CONDITIONED INHIBITION AND EXCITATION OF AN OPERANT RESPONSE

CONDITIONED INHIBITION AND EXCITATION IN OPERANT DISCRIMINATION LEARNING

by

PAUL L. BROWN, B.A.

A Thesis

Submitted to the Faculty of Graduate Studies

in Partial Fulfilment of the Requirements

for the Degree

Master of Arts

McMaster University

May 1966

MASTER OF ARTS (1966)
(Psychology)

McMASTER UNIVERSITY
Hamilton, Ontario

TITLE: Conditioned Inhibition and Excitation in Operant Discrimination Learning

AUTHOR: Paul L. Brown, B.A. (Dartmouth College)

SUPERVISOR: Professor H. M. Jenkins

NUMBER OF PAGES: iv, 148

SCOPE AND CONTENTS:

Pavlov's procedure for demonstrating conditioned inhibition was applied to the case of a discriminated operant to see whether a parallel exists in the operant case. A stimulus (tone) that had become a signal for not responding when paired with one excitatory stimulus (key-color used in conjunction with a go/no-go auditory discrimination) also served as a signal for not responding when it was combined with another excitatory stimulus (key-color used for transfer test) that was clearly discriminated from the one employed in the original training. Skinner's objections to Pavlov's demonstration of conditioned inhibition were shown not to apply to the present experiment. A second experiment showed that training of a kind that led to a conditioned inhibitory function for a stimulus paired with nonreinforcement can also lead to a conditioned excitatory function for a stimulus paired with reinforcement. Appropriate controls made it evident that these results were not due to unconditioned effects of tone. When training and testing procedures which parallel those used in classical conditioning are applied to the discriminated operant, the functions of stimuli in the two types of conditioning prove to be more similar than was previously thought.

ACKNOWLEDGEMENTS[1]

The author wishes to express his sincere gratitude to Professor H. M. Jenkins for his generous assistance and guidance throughout all phases of the research.

The author would also like to gratefully acknowledge the experimental assistance of Jan Licis and Carol Glencross.

For her preparation of the manuscript, patience and encouragement, my deepest appreciation goes to my wife, Jean.

[1]This investigation was supported in part by a Public Health Service predoctoral fellowship F1 MH-29,459-01 from the National Institue of Mental Health.

TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

A simple form of discrimination training equally applicable to classical and operant conditioning, consists of successive presentations of two stimuli, only one of which is coupled with reinforcement. Pavlov used a procedure of this type, which he referred to as the method of contrasts, in the study of classical conditioning. Skinner also made extensive use of the procedure in his experiments in discriminative operant conditioning.

In the typical case, training is begun on the positive or reinforced stimulus. When the negative, or unreinforced stimulus is subsequently added to the sequence of presentations it evokes at first the response which has been reinforced in the presence of the positive stimulus (generalization). However, with continued training, responding to the negative stimulus may be completely or at least substantially eliminated while responding to the positive stimulus is maintained. A discrimination of this type is often called a "go/no-go" discrimination.

There can be no doubt that a close understanding of what is involved in the development of an elementary go/no-go discrimination is central to behavior theory. A fundamental question about discriminations of this type

concerns the function of the positive and of the negative stimulus in controlling the response. The present thesis is directed toward that question in the operant case. However, the questions about the functions of stimuli which the experiments are designed to answer were first explored by Pavlov and his associates in classical conditioning. In what follows we shall attempt to state the issue in a somewhat general fashion, so that it may be asked of both operant and classical arrangements. We shall then trace the relevant evidence and argumentation from both classical and operant conditioning studies.

When an animal has learned to respond to one stimulus, S_1^+, and not to another, S_2^-, several interpretations of the functions of the stimuli are possible. Jenkins (1965) has expressed the alternatives as follows:

> "One can equally assume the animal to be operating by any one of the following rules: 1. Respond if S_1; otherwise do not respond. 2. Do not respond if S_2; otherwise respond. 3. Respond if S_1, and do not respond if S_2. The first rule involves only excitatory control, the second, only inhibitory control, the third a combination of the two." (Jenkins, 1965, p.56)

Rule 2 is conceivable only when the animal is always confronted with either S_1 or S_2 in the experimental setting. Although this is the case in some procedures of discriminitive operant conditioning, since S_1 and S_2 may be the only stimuli encountered, it is never the case in discriminitive classical conditioning. In the latter case, discrete presentations of S_1 and S_2 are separated by

between-trial periods; thus a third stimulus condition is introduced. Therefore, performance of a go/no-go discrimination in classical conditioning implies a discrimination of S_1 from both the between-trial period and from S_2. For that reason, the performance cannot be described according to the rule: do not respond if S_2, otherwise respond. Further, in those operant arrangements wherein Rule 2 is, on the face of it, conceivable, the rule can be rejected readily by observation of the animal's behavior with respect to systematic variations of the stimuli. That is, one can observe a decrement in responding when the positive stimulus is varied away from its training value. This would not be expected if the go/no-go discrimination depended merely on the presence or absence of S_2.

The more viable issue concerns the distinction between Rules 1 and 3. In a go/no-go discrimination, is the failure to respond on the negative trial due to active control by S_2 or is it only that the generalization of the excitatory effects of S_1 have been eliminated or reduced? Otherwise said, is the failure of S_2 to evoke a response adequately accounted for by noting that S_2 is not S_1, or does the particular value of S_2 as such gain active control over not responding? The operational meaning of the intended distinction will become clearer in the context of the experiments to be reviewed.

Pavlov and Skinner have each given careful consideration

to the alternatives of Rules 1 and 3. We begin with a discussion of Pavlov's experiments and his interpretation.

PAVLOV ON THE INHIBITORY FUNCTION OF THE NEGATIVE STIMULUS

Pavlov (1927) identified four types of internal inhibition. These were, 1. inhibition related to experimental extinction, 2. conditioned inhibition, 3. inhibition of delay, and 4. differential inhibition. Conditioned inhibition and differential inhibition were considered fundamental to discriminative conditioning.

Conditioned inhibition was the first to capture Pavlov's attention. Pavlov reports the general method of experimentation on conditioned inhibition as follows:

> "A positive conditioned stimulus is firmly established in a dog by means of the usual repetitions with reinforcement. A new stimulus is now occasionally added, and whenever the combination is applied, ...it is never accompanied by the unconditioned stimulus. In this way the combination is gradually rendered ineffective, so that the conditioned stimulus when applied in combination with the additional stimulus loses its positive effect, although when applied singly and with constant reinforcement it retains its full powers." (Pavlov, 1927, p. 68)

Pavlov designated the phenomenon "conditioned inhibition". Pavlov indicates that the appropriate controls were provided to show that the effect of the additional stimulus was not due to external inhibition. However, even with this possibility discounted, he states that the observation of no response (salivation) to the stimulus combination after discrimination training, while the single

positive stimulus presented singly resulted in normal salivation, was not in itself evidence that the added stimulus was acting as a conditioned inhibitor. The result could also be described as a passive disappearance of the positive conditioned reflex due to the fact that the compound stimulus was never reinforced. The active inhibitory function of the added stimulus became clear, however, in experiments involving the transfer of inhibitory function. Pavlov writes:

> "(the nature of the additional stimulus can) ... be determined only by trying out the action of the additional stimulus in different modifications of the experiment. Tested singly after the conditioned inhibition has been fully established it produces no positive effect at all. The action of the additional stimulus can be tested, however, by applying it in combination with some other positive conditioned stimulus with which it has never previously been associated. In such a case the inhibitory properties of the additional stimulus become clearly revealed, the result being an immediate diminution in the positive reflex response." (p. 75)

It is clear that Pavlov regarded the fact that the inhibitory function of the added stimulus was demonstrable in combination with stimuli with which it had not previously been paired as critical to the identification of a conditioned inhibitor.

> "...where a conditioned inhibition has been firmly established the additional stimulus itself acquires inhibitory properties which can be manifested outside the parent combination. The additional stimulus is therefore termed in our investigation the conditioned inhibitor." (p. 77)

Pavlov reports an experiment by Dr. Leporsky which demonstrates the effect.

> "Three alimentary conditioned reflexes have been established in the dog used for this experiment, the three stimuli being the flash of a lamp, a rotating object, and the tone C sharp of a pneumatic tuning fork. Two independent conditioned inhibitions of the reflex to rotation have also been firmly established, one by use of tactile stimulation of the skin and the other by the use of a metronome." (pp. 75-76)

When the tactile stimulation (conditioned inhibitor) was applied for the first time with the flashing of a lamp (a positive stimulus when presented singly) the result was a diminution of response almost to zero to this new combination. Likewise, when the metronome (conditioned inhibitor) was paired for the first time with the C sharp (another positive stimulus when presented singly) there was no salivation to this compound.

Pavlov draws the following conclusion:

> "It follows therefore, that when an additional stimulus is used with an alien homogeneous conditioned reflex, its inhibitory property becomes thereby immediately revealed." (p. 76)

The inhibited reflex is said to be homogeneous because it entails the same response; i.e., salivation to food.

An experiment by Dr. Babkin serves to show that this inhibitory property can be demonstrated when the additional stimulus (conditioned inhibitor) is combined for the first time with the positive stimulus for a heterogeneous conditioned reflex. In this case, the original reflex was salivation to food, the inhibited one was salivation to acid.

Pavlov used the term differentiation to refer to another form of discriminative conditioning. In the differentiation of a conditioned reflex the positive and negative trials are distinguished by different values along some dimension of a single stimulus rather than by the addition of a separate stimulus on the negative trial. In such cases, Pavlov referred to differential inhibition rather than conditioned inhibition, although, as we shall see, he regarded the two types of inhibition to be the result of a common underlying inhibitory function.

Pavlov describes the procedure for differentiation of a conditioned reflex as follows:

> "A differentiation is established between two closely allied stimuli, so that one of them which is reinforced gives a constant positive conditioned effect, while the other which remains unreinforced gives no secretory effect." (p. 125)

Pavlov refers to the reinforced stimulus as the "positive stimulus" and the non-reinforced stimulus as the "differentiated stimulus". For example in an experiment by Dr. Beliakov an organ pipe tone is made a positive stimulus (reinforced) while a tone 1/8 lower is "firmly differentiated from it" (unreinforced). Upon testing we find the positive tone eliciting normal salivary secretions while the tone 1/8 lower produces no response. When the positive stimulus is presented right after the differentiated one, responding is diminished. Pavlov interprets this to mean:

> "...that after application of the differentiated tone there remains in the nervous system a state of inhibition which is for some time sufficiently powerful to weaken the excitatory process set up by the application of the positive stimulus." (p. 125)

He goes on to say,

> "The inhibition which is exhibited in differentiation must be recognized as constituting the fourth type of internal inhibition which may be called differential inhibition." (p. 125)

Pavlov writes of the relation of conditioned inhibition to differential inhibition as follows:

> "It would to our mind be quite appropriate to bring conditioned inhibition also under the heading of differential inhibition since in both cases we deal with the removal by means of internal inhibition of an excitatory effect of simple or complex stimuli which acquired their excitatory properties spontaneously in virtue of their partial resemblance to the original positive conditioned stimulus." (pp. 125-126)

Thus one can see that Pavlov considered conditioned inhibition and differential inhibition to be one and the same. However, it is the compound nature of the stimuli and the detachability of the conditioned inhibitor in conditioned inhibition which allow one to demonstrate most convincingly the active inhibitory properties of certain stimuli. Stimuli varying along a single dimension as in differential inhibition can be shown to have inhibitory properties only by the after-effect on subsequent presentations of positive stimuli since one cannot "detach" a stimulus difference such as 1/8 of a tone.

