintained that independence between a CS and UCS[1] is a neutral condition which leads to no conditioning between the two events. Evidence in support of this proposition may be found in an experiment conducted by Rescorla (1966), in which rats were initially trained in an unsignaled Sidman Avoidance task and then divided into three distinct groups, depending upon the manner in which each group received the Pavlovian pairing of a tone (CS) and shock (UCS). Group 1 was administered the CS and UCS pairings according to a truly random procedure. Group 11 received the same stimulus presentations according to an explicit pairing procedure. Group 111 received a backward conditioning procedure. The results of the experiment showed that when the rats were later placed back in the Sidman Avoidance situation and response rates to presentations of the tone were measured, groups 11 and 111 increased and decreased their rates of responding, respectively, while Group 1 demonstrated no significant response rate change to presentations of the tone.

Further support for Rescorla's proposition comes from an

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[1] Earlier in this manuscript an equivalence of stimulus-outcome and response-outcome contingencies was established. Therefore, all remarks made concerning the former apply as well to the latter.

experiment in which rats again received presentations of a tone CS and a shock UCS (Rescorla, 1968, Experiment 1). Group 1 received the tones and shocks in a truly random procedure, with the shocks occurring in both the presence and absence of the CS. Group 11 received exactly the same treatment, with the exception that all shocks scheduled to occur in the absence of the CS were omitted. Group 111 received the same reduced number of shocks as did Group 11. However, for Group 111 the occurrences of the UCS's were distributed randomly during the presence and absence of the CS, as was the case with Group 1. Rescorla reported that when the CS was subsequently presented while the rats bar-pressed for food, only Group 11 (i.e., the group that received explicit CS-UCS pairings) demonstrated fear of the CS (i.e., the conditioned emotional response). The remaining two groups, for which the CS and UCS presentations were independent (non-contingent), showed no reliable conditioning of fear.

It would seem, however, even in the face of the Rescorla findings, that the prediction of the outcome of the experiment proposed here was in favor of the learned helplessness hypothesis. This is because more recent evidence has demonstrated that learning does indeed occur in situations where CS's and UCS's are presented independently of one another. For example, Mellgren and Ost (1971) reported that rats subsequently took longer to learn that discriminative conditioned stimuli predicted food after experience with a training procedure in which the CS's were presented independently of food. MacKintosh (1973) reported a comparable retardation of conditioning in pigeons resulting from prior presentations of non-contingent (i.e., zerocorrelated) CS's and UCS's. In that experiment MacKintosh exposed pigeons to one of four different training procedures before placing them into an autoshaping situation. Group 1 received presentations of a CS (illumination of a translucent response disc) paired with food on a truly random schedule. Group 11 received the identical number of CS presentations but none of the food. Group 111 received the grain presentations but did not experience the CS. Finally, Group 1V was merely given exposure to the experimental chamber but received neither CS nor grain presentations. When the subjects were later exposed to the autoshaping procedure, it was found that Group 1, the group which had received random pairings of the response key and grain, pecked at a significantly lower rate than either of the other three groups.

In an experiment using rats as subjects, MacKintosh (1973) showed that random presentations of a given CS and a particular UCS retarded the subsequent formation of an association between the two. In that experiment there were two major groups:

> animals given conditioning with water as the UCS, and those given conditioning with shock as the UCS. Within each of these two groups, different sub-groups received a variety of treatments in the first phase of the experiment. These treatments involved exposure to: the CS alone; the appropriate UCS alone; random presentations of the CS and the appropriate UCS; random presentations of the CS and the opposite UCS; and, finally, simple exposure to the apparatus. (MacKintosh, 1973, p. 87)

The results of the study showed that for both those groups conditioned to water and those groups conditioned to shock all but one group conditioned at approximately the same rate, and in each instance the group that did not condition well was composed of animals previously exposed to random presentations of the CS and UCS used in conditioning. MacKintosh called this effect "learning to ignore" the stimulus as a predictor of the reinforcement. As he put it:

> animals may learn that a particular stimulus signals nothing of consequence, and this learning may not only underly current changes in the behaviour elicited by that stimulus (as in habituation), but may also affect subsequent learning about the relationship between that stimulus and other events. (MacKintosh, 1973, p. 91)

The present experiment, then, was a test of the prediction derived from the work of Seligman on learned helplessness and from that of MacKintosh on learning to ignore, that an effect analogous to learned helplessness would occur in the positive analogue of that paradigm.