In summary then, Pavlov's most convincing demonstration of the active inhibitory powers of stimuli rested

on the transfer of inhibitory control to new stimulus combinations.

We shall use the following notation to represent his procedure. Pavlov reinforced presentations of one stimulus, S(A) (the positive conditioned stimulus), and did not reinforce when S(A) was presented with another stimulus, S(B) (additional stimulus). Thus S(A) was excitatory, while the combination of S(A) S(B) eventually produced no response. When S(B) was now paired with a third positive stimulus, S(C), (previously unassociated positive stimulus) which was excitatory when presented alone, the new combination S(C) S(B) was found to produce no response. Pavlov assigned the result to the inhibitory effect of S(B) (the conditioned inhibitor).

SKINNER ON DISCRIMINITIVE CONDITIONING IN THE OPERANT CASE

Skinner provides us with an account of discriminative conditioning in the operant case. He gives a complete description of discrimination solely with reference to the contingencies of reinforcement. He defines discrimination as a process which creates a difference in strength between two related responses (Skinner, 1938, p. 227). According to Skinner, mere reinforcement of responses to S_1 is not sufficient to establish a discrimination since this continuous reinforcement would, through induction, increase the strength of the same response to S_2. It is

to overcome this generalization or induction that a method of differential reinforcement is needed.[1] In this manner the probability of response in the presence of S_1 is built up through reinforcement while responses in the presence of S_2 are extinguished through non-reinforcement. This procedure is sufficient to produce a discrimination.

In summary then Skinner's paradigm for producing a discrimination consisted of reinforcing responses in the presence of one stimulus, S(A), and never reinforcing responses in the presence of a stimulus S(A') which differed from S(A) along some continuum. In this way a difference in strength of responses in the presence of each stimulus results and a discrimination is produced.

Skinner acknowledges the fact that Pavlov has extended the notion of inhibition to the case of a

---

[1]Pavlov used the term induction for changes in strength of response to one stimulus resulting from prior stimulation. Negative induction is the decrease in strength of a response when the positive conditioned stimulus which elicits it is applied immediately after the termination of some other excitatory stimulus. Positive induction is the increase in response strength observed when an inhibitory stimulus is applied just prior to the positive conditioned stimulus. Pavlov stressed the importance of the temporal relation between the stimuli and stated that the duration of induction varied from several seconds to one or two minutes. On the other hand, Skinner used the term induction to refer to the case in which the change in strength of one response was accompanied by a similar but not so extensive change in a related response. It is the possession of common properties of either stimulus or response which is responsible for the induction in this case and the effect is regarded as independent of the time interval separating the stimuli.

discrimination of a stimulus, but goes on to point out that discriminitive learning is only a form of extinction (or only requires extinction) and no concept of inhibition is needed:

> "If a discrimination is established between two composite stimuli differing with respect to their membership, such that the reflex S(A)·R is always reinforced while S(A)S(B)·R is not, then S(B) acquires apparent power to suppress the action of S(A)·R. The effect of S(B) is called by Pavlov conditioned or differential inhibition. The case resembles true inhibition more closely than simple extinction because it involves a second stimulus; but according to the present interpretation a discrimination is only a modified form of extinction, and no concept of inhibition is needed to account for it. S(B) does not act to inhibit the reflex of S(A)·R in a way comparable with say, the inhibition of eating or of salivation by a loud sound. It is the differentiating property of a composite stimulus." (Skinner, 1938, p. 232)

For Skinner, Pavlov's "conditioned inhibitor" was merely the differentiating property of a composite stimulus. While Pavlov would characterize the stimulus difference as S(A) being positive and S(A)S(B) negative, Skinner would point out that the composite was merely another form of S(A) and thus the two stimuli would be better characterized as S(A) vs. S(A').

Skinner is not at all impressed by Pavlov's demonstration of inhibition through the transfer of inhibitory power:

> "The proof offered by Pavlov that the action of S(B) in reducing the magnitude of R in response to S(A) is really inhibitory and 'not merely a passive disappearance of the positive conditioned reflex owing to the compound stimulus remaining

> habitually unreinforced' is based primarily upon the transfer of 'inhibitory' power from one stimulus complex to another. A tactile stimulus, for example, which has become 'inhibitory' when combined with the stimulus of a rotating object is found to 'inhibit' a response to a flashing lamp, in connection with which it had never gone unreinforced. But all evidence of this sort is weakened by the fact that different conditioned reflexes of Type S based upon the same reinforcing stimulus are not independent entities. The very important problem of their inductive interrelation has not been worked out." (Skinner, 1938, p. 231)

In other words, Skinner would account for the whole of the diminution of response to a new stimulus not paired with the "inhibitor" by stating that it was merely an example of generalized extinction due to the inductive effect of non-reinforcement of the compound stimulus. To show that this could indeed take place, Skinner cites an experiment by Babkin, originally reported by Pavlov:

> "For the moment the weakness of the evidence of transfer from one reflex to another within such a group may be indicated simply by citing Pavlov's demonstration that the simple extinction of the reflex S:metronome · R:salivation produced the complete extinction of S:Tactile stimulus · R:salivation and a weakening of S:buzzer · R:salivation. This apparently establishes the inductive continuity of these rather diverse stimuli, which would account for the apparent transfer of inhibitory power in the cases cited by Pavlov. The necessary extinction of S(A)S(B) · R may affect another reflex S(C) · R directly and account for the apparent effect of S(B) when presented with S(C)." (Skinner, 1938, p. 233)

Notwithstanding the inductive continuity of the stimuli and responses Pavlov worked with, it is hard to see how this can be taken as a serious criticism of his experimental demonstration. In the transfer demonstration

the reflex S(C) · R:salivation was maintained at a high strength by reinforcement. In another experiment by Babkin this is demonstrated quite clearly:

> "A dog has a conditioned alimentary reflex which has been established by the use of a metronome, while the addition of a whistle provides a powerful inhibitory combination. Beside this a conditioned reflex to acid has been established in response to tactile stimulation of the skin. The metronome and the tactile stimuli belong therefore to heterogeneous conditioned reflexes and the positive effect of one of them (i.e., the metronome) is completely inhibited by the sound of the whistle. The whistle is now for the first time combined with the heterogeneous tactile conditioned stimulus (Experiment by Dr. Babkin)."

Time	Stimulus applied during 1 minute	Salivary secretion drops/minute
3:08 P.M.	Tactile	3
3:16 "	Tactile	8
3:25 "	Tactile plus Whistle	Less than 1 drop
3:30 "	Tactile	11

(Pavlov, 1927, p. 77)

One can clearly see that the reflex S(C), tactile stimulus · R Salivation, is maintained at a high level (strength) and that the effect observed when S(B), whistle, is added cannot be attributed to some secondary or generalized extinction.

Skinner also uses some arguments of a logical nature to cast doubt on the need or appropriateness of the concept of inhibition in the go/no-go discrimination, by asking how the concept would apply to the case of a single stimulus with different properties:

> "Other confusing or absurd cases may be generated by basing the discrimination upon the

> value of a single property. For example we should be required to show that the response to a light could be inhibited by changing the pitch or odor of the light in order to demonstrate transfer from experiments in which such changes had acquired inhibitory power through discrimination. It is only when the differentiating component has the status of a stimulus that the inhibitory power is assigned to it. When it is a single property or a change in a property, the analogy with true inhibition is less compelling". (Skinner, 1938, p. 233)

Pavlov would probably agree that a demonstration of inhibitory power through transfer would be quite impossible since the differentiating factor cannot be "detached" and recombined with a new stimulus. However, the transfer was only a convincing demonstration and not a defining property of inhibition. The inhibitory property of a stimulus becomes more apparent when we test for some trace of inhibition after its presentation (Pavlov, 1927, pp. 126-127). It was the striking similarity of the effects of both compound and single negative stimuli which led Pavlov to treat conditioned and differential inhibition as one in the first place.

Skinner does make one concession to the possibility of inhibition however:

> "It is possible that the member of a composite stimulus correlated with non-reinforcement may acquire a true conditioned inhibitory power quite aside from the process of discrimination. Failure to reinforce a response is one of the operations depressing reflex strength through an emotional change, and there is little or no distinction to be drawn between inhibition and one kind of emotion. In simple extinction the effect of failure to reinforce produces the cyclic fluctuation which characterizes the process.

> In a discrimination the presence of S(B) upon each occasion when the reflex is unreinforced may give it a conditioned emotional power, which may be transferred to another situation if S(B) is itself transferable. But S(B) then depresses the strength of a new reflex, not because it has acquired inhibitory power from having been the property correlated with non-reinforcement, but because it has previously been correlated with an emotional operation necessarily bound up with non-reinforcement. A failure to reinforce has two effects: a change in reflex strength through conditioning and an emotional state. In 'conditioned inhibition' the transfer should be due to the former, but an indication of transfer may in reality be based upon the latter." (SKinner, 1938, pp. 233-234)

This distinction between an emotional state and true inhibition seems rather arbitrary and somewhat unusual for Skinner who emphasizes observable behavior as the only worthwhile data. It is hard to see how the two could ever be experimentally separated.

Given this wide divergence of view on the function of stimuli, it will be useful to consider some current concepts of the function of negative stimuli in operant behavior.

FUNCTIONS OF THE NEGATIVE STIMULUS IN OPERANT CONDITIONING

An experiment that seems, at first, to establish that the negative stimulus can exert active control over not responding was reported by Honig (1961). In a study investigating gradients of extinction (or inhibition), Honig focused attention on the decremental gradients which could be observed around the negative training stimulus.

Pigeons were trained to peck at 13 different spectral values on a lighted key ranging from 510 to 630 mu. They received food reinforcement on a VI schedule. Extinction was then carried out at one value (570 mu). Generalization tests with all 13 stimuli revealed an orderly extinction gradient with its minimum at or near 570 mu. The fact of increased responding as stimuli values moved away on either side of 570 mu would suggest that there is some specific control of an inhibitory nature possessed by the negative stimulus.

However, Honig's results were confounded by the fact that test stimuli more remote from the negative stimulus were necessarily closer to some positive stimulus value. Therefore, the results could be explained by generalization decrement as a function of the distance from some excitatory value or values.

A more direct method for investigating inhibitory gradients was proposed by Jenkins and Harrison (1962). In the Honig study, reinforced and nonreinforced stimuli lay along the same dimension. A change in the distance between the test stimulus and the non-reinforced stimulus required that the distance between the test stimulus and the reinforced stimulus also be changed. To overcome this, Jenkins and Harrison tested for a generalization gradient along a dimension of the non-reinforced stimulus which would appear to be orthogonal to any dimension of the reinforced stimulus. In this case test points along the inhibitory gradient would be equally distant from the reinforced stimulus.

In one of their experiments, pigeons were trained on a discrimination in which a pure tone (1000 cps) was the non-reinforced stimulus and the reinforced stimulus was a white noise equated for sound pressure level. The stimuli for the generalization test were 7 tones from 300 to 3500 cps. They reported:

> "...results showed that some degree of specific inhibitory control was exerted by the frequency of the tone, although the gradients were broad and shallow in shape." (Jenkins and Harrison, 1962, p..435)

In a second experiment, two tones of widely different frequencies were non-reinforced (300 and 3500 cps) and the positive stimulus was no tone. Again one can see that by testing along a continuum of tones of different frequencies we are testing at points equally dissimilar from the no tone condition. In this experiment, if discrimination produces a sloping gradient of inhibition, the least inhibitory effect and therefore the maximum responding, would be expected in the vicinity of 1000 cps, which, on a logarithmic scale is midway between the values of the two negative stimuli. The results did indeed show a local maximum in responding at 1000 cps for each subject.

Thus in both experiments while curves are admittedly shallow and broad, the overall results provide evidence for true inhibitory gradients and a way of looking at such gradients in a more direct manner than had previously been proposed.

Hongi, Boneau, Burstein, and Pennypacker (1963) employed stimuli which seemed to conform with the requirements set down by Jenkins and Harrison for direct observation of an inhibitory gradient. The positive stimulus was a blank key, while the negative stimulus was a key showing a line in the vertical orientation. The generalization test consisted of presentations of the line in 6 different orientations from 0 to 150 degrees including the negative stimulus condition (90 degrees). A clear inhibitory gradient was obtained. Responding increased progressively as the orientation of the line was changed from vertical (S^- in training) to horizontal.

Although this experiment approached the problem along the lines suggested by Jenkins and Harrison, the result may be subject to a further criticism. When pigeons peck at an illuminated key with a small opaque dot, pecks may be restricted to a very small area around the dot. If pigeons confine their observation as well as their pecks to a small area, experiments which vary the orientation of a single line on the key may not be what they seem. The rotation of the line may leave the area once occupied by the line blank. Thus, when the line is rotated the key may appear more like the blank key which was the positive stimulus in training.

We turn briefly to two studies which are not ideally constructed for the purpose of making the distinction between rules 1 and 3, but which do nevertheless, strongly suggest inhibitory control of nonreinforced stimuli.

Hanson (1959) in an experiment designed to investigate the effects of discrimination training on the generalization gradient, cites results which suggest that this discrimination training imparts some active control (inhibitory control?) to the negative stimuli.

Subjects were pigeons trained to peck at a monochromatically illuminated key for food reinforcement on a VI schedule. There were four experimental groups which were given discrimination training between a positive (550 mu) and one of four negative (555, 560, 570, 590 mu) stimuli. A control group was included which learned to peck at the positive stimulus for food but was given no subsequent discrimination training. When the discrimination was learned, generalization tests were given in extinction. Each test consisted of random presentations of 13 different stimuli ranging from 480 to 620 mu.

One of the most striking results is now commonly referred to as the "peak shift" effect. When the post discrimination gradients were compared with the generalization gradients given by the control group, the post discrimination gradients were displaced away from the negative stimulus in the direction of the positive. Thus, the highest rate of responding occurred, not to the wavelength specifically reinforced as might be expected, but to a wavelength displaced from the reinforced stimulus in a direction away from the negative stimulus. The displacement was interpreted

by Hanson to be the result of an inhibitory gradient surrounding the negative stimulus.

Cornell and Strub (1965) proposed an alternative to the generalization test technique for demonstrating inhibitory stimulus control in the operant situation. Rats were trained to press a lever for food on a VI schedule. Three lights located in a row on the same wall as the lever were the stimuli. The two outside lights were individually established as separate positive stimuli, while responding to the center light (negative stimulus) was extinguished through nonreinforcement. When the discrimination was learned Ss were tested in extinction. The extinction test consisted of random presentations of each of the three separate stimuli and each of the four possible combinations of the training stimuli. Data were presented in the form of mean cumulative responses in extinction in the presence of the various stimuli and stimuli combinations. Cornell and Strub concluded:

> "On the basis of the data it is clear that the simultaneous presentation of both excitatory and inhibitory stimuli during extinction does provide evidence for the conclusion that the latter functions as a signal for not responding (i.e., it exerts inhibitory control) since, whenever S_D was presented in combination with one or two S^Ds there was a decrement in responding. This was true of every animal tested when his responding in the presence of the excitatory plus inhibitory combination was compared with his responding in the presence of the excitatory component alone."[2] (Cornell and Strub, 1965, p. 26)

---

[2] In this thesis S^+ and S^- will be used rather than S^D and S employed by some authors as in this quotation.

Cornell's experiment very likely does involve control of not responding by S^-, but it is not the clearest demonstration. The stimuli are all lights in close spatial proximity. One might criticise the results by saying that when S^- was presented in combination with S^+, there was some perturbation of the S^+, making it look less like the original positive stimulus and resulting in a generalization decrement, since the pattern of light associated with S^+ is no longer present. However, Cornell's experiment does show that when the two S^+s were presented together for the first time in extinction, which might have perturbed each individual S^+, the result is not generalization decrement but rather increased responding. This strengthens the argument that S^- does exert inhibitory control.

It may be noted that in most of the foregoing experiments, there were no controls for the possibility that observed decrements were due to external inhibition. Such controls would involve groups in which no discrimination training took place and the negative stimulus for the experimental group was introduced for the first time in extinction. In the Honig (1961) study it is unlikely that the spectral value chosen for the negative stimulus would exert such an unconditioned inhibitory effect. Similarly, Jenkins and Harrison (1962), Honig, et. al. (1963), and Cornell (1965) might have included groups which never received the negative stimuli until the test in extinction.

Hanson (1959) did include the appropriate control for external inhibition and found none. Hanson's results coupled with data from control groups to be presented in this thesis make it seem highly unlikely that any external or unconditioned inhibition is responsible for the results obtained in the operant conditioning experiments mentioned above.

Taken together, the experiments reviewed above, provide considerable evidence that in discriminative operant conditioning animals may learn to not respond on signal. It now seems very likely that there is inhibitory control in addition to excitatory stimulus control in operant discrimination learning.

If our conclusion is correct, one might expect the application to the operant case of the Pavlovian paradigm of training and testing for conditioned inhibition would produce closely parallel results. It is, in fact, puzzling that the possibility of a parallel has not been previously investigated. Perhaps the reason lies in the early divergence between Pavlov's and Skinner's choice of stimuli. Pavlov dealt first with the case in which the unreinforced occasion consisted of the positive stimulus plus another separate stimulus which became the conditioned inhibitory. The problem of differentiation between values of a single stimulus (e.g., frequency of a tone) was treated later and subsumed as a special case of conditioned inhibition. Skinner's primary reference, on the other hand, was either to the case where reinforcement and nonreinforcement were with respect to neighboring values of a single stimulus or

where the presence versus absence of a stimulus distinguished reinforced from nonreinforced occasions. Skinner took Pavlov's experiments with compound stimuli to be a special case of his own arrangements. The early divergence in the choice of arrangements has persisted. To this date there are very few experiments in operant conditioning which make use of compound stimuli.

The experiment on conditioned inhibition in the present thesis makes use of compound stimuli in order to see whether a parallel exists in the operant case for the Pavlovian demonstration of conditioned inhibition.

CHAPTER II

THE EXPERIMENT ON CONDITIONED INHIBITION

The general paradigm for conditioned inhibition, the particular arrangement used by Pavlov, and the one used in the present experiment are noted in Table 2-1. As will be seen, the Pavlovian paradigm has been modified in certain respects in the present experiment in order to take account of Skinner's objections to Pavlov's demonstration of conditioned inhibition.

Skinner's general objection to the Pavlovian demonstration was that the several reflexes involved had a great deal of "inductive continuity". In other words, changes in the strength of one reflex might cause changes in the strength of certain other reflexes directly rather than as the result of a specific inhibitory effect. Thus, Skinner raised the possibility that the nonreinforcement of S(A) plus S(B) might have weakened the response to S(C) even before the addition of S(B). That interpretation can be readily eliminated by showing that the response to S(C) alone is maintained while the response to S(C) plus S(B) is reduced. In fact we have already seen that this objection is not well founded since Babkin's experiment (p. 13 of the present report) shows that the response to S(C) alone

TABLE 2-1

TRAINING AND TESTING PROCEDURES FOR CONDITIONED INHIBITION

TRAINING PHASE

General Case	Pavlov's Experiment	Present Experiment
S(A) • R(A) reinforced	Metronome • Salivation to Food	Green Key • Peck Left-Food
S(A) + S(B) nonreinforced	Metronome + Whistle - No Food	Green Key + Tone - No Food
S(C) • R(C) reinforced	Tactile • Salivation to acid	Red Key • Peck Right - Food

TESTING PHASE

Stimulus	Expected behavior	Stimulus	Expected behavior	Stimulus	Expected behavior
S(A)	R(A)	Metronome	Salivation	Green Key	Peck Left
S(A) + S(B)	No response	Metronome + Whistle	No Salivation	Green Key + Tone	No Peck
S(C)	R(C)	Tactile	Salivation	Red Key	Peck Right
S(C) + S(B)	No response*	Tactile + Whistle	No Salivation*	Red Key + Tone	No Peck*

* Critical test for transfer of inhibitory control.

was maintained. A more troublesome question is whether the apparent transfer of inhibition arises because S(A) and S(C) are highly similar. If that were the case, the fact that S(B) inhibits the response to S(C) as well as to S(A) might be attributed to a failure of the animal to discriminate S(C) from S(A). To evaluate that possibility in the present experiment, Ss were trained to respond differently to S(A) and to S(C).