METHOD

Subjects

The subjects were 24 female albino rats of the Sprague-Dawley strain purchased from Charles River Breeders; Wilmington, Massachusetts. The animals weighed approximately 300 grams when the experiment commenced and were thereafter maintained at 80% of their ad-lib body weight. Water was always available in the home cage.

Apparatus

Materials for the experiment included six experimental rat enclosures, three insulation chests, three retractable levers, and three head-poking devices. Three of the experimental chambers were utilized as pretreatment environments, while the remaining three boxes and their respective insulation chests were used for the purposes of testing. The pretreatment environments were located in a different experiment room from the testing chambers.

Each of the pretreatment boxes, measuring 30x30x30 cm, contained a food hopper and a head-poking device consisting of a 5 cm square tube with an interruptable infared light beam located 1 cm down the length of the tube. The head-poking devices and food hoppers were located 17.5 cm apart and each was 3 cm from the floor and 3.5 cm from the side walls. The head-poking devices were located closest to the left side wall, while the food hoppers were located near the right side wall. The intelligence panels and the walls opposite were painted flat black. The remaining two side walls were painted gloss white. All floors were made of brown, wood-grain formica, while the tops were constructed of Plexiglas. Illumination for the pretreatment environments was provided by fluorescent light bulbs in the ceiling of the room in which the boxes were located.

Each of the three testing chambers, measuring 30x24x24 cm, contained a retractable lever (BRS/LVE 123-05) and a food hopper. The retractable levers measured 2.8 cm wide, 1 cm thick, and protruded 2 cm into the boxes when fully extended. All levers were located 7.5 cm from the floor, and 3 cm from the right side walls. The food hoppers were located at the center of the intelligence panels, 1.5 cm off the floors. The intelligence panels and their opposite walls were made of steel-grey aluminum. The remaining two side walls and ceilings were made of Plexiglas, while the floors were constructed of steel rods spaced 2 cm apart. The exteriors of all Plexiglas surfaces were lined with grey cardboard, thereby making the testing boxes appear a uniform grey throughout.

Procedure

Each rat was assigned to one of the following three groups: response-dependent, response-independent and control. Before the beginning of the pretreatment sessions the rats were adapted to the boxes. On this adaptation day, each animal was placed into one of the pretreatment chambers for a total of 50 min. During this period food was not available, and responses had no programmed effect. On each of the ensuing nine successive days comprising the pretreatment period, animals in the response-dependent group were placed into the pretreatment apparatus and trained, automatically, to respond (head-poke) for food reinforcement (i.e., 45 mg Noyes Pellets). A response was defined as an excursion of the head of the animal a sufficient distance into a 5 cm square tube to interrupt an infared light beam located 1 cm down the length of the tube.

On Day 1 of the pretreatment period, food reinforcement was delivered to subjects in the response-dependent group either after they had executed the proper response or, automatically, after a variable, predetermined time had elapsed with no response. (The various intervals employed here were based upon a mean interval of 45 sec.) The latter criterion is often referred to as a Variable Time (VT) Schedule. During the subsequent eight days of the pretreatment period food was available to these animals only on a continuous reinforcement schedule, and the animals were required to respond in order to receive reinforcement. Electomechanical equipment was employed to record the frequency of head-poking and to deliver reinforcements.

Subjects in the control group received the same treatment as that of the response-dependent group, except that the former animals received food in the food hopper, while occupying an identical pretreatment chamber, at the same times (i.e., yoked) as that of the animals in the response-dependent group. For the control subjects, head-poking had no programmed consequence.

Animals in the (poking) response-independent condition also received free food, while occupying a third identical pretreatment environment, at the same times as the subjects in the response-dependent group. However, for the response-independent subjects, the food pellets were not delivered to the food hopper. Instead, free pellets were dropped from a hole centerally located in the ceiling of the chamber. For the response-independent subjects, head-poking also had no programmed consequence.

The above procedures continued until the animals in the response-dependent condition had completed 100 responses and/or 50 min had passed on each of the nine days of the pretreatment phase. In this manner all three groups were equated for the number of pellets received during the pretreatment phase of the experiment. They did, however, differ in the conditions under which the receipt of food was made possible.

Daily sessions consisting of 80 testing trials commenced on the day following the pretreatment procedures described above. On each of the two testing days, the animals were placed into the second (testing) chamber and subjected to testing trials, during which the lever was extended into the box for a maximum of 10 sec and then retracted if no response occurred during that period. The interval between successive trials was determined by a variable-interval 40-sec schedule. If the animal pressed the lever during the 10-sec interval after it had reached the point of its fullest excursion into the box, the lever immediately retracted and the subject was presented with a food pellet. However, if the lever was not depressed, it was retracted at the end of the trial and no food was presented. Multiple responses on a single trial were unlikely because of the speed of retraction of the lever. However, if such responses did occur, only the first response of each trial was recorded and no additional responses had experimentally programmed consequences.