DESIGN OF THE FIRST EXPERIMENT

The design of the present experiment is outlined in Table 2-1. For clarity and simplicity the design is described with reference to only one arrangement of stimulus and response pairings. However, the assignments of stimuli to responses were balanced in the experiment.

The two responses called for in this experiment were differentiated by the location of the peck; i.e., on the right or left side of a split key. When both halves of the key were backlighted with a red light, the bird was reinforced for responding on the right side of the key. A green lighted key called for a left response. Figure 2-1 shows the arrangement. The training of these responses is referred to as the visual discrimination phase.

After the discrimination of key color was trained, a go/no-go discrimination based on the presence versus absence of a tone was trained in conjunction with just one of the

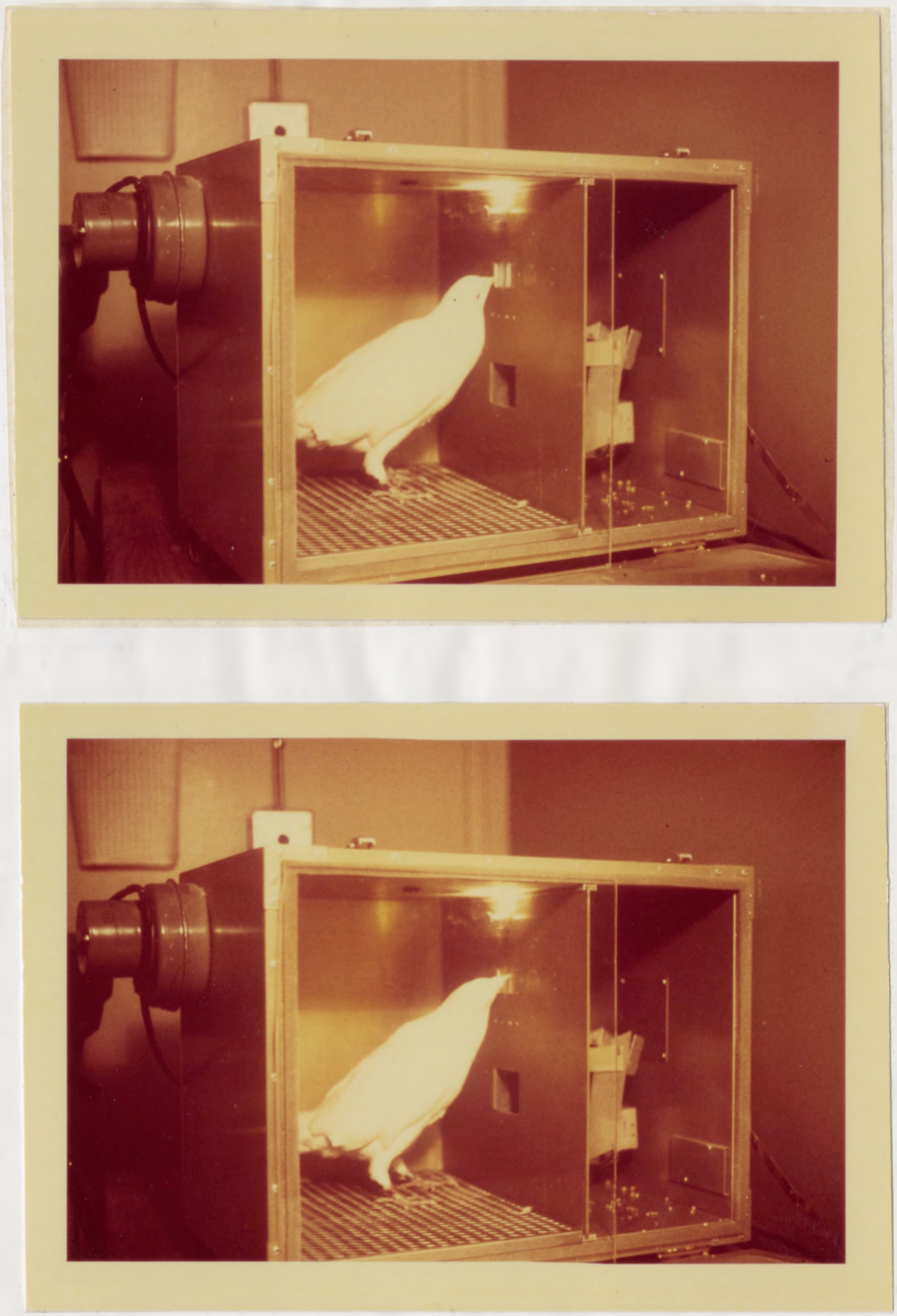


FIGURE 2-1

TYPICAL VISUAL DISCRIMINATION OF PECKING LEFT TO GREEN LIGHT AND RIGHT TO RED LIGHT.

key colors. For example, a response to the left when the key is lighted green was reinforced only when no tone was present. No responses were reinforced when a 1000 cps tone at 80 db accompanied the green key light. This training is referred to as the auditory discrimination phase. The other key color was not presented during this phase of training.

Since the auditory discrimination phase was carried out using only one key color, it was necessary to reintroduce the other color in order to insure that the visual discrimination was maintained. The post auditory discrimination phase demonstrated differential responding to the two key colors and provided evidence that both the visual and auditory discriminations were well learned. A detailed description of this phase is included in the procedure section.

Following the post auditory discrimination phase, a test for the transfer of inhibitory control was made. If the tone was functioning as a conditioned inhibitor, it should be able to inhibit responding to the red key with which it had never been paired. The test for inhibitory control was carried out in extinction. Table 2-1 sets out the four types of trials presented in the extinction test. The critical trial for demonstration of the inhibitory control is red key plus tone (S(C) plus S(B)). A clear diminution of responses under this condition when compared to the red key without tone would be evidence for the conditioned inhibition of an operant response. Note also that differential performance

depending on the key color would show that the two stimulus conditions (red vs. green) were clearly discriminated and that the red light did not "look" green in the presence of tone. Also, continued responding to the red key when not paired with tone would provide evidence that generalized extinction or inductive continuity was not responsible for the reduction of responses to red key plus tone.

One might suggest that any diminution of response in the presence of red key plus tone was merely due to external inhibition, i.e., an unconditioned inhibitory effect. To evaluate this possibility a control group was included which learned the pecking response to a key of just one color and was then presented with tone and no tone trials (red key and red key plus tone) in extinction to see whether the introduction of a tone previously unassociated with non-reinforcement would effect the probability of response. A more detailed description of the training and testing of the control group is found in the procedure section.

METHOD

Subjects

Subjects were male white king pigeons, five to six years old and experimentally naive. They were supplied by the Palmetto Pigeon Plant, South Carolina. Pigeons were maintained on an ad lib diet of mixed grains for a period of at least two weeks. They were then reduced to 80%

of ad lib weight by restricted feeding and were maintained within 5% of this level throughout the experiment.

Apparatus

An automatic pigeon key pecking box (manufactured by Lehigh Valley Electronics) and similar in essentials to the one described by Ferster and Skinner (1957) was used. A split response key consisting of two pieces of translucent plastic was used. The split key was located in the center of one wall of the box at a height of 10" from the floor. A peck at either half of the key closed a miniature switch for purposes of recording and for the control of other events. The two pieces of plastic were placed side by side with a separation of 1/16" so that responses on either side of the key could be recorded independently. In order to prevent a single peck from depressing both keys simultaneously, a strip of aluminum 1 1/16" high by 1/4" wide was riveted to the wall 1/16" in front of the point where the two halves of the key joined. The part of each half of the key exposed to the animal was a rectangle 1 1/16" high by 11/16" wide.

Beneath the response key was an opening through which the pigeon could reach food when a tray containing grain was raised into position.

Responses were reinforced by raising the tray containing a grain mixture into position for a period of four

seconds. The occurence of a reinforcement was signalled by lighting the tray opening while the tray was available.

The box was equipped with a 3" speaker mounted with its center 5" to the left of the center of the key and 2½" below it. Ventilation was provided by an exhaust fan mounted on the wall opposite the response key.

The general illumination of the compartment was by a no. 1820 miniature bulb mounted above the key in a housing which directed the light up against the ceiling of the box.

The sequence of stimuli was programmed with the aid of a five-channel tape reader, relay switching circuits and timers. A running record of the test sessions was also recorded on an Esterline Angus operations recorder. A closed circuit television system permitted observation of the Ss. The television camera was located outside the experimental chamber and was aimed at the pecking area through a viewing window in one wall of the box.

Stimuli

The experiment involved both auditory and visual stimuli. The auditory stimuli were a tone at 1000 cycles, generated by a General Radio Audio oscillator (Type 1311-A), or a broad band white noise supplied by a Grason-Stadler noise generator. Noise was the prevailing or background stimulus. When the tone was switched on during a trial the noise was simultaneously switched off. Either tone or noise was on throughout the experimental sessions. On trials where tone was not employed the white

tone was not employed the white noise continued without change. The intensity of both the white noise and the tone were maintained at 80 db sound pressure level as measured by means of a General Radio sound survey meter (Type 1555-A). The receiver end of the meter was placed on a level with, and 2½" in front of, the pecking area. The stimulus measurements were made with the fan running and the compartment closed. Sound levels were monitored each day and adjusted as necessary.

The visual stimuli consisted of backlighting both the left and right halves of the key with one color, either red or green. The voltage level as measured across the filament of the two light bulbs used (No. 1820) was 28.4 Volts D.C. Care was taken to adjust the position of the light bulbs to assure that both halves of the key were illuminated equally. As a further check on possible brightness differences on the left and right halves of the key, the location of the two bulbs was reversed on several occasions during the experiment. Since this in no way disturbed the discrimination, it is concluded that any brightness differences which might have existed between halves of the split key were unimportant.

Discriminated Trial Procedure

Training was by a discriminated trial procedure (Jenkins, 1962). The trial was always marked by the onset of the key light. Between trials the key was dark, but the compartment itself remained illuminated. Pigeons very quickly learn to discriminate the trial from the between trial periods in this arrangement.

An intertrial response operated a delay circuit which prevented the next trial from being initiated within 60 seconds. The circuit that initiated this delay was, however, not put into effect until one second after the termination of a trial. Thus an extra response occurring within 1 second of the offset of the key light did not initiate the delay. Trials were terminated (key light off) when a response requirement was met, or by external control if the requirement was not met before a maximum duration of eight seconds had elapsed. Four responses were required to terminate the trials. The four responses are referred to as a response unit. On reinforced trials the tray operated immediately upon the completion of the response unit. Trials were also terminated by the response unit on nonreinforced trials during the go/no-go auditory discrimination phase but the tray, of course, did not operate. A single response to the incorrect key also terminated a trial without reinforcement.

The intertrial time intervals were randomly varied from 30 to 90 seconds in five-second steps. All values were equally represented, yielding a mean intertrial interval of 60 seconds.

Training procedure for experimental group

Table 2-2 provides an outline of the training procedure followed for the experimental group (N=4). In Table 2-2 the procedure is given for one assignment of key color, response, and choice of the key color on which the auditory discrimination was carried out. Assignments of conditions for each S are given in Table 2-3.

The following notes expand, where necessary, on the description given in Table 2-2.

Phase 1. In Phase 1, the bird was trained to respond to one half of the red lighted key by the method of successive approximation as described by Ferster and Skinner (1957). The correct response for the red lighted key was, for example, to peck at the right side of the key. To facilitate this response, the left side of the key was darkened by blocking the light with a piece of opaque paper. For the first session only, several pieces of grain were attached by means of transparent adhesive tape, to the face of the right half of the key.

Phases 2, 3, and 4. As in Table 2-2.

Phase 5. A correction procedure was instituted in

TABLE 2-2

SUMMARY OF TRAINING AND TESTING PROCEDURE FOR THE EXPERIMENTAL GROUP. (See text for further explanation)

Phase 1: Tray training and reinforcement of responses to lighted half of key (right side lighted red). Intertrial periods introduced. Response to unlighted half of key (left side) terminates trial. Response requirement advanced from one to four.

Phase 2: Both halves of key now illuminated with red on all trials. Four pecks to right (response unit) reinforced, single peck to left terminates trial.

Phase 3: Right half of key darkened. Left half lighted green on all trials. Response unit on left reinforced, single peck right terminates trial.

Phase 4: Both halves of key illuminated green. Response unit on left reinforced, single peck right terminates trial as in Phase 3.

Phase 5: Irregular sequence of trials with key illuminated red (response unit on right reinforced) or green (response unit on left reinforced). Single peck to wrong side terminates trial. A correction procedure introduced so that trial repeated until correct response unit occurred.

Phase 6: Same as Phase 5 but correction procedure removed.

Phase 7: Auditory discrimination training. All trials with green key. Trial without tone: response unit on left reinforced; single response to right terminates trial without reinforcement. Trial with tone: no responses reinforced. Response unit on left or single response on right terminates trial.

Phase 8: Post auditory discrimination. Trials of three types (Green key with and without tone, red key without tone) presented in an irregular order. Reinforcement and trial termination contingency as in Phases 6 and 7.

Phase 9: Extinction test. Four types of trial presented in irregular order. Three types listed in phase 8, and in addition, red key with tone (test of inhibitory effect of tone).

TABLE 2-3

ASSIGNMENT OF BIRDS TO VARIOUS GROUPS AND STIMULUS CONDITIONS.

EXPERIMENTAL GROUP

Bird No.	Appropriate response to each key color	Key color used in auditory discrimination phase
P-25	Red - Right Green - Left	Green
P-27	Red - Left Green - Right	Red
P-29	Red - Right Green - Left	Red
P-30	Red - Left Green - Right	Green

CONTROL GROUP

Bird No.	Key color and appropriate response
P-60	Green - Right
P-100	Green - Left
S-24	Red - Left

which the programming equipment advanced in order to present the next trial in the sequence only after a correct response unit. An incorrect response terminated the trial but the programming equipment did not advance so that the same trial was presented again after an intertrial interval. A total of 80 trials, 40 red-key trials and 40 green key trials were programmed in an irregular order during each session with the restriction that the first group of 40 contain 20 red and 20 green trials. Since the program advanced only after correct trials, 80 reinforcements were delivered per session during this phase of training.

Phase 6. As in Table 2-2.

Phase 7. The key was lighted green on all trials. A total of 80 trials, 40 trials with no tone and 40 trials with tone, were presented in random order subject to the restriction that each half of the session contain 20 tone and 20 no-tone trials. On no-tone trials a response unit on the left side was reinforced as before. On tone trials, a response unit on the left terminated the trial (key light and tone off) without reinforcement. A single peck to the right side also terminated the trial without reinforcement. The key color used for this training is called the auditory training stimulus. The other key color was reserved for testing the transfer of inhibitory control and is termed the transfer test stimulus.

Phase 8. This phase of training was begun only after responding had been reduced to a very low level on green key plus tone trials. Therefore there was very little responding on such trials in this phase. The test session consisted of 120 trials made up of 40 of each type of trial (See Table 2-2) presented in an irregular order, with the restriction that 20 of each type of trial appear in the first half of the session.

Phase 9. Reinforcement was discontinued. Conditions of trial termination were unchanged. There were 40 presentations of each of the four types of trial, making a total of 160 trials. An irregular order of presentations was used. Twenty trials of each type were presented in the first half of the session. Two tests on consecutive days were run.

The decision to advance beyond Phase 5 of training or to the test was based on performance. The criteria were approximate. Birds were not advanced until fewer than 6 inappropriate responses out of 40 occurred for any type of trial. In the case of the auditory discrimination, birds were not advanced to Phase 8 until there were less than 5 response units out of a possible 40 made in the presence of the tone stimulus.

The basic data of the experiment consisted of the total number of responses and response units to each of the stimuli on the test sessions in extinction.

Training procedure for control group

The purpose of the control group was to ascertain the effect of adding a tone to a visual stimulus for the first time in extinction. The assignments of correct responses to key colors are given in Table 2-3. They were matched to those of the experimental birds. Since two different responses were not required for this group, birds learned only to respond to a single key color on the appropriate side of the key. Thus only Phases 1 and 2 were required for the training of the control group. All control birds received at least 25 sessions of training consisting of 40 trials each. At the close of training, each control S was making less than 5 incorrect responses per 40 trials. The test, in extinction, consisted of tone and no-tone trials in conjunction with the key color on which they had been trained. 40 trials of each type were presented for a total of 80 in each test session.

RESULTS

Training

A detailed record of the performance of each S in training is given in Appendix I (p.85ff). Bird P-29 in the experimental group had not learned the visual discrimination after 51 sessions and was withdrawn from

the experiment.[3] Performance on the last day of training, just prior to the test is shown for the remaining experimental Ss in Table 2-4. It is evident that each S was responding appropriately on almost all trials. Thus, each key color evoked a response to the correct side, and the presentation of tone in conjunction with one key color (auditory training stimulus) resulted in an almost complete absence of response.

Training the control group was a relatively simple matter since they were only required to respond on one side of the key which was illuminated with the same color on every trial. Their performance was virtually errorless at the close of training.

Testing

A complete record of responses, trial-by trial, in the actual order of trial presentations is shown for each S

---

[3]The visual discrimination proved to be a most difficult one to train. Even birds in the control group made considerably more responses to the wrong side than would be expected. Changes in certain aspects of the procedure may help to decrease the training time. For example, allowing four responses to the incorrect side before termination of the trial without reinforcement and increasing the separation between halves of the key may improve the discrimination. Further investigation is planned to increase the efficiency of the visual training procedure.

TABLE 2-4

PERFORMANCE ON FINAL DAY OF TRAINING

	Auditory training stimulus[1]								Transfer Test Stimulus[2]			
	No-Tone Trials				Tone Trials				No-Tone Trials			
Bird	Prs	Rsp	RU	Err	Prs	Rsp	RU	Err	Prs	Rsp	RU	Err
P-25	40	157	39	0	40	14	2	0	40	156	37	3
P-27	40	153	37	3	40	23	3	0	40	153	38	2
P-30	40	137	32	4	40	5	1	0	40	148	33	5

NOTE - The maximum number of responses possible on a given type of trial is 160. The maximum number of response units 40. Prs: Trial presentations. Rsp: Total responses. RU: Total response units. Err: Total responses to wrong side of key.

[1]Designates key-color used in conjunction with the auditory go/no-go training.
[2]Designates the other key-color on which the transfer of an inhibitory effect of tone is to be tested in extinction.

in the experimental group on the first test day in Appendix I (pp.88, 97, 105). The present summary is based on the first test session only since very few responses occurred thereafter.

Summary results for the first test session are shown for experimental and control Ss in Table 2-5. From the small number of errors (a response to the wrong side of the key) it is evident that the visual discrimination was maintained in the experimental group. Further the go/no-go discrimination based on the tone as a no-go signal was maintained for the key color on which it was originally trained (auditory training stimulus). Most important, the inhibitory effect of the tone transferred to the other key-color (transfer test stimulus). The transfer was clear, but somewhat less than complete since each animal in the experimental group made more responses when the tone was presented in conjunction with the transfer test stimulus than when it was presented with the auditory training stimulus.

The results for the control Ss show no detectable effect of the tone when it was presented for the first time in extinction. The inhibitory effect of the tone was therefore a result of conditioning and cannot be ascribed to an unconditioned inhibitory effect.

A trial by trial plot of cumulative responses in the first test session is shown for the experimental Ss

TABLE 2-5

PERFORMANCE ON FIRST DAY OF THE EXTINCTION TEST

EXPERIMENTAL GROUP

	Auditory Training Stimulus								Transfer Test Stimulus							
	No-Tone Trials				Tone Trials				No-Tone Trials				Tone Trials			
Bird	Prs	Rsp	RU	Err	Prs	Rsp	RU	Err	Prs	Rsp	RU	Err	Prs	Rsp	RU	Err
P-25	40	119	28	0	40	10	1	0	40	125	30	1	40	39	7	1
P-27	40	152	36	1	40	6	0	1	40	143	32	2	40	38	3	1
P-30	40	132	31	2	40	9	2	1	40	112	24	6	40	62	7	0

CONTROL GROUP

	No-Tone Trials				Tone-Trials			
Bird	Prs	Rsp	RU	Err	Prs	Rsp	RU	Err
S-24	40	148	34	1	40	146	34	0
P-60	40	71	16	4	40	68	14	2
P-100	40	151	35	5	40	157	37	3

NOTE - Prs: Trial presentations. Rsp: Total responses. RU: Total response units.
Err: Total responses to wrong side of key.

in Figure 2-2. The results for each type of trial have been segregated and are plotted consecutively although the trials of a given type were in fact presented interspersed with trials of other types. In Figure 2-2 errors (responses to the wrong side) which, as may be noted in Table 2-5 were very infrequent, are not differentiated from correct responses. In the few cases in which an error occurred after one or more responses had been made to the correct side, the error was not counted as a response.

The plots show that on the first few trials, each S responded at least once to the transfer test stimulus whether accompanied by the tone or not. On these trials the discrimination of key color was maintained since the responses were made to the appropriate side of the key both with tone present and with tone absent. The presentation of tone did not cause a breakdown of the discrimination based on key-color. Thus when the inhibitory effect later becomes evident, it is clear that the inhibition applies to the discriminated response.