In addition to recording the number of trials with a bar-press response, which also allowed the number of trials to the first lever-press to be analyzed, latency to bar-press on each trial was also recorded. The latter dependent measure was incorporated, since

Hulse (1972) had previously demonstrated that it was quite sensitive to the consistent introduction of response-independent food. The actual data analysis was ultimately performed upon the speeds to bar-press on every trial. Speed was obtained in each case by determining the reciprocal of each latency score (i.e., 1/latency in seconds = speed).

RESULTS

Analysis of variance of the frequencies of head-poking responses which occurred during the pretreatment period indicated statistically significant differences among the three groups (response-dependent, response-independent, and control) on each of the nine days, $\underline{F}s\ (2, 21) \geq 4.98$, $\underline{p}s < .05$. Analysis with the Tukey (b) test demonstrated that the response-dependent (D) animals executed significantly more head-poking responses than either the control (C) or response-independent (I) subjects on each of the nine days comprising the pretreatment period ($\underline{p}s < .05$), while the latter two groups did not differ from each other in this regard on any of the nine days of the pretreatment period ($\underline{p}s > .05$). Table 1 presents the mean number of head-poking responses produced by each of the three groups (D, C, and I) on each of the nine days of the pretreatment period.

Analyses of variance conducted upon the bar-pressing behavior recorded during the testing phase of the experiment revealed that the three groups (D, C, and I) significantly differed from each other with regard to the dependent measures of speed to bar-press and the number of trials with a bar-press response, but did not differ significantly from each other with regard to the number of trials elapsed before the occurrence of the first bar-press response.

Tables 2 and 3 are summaries of the one-way analyses of variance that were conducted upon the speed to bar-press data and the total number of trials with a bar-press response, respectively, produced on test days one and two combined. Tables 4 and 5 present the mean speed to bar-press data and the mean number of trials with a bar-press response, respectively, produced on test days one and two combined by each of the three experimental groups (D, C, and I). Planned analyses with the use of the Tukey (b) test showed that for the combined two days of testing the animals in the response-dependent group responded faster and on more trials than either the response-independent subjects or the controls ($ps < .05$), while the latter two groups did not significantly differ from each other with regard to either dependent measure ($ps > .05$).

Statistical analyses of the bar-pressing behavior produced on a daily basis indicated that the three comparison groups (D, C, and I) differed significantly from each other with regard to the number of trials with a bar-press response recorded on Day 1 ($F\ (2,\ 21) = 14.17$, $p < .001$), but did not differ of Day 2 ($F\ (2,\ 21) = 3.06$, $.07 > p > .05$). Tables 6 and 7 are summaries of the one-way analyses of variance conducted on the number of trials with a bar-press response produced on test days one and two, respectively. Tables 8 and 9 present the mean number of trials with a bar-press response produced by the three comparison groups (D, C, and I) on test days one and two, respectively. The Tukey (b) test demonstrated that on test Day 1 the subjects in the response-dependent group responded on significantly more trials than either the control subjects or the response-independent animals ($p < .05$), while the latter two groups did not significantly differ from each other with regard to this dependent measure ($p > .05$). Further analysis with the Tukey (b) test showed that on test Day 2 there were no significant differences among the three comparison groups (D, C, and I) with regard to the number of trials with a bar-press response ($p > .05$).

Further statistical analysis of the bar-press data recorded daily showed that the three experimental groups (D, C, and I) were significantly different from each other with regard to the speed with which they approached the bar and responded on both test Day 1 ($\underline{F}$ (2, 21) $= 10.21$, $\underline{p} < .001$) and test Day 2 ($\underline{F}$ (2, 21) $= 4.66$, $\underline{p} < .05$). Tables 10 and 11 are summaries of the one-way analyses of variance conducted upon the speed to bar-press data produced by the three comparison groups (D, C, and I) on test days one and two, respectively. Tables 12 and 13 present the mean speeds to bar-press recorded on test days one and two, respectively, for the three experimental groups (D, C, and I). Application of the Tukey (b) test demonstrated that on each of the two testing days the subjects in the response-dependent group approached and responded to the bar significantly faster than either the response-independent or control groups ($\underline{p}$s $< .05$), while the latter two groups did not significantly differ from each other on this measure at the .05 level of significance.