Figure 2-3 is presented in order to examine the immediacy of the inhibitory effect and specifically to see if there was evidence of inhibition on the very first test trials. The first four tone and no-tone transfer test stimulus trials as copied from the Esterline Angus event recorder chart are presented with the corresponding tone and no-tone trials matched. Latency of the first response

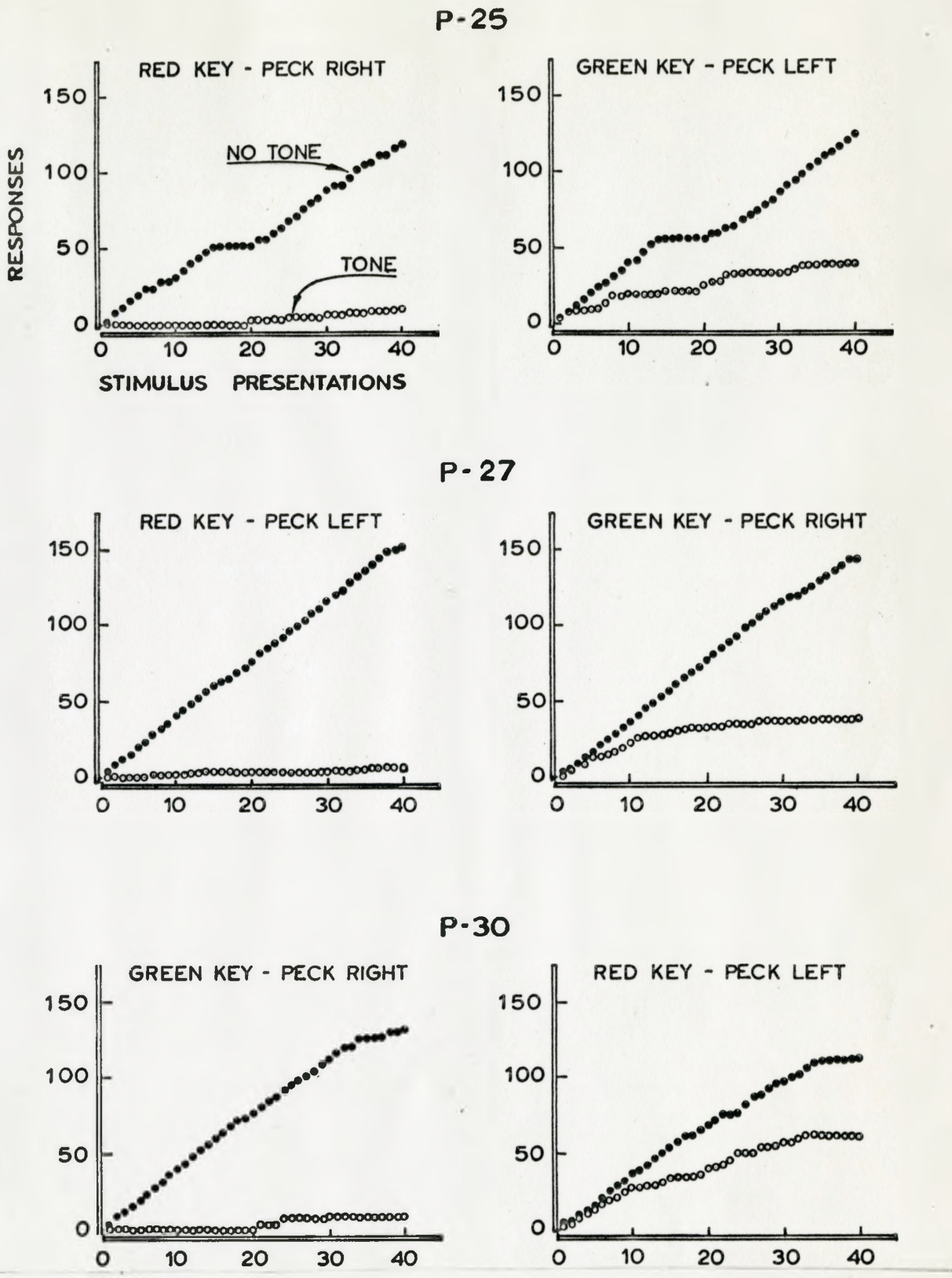


FIGURE 2-2

CUMULATIVE RESPONSES ON EACH TRIAL TYPE FOR FIRST TEST SESSION.

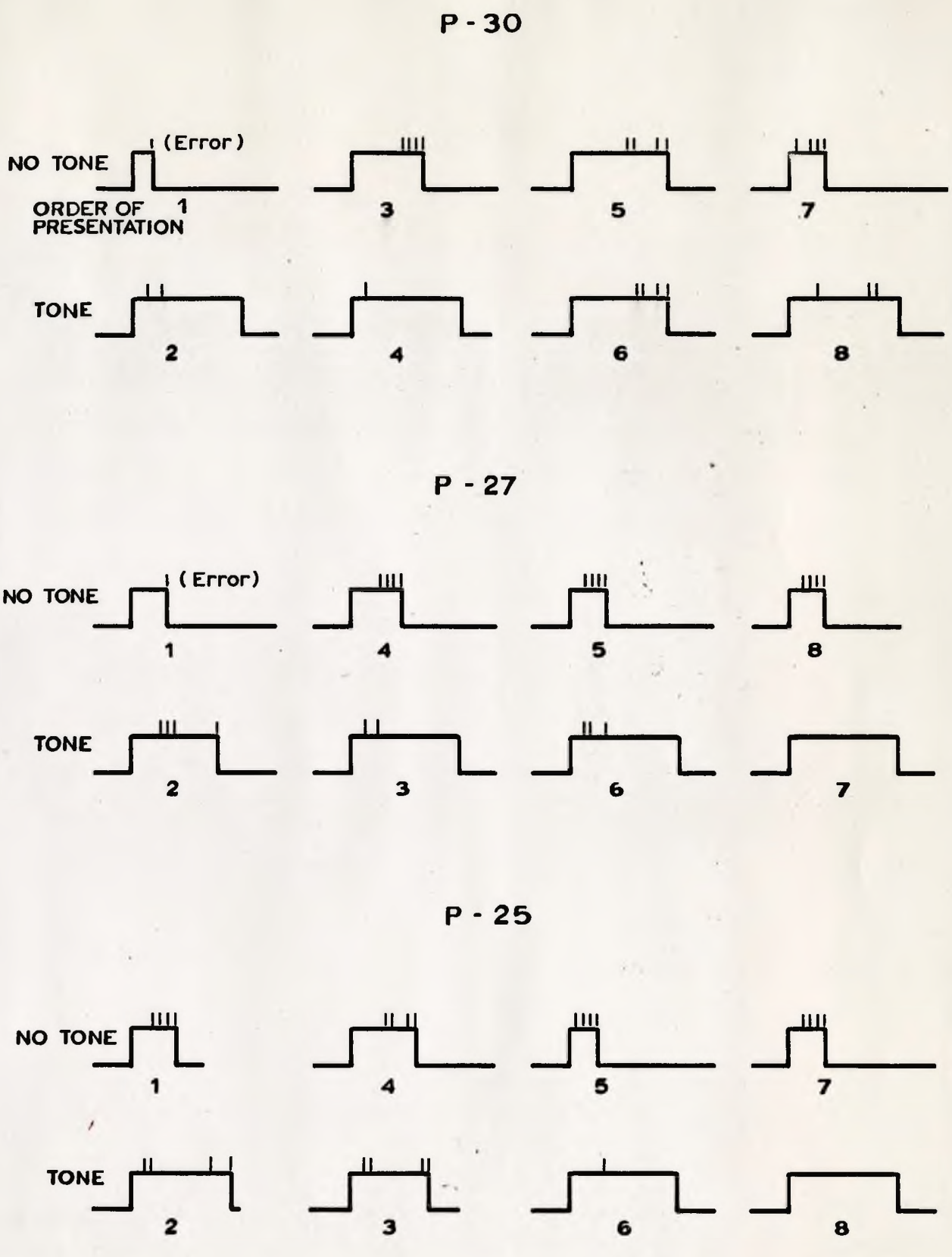


FIGURE 2-3

DETAIL ON FIRST FOUR PAIRS OF TONE/NO-TONE TRIALS ON TRANSFER TEST STIMULUS. (Vertical hash marks are pecks.)

and time to complete the response unit on each trial is shown in Figure 2-3. The clearest effect of the tone on the first trial may be seen for bird P-25. While the response unit was completed on the first tone trial, the latency and time to completion were longer than on the no-tone trial. By the third and fourth paired comparisons the inhibitory effect is clearly seen. It is unfortunate that a direct comparison of the first tone and first no-tone trials for P-27 and P-30 cannot be made since both these birds made errors on the first response to the no-tone presentations and terminated the trial. While P-27 did complete the response unit on the first tone trial, the latency of the first response and time to completion was longer than that for any subsequent no-tone trial. Where direct comparisons between tone and no-tone trials are available for this bird failure to complete the response unit on the second and third tone trials, and failure to respond at all on the fourth tone trial as compared to the rapid responding on no-tone trials makes the inhibitory effect manifest. Bird P-30 failed to complete the response unit on the first tone trial, and while direct comparison is not available with the first no-tone trial, all subsequent no-tone trials show rapid responding and completed response units. This strongly indicates that here too, an inhibitory effect was present at the outset. Later paired trials for P-30 also

show a diminution in responding on tone trials when measured by latency and completion of response units.

All birds were closely observed via the closed circuit television system and special attention was paid to the early tone presentations with the transfer test stimulus. The latency data depicted in Figure 2-3 was reflected in a hesitancy to respond for all experimental birds. On the very first tone trial with the transfer test stimulus the Ss paused for varying amounts of time directly in front of the key before the first peck and between pecks.

The results cited above indicate that an inhibitory effect was present from the very first trial although somewhat attenuated by the fact that the response probability on the transfer test stimulus was high.

The following statistical test was made of the difference in responding on tone and no-tone trials on the transfer test stimulus in the experimental group. We considered 40 pairs of trials consisting of the nth presentation (n=1-40) of transfer test stimulus with tone and the nth presentation of transfer test stimulus without tone. Since those pairs that show responses on both trials or on neither trial are indecisive with respect to the inhibitory effect of the tone, we were concerned with the subset consisting of all pairs of trials on which one or more responses occurred on just one trial of the pair. On the null hypothesis half of the trial pairs in this

subset contain a response on no-tone trials and of course, half on tone trials. The actual number of such pairs that show the response on no-tone trials and tone trials was as follows: For P-25, 20 on no-tone trials and 2 on tone trials; for P-27, 20 on no-tone trials and 0 on tone trials; for P-30, 10 on no-tone trials and 1 on tone trials. A binomial test (two tailed) of these frequencies permits rejection of the null hypothesis at the .01 level or better in each case.[4]

CONCLUSIONS

The application of the Pavlovian paradigm for the demonstration of conditioned inhibition to the operant case has shown that a clear parallel exists. A stimulus (tone) that has become a signal for not responding when paired with one excitatory stimulus (key color used in

---

[4]The problem of a within-animal test of the significance of the difference in responses to two stimuli presented in random order is made difficult by the lack of independence for the successive observations. While the nature of the nonindependence cannot be specified, it is clear that the observations are not independent since early in the test responses occur to both stimuli while as extinction progresses a point is reached where responses no longer occur to either stimulus. The present strategy of considering neighboring pairs of trials and just those pairs for which a response occurs on only one of the trials seems intuitively to minimize the role of nonindependence since the observations are taken after a comparable number of previous extinction trials. However, no formal rationale for the procedure can be offered at this time.

conjunction with a go/no-go auditory discrimination) also serves as a signal for not responding when it is combined with another excitatory stimulus (key color used for the transfer test) that is clearly discriminated from the one employed in the original training. An appropriate control makes it evident that we are dealing with a conditioned inhibitory effect rather than an unconditioned effect.