Finally, as mentioned earlier, there were no significant differences among the three comparison groups (D, C, and I) with regard to the number of trials that elapsed before the first bar-press response occurred on either test days one or two ($\underline{F}$s (2, 21) ≤ 1.48, $\underline{p}$s $> .05$). Tables 14 and 15 are summaries of the one-way analyses of variance conducted upon the number of trials before the first bar-press response occurred on test days one and two, respectively. Tables 16 and 17 present the mean number of trials before the first bar-press response occurred on test days one and two, respectively, for each of the three comparison groups (D, C, and I). Application of the

Tukey (b) test showed that there were no significant differences among the three groups (D, C, and I) on either test day one or two with regard to the number of trials elapsed before the occurrence of the first bar-press response ($\underline{p}$s $>.05$).

Furthermore, there was no significant difference among the three experimental groups (D, C, and I) when the number of trials before the first bar-press response was analyzed over the combined two days of testing, $\underline{F}\ (2, 21) = 1.25$, $\underline{p} > .05$. Table 18 is a summary of the one-way analysis of variance conducted upon the aforementioned data. Table 19 presents the mean number of trials before the first bar-press response on test days one and two combined for each of the three comparison groups (D, C, and I). There were no significant differences among these means at the .05 level of significance, according to the Tukey (b) test.

Table 1

Means and Standard Errors of Head-Poking Responses Emitted by the Three Groups on Each of the Nine Pretreatment Days

	Group		
Days	Response-dependent	Control[c]	Response-independent
1	93.75[a]	58.25	38.62
	(4.55)[b]	(8.63)	(8.06)
2	88.62	58.00	60.50
	(4.56)	(9.50)	(7.93)
3	102.75	44.73	40.73
	(1.14)	(8.88)	(3.95)
4	102.00	26.00	23.75
	(1.07)	(2.51)	(3.50)

Table 1-*continued*

	Group		
Days	Response-dependent	Control	Response-independent
5	101.12	20.50	14.00
	(.74)	(3.42)	(2.55)
6	100.25	13.00	12.25
	(.16)	(2.30)	(2.39)
7	100.75	11.12	8.12
	(.74)	(2.56)	(2.11)
8	102.50	21.12	16.00
	(.98)	(4.89)	(2.57)
9	102.50	17.62	17.75
	(1.10)	(4.35)	(3.90)

Note. *n* = 8 for each cell.

Table 1-*continued*

[a] Means underlined by a common line do not differ significantly from each other; means not underlined by a common line do differ at the .01 level of significance, according to the Tukey (b) test.

[b] Standard errors appear in parentheses.

[c] Since the control group head-poked more often than the response-independent group on seven of the nine pretreatment days, the possibility that this was a non-chance occurrence was persued. To this end, a *post-hoc* two-way analysis of variance was conducted upon these data, with groups (control vs. response-independent) serving as one factor and days of the pretreatment phase serving as the second factor. The relevant results of that analysis indicated that neither the main effect of groups (control vs. response-independent) nor the interaction between groups and days was statistically significant. The F-ratios for the groups effect and the interaction between groups and days of the pretreatment phase were $F\ (1, 14) = 1.17$, $p > .05$ and $F\ (8, 112) = .883$, $p > .05$, respectively.

Table 2

Analysis of Variance:

Speed[a] to Bar-Press on Test Days

One and Two Combined

Source	*SS*	*df*	*MS*	*F*
Between	.0580	2	.0290	7.09[*]
Within	.0860	21	.0040	
Total	.1440	23		

[a] The reciprocal of latency in seconds.

[*] $p < .005$.

Table 3

Analysis of Variance: Trials With a Bar-Press Response on Test Days One and Two Combined

Source	SS	df	MS	F
Between	10709.08	2	5354.54	7.85*
Within	14318.87	21	681.85	
Total	25027.95	23		

*$p < .005$.

Table 4

Means and Standard Errors of Speed[a] to Bar-Press on Test Days One and Two Combined for the Three Groups

	Group[b]	
Response-dependent	Control	Response-independent
.3748[c]	.2818	.2621
(.0224)[d]	(.0266)	(.0183)

[a] The reciprocal of latency in seconds.

[b] *n* = 8 for each group.

[c] Means underlined by a common line do not significantly differ from each other; means not underlined by a common line do differ at the .05 level of significance, according to the Tukey (b) test.

[d] Standard errors appear in parentheses.

Table 5

Means and Standard Errors of Number of Trials With a Bar-Press Response on Test Days One and Two Combined for the Three Groups

	Group[a]	
Response-dependent	Control	Response-independent
92.25[b]	54.75	42.62
(5.88)[c]	(12.34)	(8.29)

[a] *n* = 8 for each group.

[b] Means underlined by a common line do not significantly differ from each other; means not underlined by a common line do differ at the .05 level of significance, according to the Tukey (b) test.

[c] Standard errors appear in parentheses.

Table 6

Analysis of Variance:

Trials With a Bar-Press Response on Test Day 1

Source	*SS*	*df*	*MS*	*F*
Between	3455.58	2	1727.79	14.17*
Within	2560.37	21	121.92	
Total	6015.95	23		

*$p < .001$.

Table 7

Trials With a Bar-Press Response on Test Day 2

Source	*SS*	*df*	*MS*	*F*
Between	2214.08	2	1107.04	3.06*
Within	7583.75	21	361.13	
Total	9797.83	23		

*$.07 > p > .05$

Table 8

Means and Standard Errors of Number of Trials With a Bar-Press Response on Test Day 1 for the Three Groups

	Group[a]	
Response-dependent	Control	Response-independent
34.25[b]	17.12	5.00
(4.25)[c]	(4.81)	(2.09)

[a] $\underline{n}$=8 for each group.

[b] Means underlined by a common line do not significantly differ from each other; means not underlined by a common line do differ at the .05 level of significance, according to the Tukey (b) test.

[c] Standard Errors appear in parentheses.

Table 9

Means and Standard Errors of Number of Trials With a Bar-Press Response on Test Day 2 for the Three Groups

Group[a]		
Response-dependent	Control	Response-independent
58.00[b]	37.62	37.62
(3.70)[c]	(8.46)	(7.07)

[a] n=8 for each group.

[b] Means underlined by a common line do not significantly differ from each other at the .05 level of significance, according to the Tukey (b) test.

[c] Standard errors appear in parentheses.

Table 10

Analysis of Variance:

Speed[a] to Bar-Press on Test Day 1

Source	SS	df	MS	F
Between	.0045	2	.0022	10.21[*]
Within	.0046	21	.0002	
Total	.0091	23		

[a] The reciprocal of latency in seconds.

[*] $p < .001$.

Table 11

Analysis of Variance:

Speed[a] to Bar-Press on Test Day 2

Source	SS	df	MS	F
Between	.0304	2	.0152	4.66*
Within	.0684	21	.0032	
Total	.0988	23		

[a] The reciprocal of latency in seconds.

[*] $p < .05$.

Table 12

Means and Standard Errors of Speed[a] to Bar-Press on Test Day 1 for the Three Groups

Group[b]		
Response-dependent	Control	Response-independent
.1356[c]	.1121	.1032
(.0080)[d]	(.0039)	(.0017)

[a] The reciprocal of latency in seconds.

[b] *n* = 8 for each group.

[c] Means underlined by a common line do not significantly differ from each other; means not underlined by a common line do differ at the .01 level of significance, according to the Tukey (b) test.

[d] Standard errors appear in parentheses.

Table 13

Means and Standard Errors of Speed[a] to Bar-Press on Test Day 2 for the Three Groups

	Group[b]	
Response-dependent	Control	Response-independent
.2392[c]	.1696	.1588
(.0188)[d]	(.0237)	(.0175)

[a] The reciprocal of latency in seconds.

[b] *n*=8 for each group.

[c] Means underlined by a common line do not significantly differ from each other; means not underlined by a common line do differ at the .05 level of significance, according to the Tukey (b) test.

[d] Standard errors appear in parentheses.

Table 14

Analysis of Variance:

Number of Trials Before the First Bar-Press Response

on Test Day 1

Source	SS	df	MS	F
Between	119.08	2	59.54	.600*
Within	2082.75	21	99.17	
Total	2201.83	23		

*$p > .05$.

Table 15

Analysis of Variance:

Number of Trials Before the First Bar-Press Response on Test Day 2

Source	SS	df	MS	F
Between	657.58	2	328.79	1.48*
Within	4658.37	21	221.82	
Total	5315.95	23		

*$p > .05$.

Table 16

Means and Standard Errors of Number of Trials Before the First Bar-Press Response on Test Day 1 for the Three Groups

Group[a]		
Response-dependent	Control	Response-independent
16.87[b]	20.37	15.00
(3.47)[c]	(3.86)	(3.19)

[a] n=8 for each group.

[b] Means underlined by a common line do not significantly differ from each other at the .05 level of significance, according to the Tukey (b) test.

[c] Standard errors appear in parentheses.