Skinner's objections to Pavlov's demonstration of conditioned inhibition do not apply to the present experiment. The extinction of responding to the combination of tone with one key-color did not cause loss of response to the second key color as the result of generalized or secondary extinction. That is clear because the response to the second key color remains strong in the absence of the tone. Further, the inhibitory effect of tone on the response to the second key-color cannot be ascribed to a failure to discriminate between the key colors since the differential response to the colors (peck right vs. peck left) was maintained during the test session.

It now seems likely that Skinner's objections are also irrelevant to the Pavlovian case.

CHAPTER III

THE EXPERIMENT ON CONDITIONED EXCITATION

The experiment on conditioned inhibition has shown that a stimulus paired with nonreinforcement can become a conditioned inhibitor of an operant response. The paradigm for the experiment readily suggests a counterpart to conditioned inhibition; namely, conditioned excitation. In order to examine the possibility of a conditioned excitatory function, the added stimulus of the tone is paired with the reinforced rather than the nonreinforced trials. A test for transfer of the excitatory function could be similar in design to the test previously described for the inhibitory function. Although Pavlov did not use the term "conditioned excitation" the parallel to conditioned inhibition is evident.

There are a number of experiments in the literature which have demonstrated the facilitative effect of a positive discriminative stimulus when transferred to a new response. In fact, more attention has been focused on the facilitative effects of stimuli than on inhibitory effects. The general plan of these experiments has been to establish a discriminative stimulus (S^+) for some response and then test for the transfer of the discriminative effect when S^+ is introduced into a new response situation.

Transfer of the discriminative effect has been tested in two ways. One way is to introduce the stimulus in extinction and to observe its effect on probability of response or on resistence to extinction. A test of this kind parallels the test used by Pavlov, and in the present thesis, for conditioned inhibition. A second method of testing might be referred to as the "new learning" method. In this method an S^+, and in some cases an S^-, are established. Then, a second discrimination is trained involving the same stimuli but a different response. The transfer effect is evaluated by comparing speed of learning the second discrimination with that of learning the original one. A variation of this method is to compare the rate of learning the second discrimination when the reinforced and nonreinforced stimuli in the original training continue to be reinforced and nonreinforced in the second discrimination (consistent assignment of stimuli) with the rate of learning when the assignment of the stimuli to reinforced and nonreinforced occasions is reversed in the second discrimination. Transfer implies that a consistent assignment would result in more rapid acquisition of the second discrimination than would a reversed assignment.

The actual discrimination training may or may not be contingent on a specified response. In addition under certain circumstances a positive conditioned stimulus may be established without explicit discriminative training. A classification of experiments on the transfer of a

facilitative discriminative effect is provided in Table 3-1. The experiments are classified according to whether or not reinforcement in original training was contingent or noncontingent upon some response. A further distinction is made depending upon whether or not specific discrimination training was involved in establishing the positive stimulus.

Williams (1941) investigated the relation between habit strength and transfer. A new learning technique was employed. He trained rats under continuous reinforcement to press a horizontal bar (downward pressure) and then tested for transfer to the learning of a response to a vertical bar (sidewise pressure). Under continuous reinforcement all the stimuli associated with the horizontal bar may be characterized as being trained as positive stimuli in a nondiscriminative manner with reinforcement contingent upon an operant response. For transfer testing, the vertical bar was merely inserted in place of the horizontal one. Thus the stimulus conditions were quite similar in the training and transfer test situation. Using a measure of savings in learning time, Williams found negative transfer from the first learned habit to the second learned habit for small amounts of training on the first habit and positive transfer for larger amounts of training. A resistence to extinction measure showed positive transfer from the first learned habit to the second when the second habit was based on a small amount of training but negative

TABLE 3-1

CLASSIFICATION OF EXPERIMENTS ON THE TRANSFER OF THE EFFECT OF A STIMULUS ASSOCIATED WITH REINFORCEMENT.

Nondiscriminative Training - Contingent Reinforcement

Williams (1941). No specific stimulus. Trained horizontal bar press. Tested transfer to vertical bar press. New learning test.

Trapold and Odom (1965). Same as Williams (1941). New learning test.

Trapold and Fairlie (1965). Same as Williams (1941). New learning test.

Discriminative Training - Contingent Reinforcement

Walker (1942). Tone stimulus. Trained running response in straightaway. Tested transfer to lever pressing response. Extinction test.

Trapold and Odom (1965). Houselight stimulus. Trained pressing response to vertical bar, tested transfer to horizontal bar. New learning test.

Trapold and Fairlie (1965). Same as Trapold and Odom (1965). New learning test.

The present experiment on conditioned excitation. Tone stimulus. Trained pecking response to one half of a split key. Tested transfer to pecking response on the other half of key. Extinction test.

Discriminative Training - Noncontingent Reinforcement

Estes (1943). Tone stimulus paired with food. Tested transfer to lever pressing response for food. Extinction test.

Estes (1948). Same as Estes (1943). Extinction test.

Morse and Skinner (1958). Colored light stimulus paired with food. Tested transfer to key pecking response for food. Extinction test.

Bower and Kaufman (1963). Tone or clicking paired with food. Tested transfer to lever pressing response for water. Extinction test.

Bower and Grusec (1964). Tone or clicking paired with water. Tested transfer to lever pressing for water. New learning test.

Trapold and Fairlie (1965) Houselight paired with food. Tested transfer to lever pressing for food. New learning test.

transfer when it was based on a larger amount of training.

Trapold and Odom (1965) and Trapold and Fairlie (1965) also employing a new learning test, conducted experiments which in part replicated the work of Williams. They reported no facilitative transfer effect due to previous training. However, it should be noted that the amount of training given in these two latter studies was of a magnitude which Williams would describe as a "small amount". Thus, a closer comparison reveals results consonant with those of Williams since he found negative or no transfer for small amounts of training on the first discrimination.

Experiments in which discriminative training was carried out with contingent reinforcement have also illustrated the transfer of facilitative discriminative effects of stimuli. Walker (1942) trained rats to press a lever for food on a VI schedule. Subsequent discrimination training was then given on a runway where, for the experimental group, the sound of a tone accompanied trials on which food was given, and no tone was presented on nonreinforced runs. A control group heard tone on both reinforced and nonreinforced trials. The rats were then returned to the lever pressing situation for the transfer testing in extinction during which the tone was alternately on and off for ten minute intervals. When Ss in the experimental group who showed evidence of learning the original discrimination (running faster on

tone trials) were compared to the control group, the experimental Ss showed a distinct acceleration in rate of lever pressing when the tone was sounding. The control group showed no effect of the tone.

Trapold and Odom (1965) ran a group of rats which received discrimination training (S^+ was houselight on, houselight off was S^-) on a horizontal (or vertical) bar pressing response. Transfer testing with a vertical (or horizontal) bar pressing response showed that the discrimination was learned much faster with the second response. Trapold and Fairlie (1965) replicated these results. Both used a new learning method of testing for transfer.

When discriminative conditioning is carried out with noncontingent reinforcement, the parallel to Pavlovian conditioning becomes even more apparent. This is interesting since mere failure to make reinforcement contingent upon a specific response does not preclude the development of some "superstitious" behavior. However, simply pairing reinforcement with some stimulus is more like the procedure of classical conditioning. Whether there is any real difference in the manner in which contingent versus noncontingent reinforcement contacts the organism is a most interesting question that remains to be answered.

Estes (1943) investigated the effects of a "Pavlovian conditioned stimulus" (noncontingent pairings) upon an operant

response. Rats were trained to press a bar on a F I schedule for food. Following this the bar was removed from the box and food was paired with tone for a number of times. This is classified as a discriminative training procedure since there was a no-tone period during which no food was presented. Following the "Pavlovian conditioning" the bar was introduced and an extinction test consisting of 10 minute intervals, some with tone and some without, ensued. Results showed that the tone exerted a facilitative effect on the rate of responding. In another experiment, Estes showed that similar results could be obtained when the operant response was made part of the rats repetoire after the "Pavlovian conditioning" (Estes, 1948).

Morse and Skinner (1958) found similar results using pigeons with noncontingent training and transfer testing in extinction on a key peck response.

While Estes' experiment used food reinforcement for both the operant response and the Pavlovian conditioning, Bower and Kaufman (1963), using an extinction test, demonstrated that a stimulus paired in the Pavlovian manner with food reinforcement acquired some discriminative control over an unrelated response reinforced by water when the animal was thirsty but not hungry. These results extend the generality of the transfer effect by showing that discriminative control transfers across different drive-reward systems.

The possibility exists in the experiments mentioned above which employed an extinction method of testing, that the discriminative stimulus employed exerted some disinhibitory or unconditioned facilitative effect. Walker (1942) did have a group which might be considered a control for this in that the tone was presented on all training trials with only half being paired with reinforcement. This group showed no discriminative effect of the tone. Unfortunately, this is not the most appropriate control for disinhibition since control Ss had considerable experience with the tone by the time of extinction testing and we are unable to evaluate the effect of a novel tone presentation on responding in extinction. Estes (1943, 1948) did not employ controls for this factor, however he considers Walker's control as sufficient to negate the possibility that the tone exerted any unconditioned facilitative effect on lever pressing in his experiments. Neither Morse and Skinner (1958) nor Bower and Kaufman (1963) used control groups.

Bower and Grusec (1964) used a new learning method to study the effect of prior noncontingent discrimination training upon subsequent learning of an operant discrimination involving the same stimuli. They showed marked transfer from the noncontingent discrimination training. The rate of learning the discrimination was more rapid with a consistent than with a reversed assignment of the positive and negative stimuli from the previous training.