Table 17

Means and Standard Errors of Number of Trials Before the First Bar-Press Response on Test Day 2 for the Three Groups

	Group[a]	
Response-dependent	Control	Response-independent
2.50[b]	15.12	10.75
(.94)[c]	(7.15)	(5.57)

[a] n=8 for each group.

[b] Means underlined by a common line do not significantly differ from each other at the .05 level of significance, according to the Tukey (b) test.

[c] Standard errors appear in parentheses.

Table 18

Number of Trials Before the First Bar-Press Response

on Test Days One and Two Combined

Source	*SS*	*df*	*MS*	*F*
Between	1055.25	2	527.62	1.25*
Within	8795.37	21	418.82	
Total	9850.62	23		

*$p > .05$.

Table 19

Means and Standard Errors of Number of Trials Before the First Bar-Press Response on Test Days One and Two Combined for the Three Groups

Group[a]		
Response-dependent	Control	Response-independent
19.37[b]	35.50	25.75
(3.20)[c]	(9.97)	(6.98)

[a] n=8 for each group.

[b] Means underlined by a common line do not significantly differ from each other at the .05 level of significance, according to the Tukey (b) test.

[c] Standard errors appear in parentheses.

Discussion

The results of the present experiment represent a partial replication, in an appetitive situation, of the typical learned helplessness findings. In each instance in which statistical significance was established (e.g., five out of a possible nine times), the bar-pressing response levels of the subjects that had previously received response-independent food pellets was depressed when compared with the response levels of those animals previously trained to make a different, active response (head-poking) in order to procure nourishment. However, in contrast with the usual learned helplessness results, on no occasion did the response levels of the control group differ significantly from the performance of the response-independent subjects.

One possible explanation for the seemingly anomolous findings mentioned above has to do with the nature of the control group employed in the current experiment. In order to control for the effects of experience with the experimental chamber and feeding therein relative to experience with response-independent food-pellet presentations, the present experiment employed a group (e.g., the control group) which received magazine training on all the days that the response-dependent and response-independent animals received their respective treatments. Conceivably, this extensive training where subjects were required to do no more than approach the food hopper at the sound of the magazine may have created a certain amount of "helplessness" among animals assigned to the control group. In other words, the extent of contingency learning among subjects treated in this fashion may have been closer to that of the response-independent (non-contingency) animals rather than that of the response-dependent (contingency) subjects. The fact that the control subjects showed a non-significant tendency to learn the second task more readily than the non-contingent animals (cf. Tables 4, 5, 8, 9, 12, and 13) suggests that the approach response they learned in the first phase of the experiment constituted somewhat more of a response-contingency than that of the non-contingent animals who found their food pellets on the floor.

The results of the present experiment also represent an extension of the of the findings reported by Welker (1976) with pigeons in an appetitive-stimulus, learned helplessness situation. Welker reported that the response levels of subjects who were tested for acquisition of a treadle-pressing response on a continuous schedule of reinforcement following exposures to response-independent grain was depressed relative to those subjects who were previously trained to make an active response (key-peck) for nourishment. The present results are a replication of these findings with rats as subjects in a discrete-trials learning situation, thereby suggesting that the effects of response-independent events are generalizable to an appetitive, discrete-trials learning task employing rats as subjects. Further, since the current experiment employed experimental chambers of markedly different appearances during training and testing, a procedure ignored by previous research projects conducted upon appetitive learned helplessness (cf. Seligman, Meyer, and Testa cited by Seligman, 1975, p. 34; and Welker, 1976), the present results may be considered to suggest that the effects of response-independent food were not dependent upon the rats learning the relationship between responding and the specific environmental stimuli in the contingent or non-contingent situation.

The findings of the current experiment are also consistent with the thesis presented by MacKintosh (1973), which suggests that animals learn to "ignore" independently presented events and attend to contingently presented events. Further, the absence of a null result here is inconsistent with the interpretation made above of the position set forth by Rescorla (1967), which suggested that independence between two events is a neutral condition which leads to no conditioning between the two events.

Although the present results have been interpreted from a learned helplessness point of view, an alternative interpretation could be considered to provide an explanation for these findings. For example, an associative interpretation of the present results would assert that animals merely transferred certain responses, conditioned as a result of reinforcement, from the pretreatment to the testing phase. According to such an interpretation, during the pretreatment phase of the experiment animals in the response-dependent group learned to head-poke for food, while subjects in the response-independent group learned a response such as foraging, or sniffing around the floor in search of food. The learned behavior of the control group would be considered to be that of hovering near the food hopper. In this associative interpretation, then, during the testing phase the rats in the response-dependent situation may have merely demonstrated positive transfer (i.e., head-poking behavior in the testing chamber, which did not contain a hole, may have facilitated, or failed to hinder the development of lever-pressing). On the other hand, the assumed responses learned by the subjects in the response-independent (foraging) and control (hovering) groups during the pretreatment phase may have subsequently hindered the development of lever-pressing in the testing phase, i.e., the animals in the latter two groups may have merely demonstrated negative transfer.

Such a model necessarily assumes that the experimental chambers would elicit the assumed responses outlined above. It is the case, however, that in the present study an attempt was made to preclude such transfer by eliminating common environmental cues in the pretraining and test phases by using experimental chambers with different dimensions, shapes, colors, floors, and ceilings; and by locating the pretraining and testing environments in different rooms. Each of the three pretreatment environments measured 30x30x30 cm, with a brown, wood-grain formica floor and a Plexiglas top. The intelligence panels and the walls opposite were painted flat black, while the remaining two side walls were painted gloss white. The testing chambers measured 30x24x24 cm, with floors constructed of steel rods spaced 2 cm apart. The intelligence panels and their opposite walls were made of steel-grey aluminum. The remaining two side walls and ceilings were made of Plexiglas. The exteriors of all Plexiglas surfaces were lined with grey cardboard, thereby making the testing environments appear a uniform grey throughout.

In addition to being located in different experimental rooms, the pretreatment and testing chambers were also oriented differently, i.e., the pretreatment environments were situated side-by-side with their fronts facing south, while two of the testing chambers were situated in an exactly reversed manner, and the third testing box was located in an east-west plane.

It would seem likely that the net effect of such differences as those outlined immediately above would be to minimize the possibility of the transfer of the aforementioned putative associations from the pretreatment phase to the testing phase. For example, it seems unlikely that the foraging behavior assumed to have been learned by the response-independent subjects in the pretreatment chamber, with its smooth, brown formica floor, would transfer at high strength to the testing chamber, with its grid floor composed of steel rods spaced 2 cm apart.

However, such an associative interpretation of the current experiment cannot be entirely ruled out. In fact, the only definitive research project that could provide a potential differentiation between the learned helplessness model and the associative-transfer alternative would involve: (1) specification of the compatibility relations among response topographies in the rats' behavioral repetoire, and (2) observation of any responses actually conditioned during response-independent feeding.

In view of the control procedures employed in the present research project (i.e., different experimental chambers in the pretraining and testing phases), the associative explanation of the results obtained here seems a bit strained. Similarly, the associative model is quite strained as an explanation for numerous other experiments reported in the learned helplessness literature. For example, Maier (1970) conducted an experiment in which one group of dogs was trained to escape from shock by holding still, a response presumed to be quite incompatible with jumping over a hurdle in a shuttle box. A second group of dogs was subjected to inescapable shock yoked to the first group, while a third group received no pretreatment. Following this pretreatment all groups received 12 days of testing in a shuttle box where subjects were required to jump a hurdle in order to escape shock. The results indicated that the group trained to perform a response incompatible with shuttling (i.e., hold still) was slow to learn shuttling, but all subjects in this group did eventually learn. Conversely, half of the animals exposed to inescapable shock demonstrated complete failure to learn the task across the entire 12 days of testing. Thus, the training of a response presumed to be incompatible with shuttling did not duplicate the effects of inescapable shock. These results are entirely consistent with the learned helplessness hypothesis and inconsistent with an associative model, which suggests that the learned helplessness effect can be explained as an instance of negative transfer, whereby competing motor responses learned in the training phase interfere with performance in the testing situation. If this associative model were valid, there should not have been any differences in shuttling behavior between the response-dependent (escapable shock) and response-independent (inescapable shock) groups of that experiment.

Another experimental result for which an associative-transfer interpretation appears strained was reported in a project conducted by Overmier and Seligman (1967). In that experiment movement during exposure to inescapable shock was prevented by the administration of curare. The results demonstrated that curarization during exposure to inescapable shock did not prevent or reduce the subsequent learned helplessness effect. An interpretation of the Overmier and Seligman experiment based upon the transfer of previously learned incompatible responses is hard put to specify those interferring responses. Naturally, it may still be argued that in the case of curarized subjects movement-related neural processes were adventiously reinforced, but that interpretation seems especially strained.

Of course, no one experiment can establish the validity of such a complex theoretical concept as learned helplessness, but the present findings, together with the relevant findings reported in the literature, are quite compatible with the hypothesis which suggests that the experience of a non-predictive relationship between behavior and the delivery of a reinforcer, positive or negative, results in a retardation in later learning when a response does become predictive of the reinforcer.

REFERENCES

Church, R. M. Response suppression. In B. A. Campbell and R. M. Church (Eds.), *Punishment and Aversive Behavior.* New York: Appleton-Century-Crofts, 1969. Pp. 111-157.

Gampel, E. S. Inescapable vs. random reinforcements in inducing learned helplessness. *Paper presented at the 84th Annual Convention of the American Psychological Association*, Washington D. C., Sept., 1976.

Gibbon, J., Berryman, R., and Thompson, R. L. Contingency spaces and measures in classical and instrumental conditioning. *Journal of the Experimental Analysis of Behavior*, 1974, *21*, 585-605.

Hiroto, D. S. Locus of control and learned helplessness. *Journal of Experimental Psychology*, 1974, *102*, 187-193.

Hulse, S. H. Patterned reinforcement. In G. H. Bower (Ed.), *The Psychology of Learning and Motivation* (Vol. 7). New York: Academic Press, 1973. Pp. 313-362.

Levis, D. J. Learned helplessness: A reply and an alternative S-R interpretation. *Journal of Experimental Psychology: General*, 1976, *105*, 47-65.

MacKintosh, N. J. Stimulus selection: Learning to ignore stimuli that predict no change in reinforcement. In R. A. Hinde and J. Stevenson-Hinde (Eds.), *Constraints on Learning*. New York: Academic Press, 1973. Pp. 75-96.

Maier, S. F. Failure to escape traumatic shock: Incompatible skeletal motor response or learned helplessness? *Learning and Motivation*, 1970, *1*, 157-170.

Maier, S. F., Albin, R. W., and Testa, T. J. Failure to learn to escape in rats previously exposed to inescapable shock depends on the nature of escape response. Journal of Comparative and Physiological Psychology, 1973, 85, 581-592.

Maier, S. F. and Seligman, M. E. P. Learned helplessness: Theory and evidence. Journal of Experimental Psychology: General, 1976, 105, 3-46.

Maier, S. F. and Testa, T. J. Failure to learn to escape by rats previously exposed to inescapable shock is partly produced by associative interference. Journal of Comparative and Physiological Psychology, 1975, 88, 554-564.

Mellgren, R. L. and Ost, J. P. W. Discriminative stimulus preexpsure and learning of an operant discrimination in the rat. Journal Comparative and Physiological Psychology, 1971, 77, 179-187.

Overmier, J. B. Interference with avoidance behavior: Failure to avoid traumatic shock. Journal of Experimental Psychology, 1968, 78, 340-343.

Overmier, J. B. and Seligman, M. E. P. Effects of inescapable shock upon subsequent escape and avoidance learning. Journal of Comparative and Physiological Psychology, 1967, 63, 28-33.

Padilla, A. M., Padilla, C., Ketterer, T., and Giacolone, D. Inescapable shocks and subsequent avoidance conditioning in goldfish (Carrasius auratus). Psychonomic Science, 1970, 20, 295-296.

Rescorla, R. A. Predictability and number of pairings in pavlovian fear conditioning. Psychonomic Science, 1966, 4, 383-384.

Rescorla, R. A. Pavlovian conditioning and its proper control procedures. Psychological Review, 1967, 74, 71-79.

Rescorla, R. A. Probability of shock in the presence and absence of the CS in fear conditioning. Journal of Comparative and Physiological Psychology, 1968, 65, 1-5.

Seligman, M. E. P. Helplessness. San Francisco: W. H. Freeman, 1975.

Seligman, M. E. P. and Beagley, G. Learned helplessness in the rat. Journal of Comparative and Physiological Psychology, 1975, 88, 534-541.

Seligman, M. E. P. and Groves, D. Non-transient learned helplessness. Psychonomic Science, 1970, 19, 191-192.

Seligman, M. E. P., Maier, S. F., and Solomon, R. L. Unpredictable and uncontrollable aversive events. In F. R. Brush (Ed.), Aversive Conditioning and Learning. New York: Academic Press, 1971. Pp. 347-400.

Seligman, M. E. P., Rosellini, R. A., and Kozak, M. Learned helplessness in the rat: Reversibility, time course, and immunization. Journal of Comparative and Physiological Psychology, 1975, 88, 542-547.

Thorton, J. W. and Jocobs, P. D. Learned helplessness in human subjects. Journal of Experimental Psychology, 1971, 87, 369-372.

Winer, B. J. Statistical principles in experimental design. New York: McGraw-Hill, 1962.