An evaluation of the importance of contingent versus noncontingent training procedures in the transfer of discrimination learning was made by Trapold and Fairlie (1965). The "contingent" group of Ss (rats) received discrimination training where responses to a horizontal bar were reinforced when the houselight was on (S^+) and were not reinforced when the houselight was off (S^-). The other group received noncontingent discrimination training by simply presenting reinforcements during S^+ and not during S^-. Following the original discrimination training, both groups received contingent discrimination training with a vertical bar-pressing response. For half of each group S^+ and S^- were consistent and for the other half they were reversed. Highly significant transfer effectswere found under both contingent and noncontingent original training procedures and no significant differences were found between the amount of transfer resulting from the two conditions.

In summary then, transfer of a facilitative effect has been shown to take place with both discriminative and nondiscriminative training procedures. Transfer of stimulus control has been found across different drive-reward systems. The transfer is strong whether contingent or noncontingent training procedures are used and it does not seem to matter whether or not the response on which transfer is to be tested is part of the organism's behavior prior to or after

the training. Further, the transfer has been shown to take place across markedly different responses.

A study not employing the transfer technique but nevertheless highlighting what may be termed the conditioned excitatory character of S^+ is one by Wolf (1963). Wolf directed his attention to the facilitative effect of combined S^+s. Rats were trained to respond in the presence of two different discriminative stimuli presented on separate trials (two different pairs of lights or a pair of lights and a tone) and not to respond under S^- (total darkness). In extinction these stimuli were presented separately as in training, while on other trials they were combined (presented simultaneously). The result of the combination of S^+s was to increase the response probability to a point over that found when either of the S^+s was presented singly. The author concluded that summation occurs in operant behavior as well as in respondent behavior. Cornell and Strub's experiment (1965), mentioned earlier, also included trials in extinction with combined S^+s and showed similar results.

Whether or not the term conditioned excitation is appropriate or necessary may well be asked at this point. We have reviewed a number of experiments in the literature which studied the transfer of facilitative effects without mention of conditioned excitation. Detachability, or the ability to recombine and move a stimulus to a different situation in order to observe its effect on some other

response was a feature of the Pavlovian demonstration of the inhibitory property of certain stimuli. When this feature also applies to positive stimuli the concept of conditioned excitation is strongly suggested. The new learning method of testing taken alone would not suggest such a property. One merely sees a positive and a negative stimulus operating in a different situation and resulting in a savings in the new learning. There is no baseline against which to observe excitation, and no "excitor" to move around. The extinction test method, on the other hand, does begin to suggest the possibility of excitation. In this case we have a relatively low baseline level of responding. When a previously positive stimulus is now presented an increment in response strength may be observed which suggests an excitatory effect. The detachability of a stimulus adds to this impression for it enables one to move, not the entire positive stimulus, but only that discriminative feature which signals the reinforcement. It is obvious then that both the nature of the stimuli and the type of test employed are features which lead one to talk about conditioned excitation. Although certain procedures are required for a convincing demonstration of conditioned excitation in the first place, it may well be that many discriminative conditioning situations which do not use these procedures involve the same underlying process.

DESIGN OF THE SECOND EXPERIMENT

The general plan of the experiment on conditioned excitation was similar to that of the first experiment. The only important difference in the training procedure was that the tone was now associated with the reinforcement of response to one of the key-colors, while responses in the absense of the tone were nonreinforced. As previously, the key-color used in conjuntion with auditory discrimination training is referred to as the auditory training stimulus and the other key-color, with which tone is not paired until the test, is referred to as the transfer test stimulus.

The procedure for testing the excitatory effect was, however, different in several respects from the one used to test for an inhibitory effect. First, the level of responding to the transfer test stimulus in the absence of tone was reduced by extinction prior to the test in order to provide a low baseline from which to observe a possible increase due to the introduction of the tone. Second, only the transfer test stimulus with and without tone was presented during the first test session. For the second test session, however, all four trial types were presented as in the previous experiment.

Another control group trained without the tone was included to evaluate the possibility of unconditioned effects of the tone when tone is introduced for the first

time in extinction. Although the control group in the previous experiment showed no unconditioned effects of tone, the present procedure of testing differs from the previous one in a way that might result in a disinhibitory effect. Specifically, such an effect might be expected from the addition of the tone to the transfer test stimulus after a series of nonreinforced trials in the absence of the tone. The inclusion of a control group which was given the same series of extinction trials prior to the introduction of the tone provides a check against that eventuality.

METHOD

Subjects

Subjects were experimentally naive male white king pigeons, five to six years old. They were maintained in the same manner as were those of the first experiment.

Apparatus

The same apparatus and stimuli were employed as in the first experiment.

Training procedure: Experimental group

Phases 1-6 of the training procedure for the experimental group ($n=4$) were as in the first experiment with the exception that the tone was paired with the auditory

training stimulus from the outset. Table 3-2 shows the stimulus and response assignments for the experimental and control birds.

Phase 7. This was the auditory discrimination phase. Conditions were as in the previous experiment except that the tone was associated with reinforced trials rather than with nonreinforced trials.

Phase 8. This was the post auditory discrimination phase. With the exception noted above, the procedure was as in the previous experiment.

Phase 9. A number of extinction trials on the transfer test stimulus presented without tone were given. The number of such trials was adjusted to the response level of individual animals.

Phase 10. The test for transfer of an excitatory effect was made during this phase. The test was carried out in extinction. Conditions of trial termination were unchanged. Two types of trials were presented: 1. transfer test stimulus plus tone, and 2. transfer test stimulus without tone. There were 40 presentations of each type of trial. The order of presentations was random with the restriction that 20 of each type of trial occur in the first half of the session.

Phase 11. A second test session was given in which all four types of trials were presented: 1. transfer test stimulus plus tone; 2. transfer test stimulus without tone;

TABLE 3-2

ASSIGNMENT OF BIRDS TO VARIOUS GROUPS AND STIMULUS CONDITIONS

EXPERIMENTAL GROUP

Bird No.	Appropriate response to each key color	Key color used in auditory discrimination phase
P-17	Red - Left Green - Right	Green
P-18	Red - Left Green - Right	Red
P-19	Red - Right Green - Left	Green
P-21	Red - Right Green - Left	Red

CONTROL GROUP

Bird No.	Key color and appropriate response
S-48	Red - Right
P-97	Green - Right
P-99	Red - Left

3. auditory training stimulus plus tone; 4. auditory training stimulus without tone. There were 40 presentations of each type of trial for a total of 160 trials with the restriction that 20 of each type of trial occur in the first half of the session.

The basic data consisted of the total number of responses and response units emitted to each of the stimuli on the test sessions in extinction.

Training procedure: Control group

The control group (n=3) was trained as was the control group in the first experiment. Following training, animals in the control group received a varying number of extinction trials designed to match the extinction received by birds in the experimental group. Details of the treatment received by each control S are given in the appendix (pp. 140, 143, 146). The control group was then tested on tone and no-tone trials in conjunction with the key-color on which they had received all of their training. Forty trials of each type were presented for a total of 80 in each session. Two test sessions were run.

RESULTS

Training

Training data for each S in the experimental and control groups is given in the appendix (pp. 119 to 148). Training of the control group proceeded without special difficulty. Bird P-19 in the experimental group had not learned the visual discrimination to criterion after 48 sessions and was withdrawn from the experiment.

Summary results for the final day of training of the experimental S are given in Table 3-3.

Responding on the extinction trials that preceeded the test is shown for each S of both groups in the appendix (pp. 122,129,136,141,144,147). The actual amount of extinction varied for the experimental Ss since response strength was found to vary and each S required different amounts of extinction to reduce response probability to a point where it seemed likely that any excitatory nature of the tone might be seen. P-17 received 1, 40 trial extinction session on the day prior to testing. P-18 received 2, 40 trial extinction sessions on the two days immediately prior to testing and an additional 20 extinction trials just prior to the actual test session on the same day as the test session. P-21 received 3, 40 trial extinction sessions with the third session taking place on the same day and just prior to testing.

TABLE 3-3

PERFORMANCE ON THE FINAL DAY OF TRAINING

	Auditory training stimulus								Transfer Test Stimulus			
	No-Tone Trials				Tone Trials				No-Tone Trials			
Bird	Prs	Rsp	RU	Err	Prs	Rsp	RU	Err	Prs	Rsp	RU	Err
P-17	40	23	1	2	40	149	36	4	40	159	34	6
P-18	40	3	0	0	40	127	25	14	40	148	33	2
P-21	40	1	0	2	40	143	28	12	40	141	34	6

NOTE - The maximum number of responses on a given type of trial is 160. The maximum number of response units is 40. Prs: Trial presentations. Rsp: Total responses. RU: Total response units. Err: Total responses to wrong side of key.

The three Ss in the control group were matched to each experimental S for amount of extinction carried out prior to testing. P-97 was matched with P-17, P-99 with P-18 and S-48 with P-21.

First Test session

Summary results of the test for excitatory control in the first session are given in Table 3-4. Note that in the case of bird P-21 the level of response on trials of both types remained very high throughout the first 80 test trials. For that reason, an additional 80 test trials were given.

The results in Table 3-4 show that each S in the experimental group maintained the discrimination based on key-color on both tone and no-tone trials. It may be noted that although maintenance of the discrimination based on key-color was in no way unexpected in the previous experiment in which the tone was an inhibitory stimulus, another outcome might have occurred as a result of the present training regime. In the present case, training involved, for example, a peck to the left in the presence of a green lighted key accompanied by tone, and, of course, nonreinforcement when the tone was absent. When during the test, the tone accompanies the red lighted key, to which the animal has been previously trained to peck right,

TABLE 3-4

RESULTS FOR FIRST TEST SESSION IN WHICH ALL TRIALS WERE ON THE TRANSFER TEST STIMULUS.

EXPERIMENTAL GROUP

	No-Tone Trials				Tone Trials			
Bird	Prs	Rsp	RU	Err	Prs	Rsp	RU	Err
P-17	40	68	13	1	40	96	20	4
P-18	40	20	3	3	40	103	21	8
P-21	40	113	23	12	40	124	27	8
	40	78	13	11	40	142	36	10

CONTROL GROUP

	No-Tone Trials				Tone Trials			
Bird	Prs	Rsp	RU	Err	Prs	Rsp	RU	Err
P-97	40	127	25	1	40	127	23	5
P-99	40	35	8	1	40	20	5	0
S-48	40	126	29	5	40	87	17	10
	40	30	6	0	40	8	1	1

NOTE - Prs: Trial presentations. Rsp: Total responses. RU: Total response units. Err: Total responses to wrong side of key.

there is no apriori reason why the tone should not evoke a peck to the left since that was the response previously reinforced in the presence of the tone. Indeed, there is some suggestion in the case of P-18, that the tone had some tendency to cause errors; i.e., to evoke responses to the other side of the key. However, the main effect was that the key-color continued to evoke the directional response established in training. Thus the key-color has predominant control of the direction of the response.

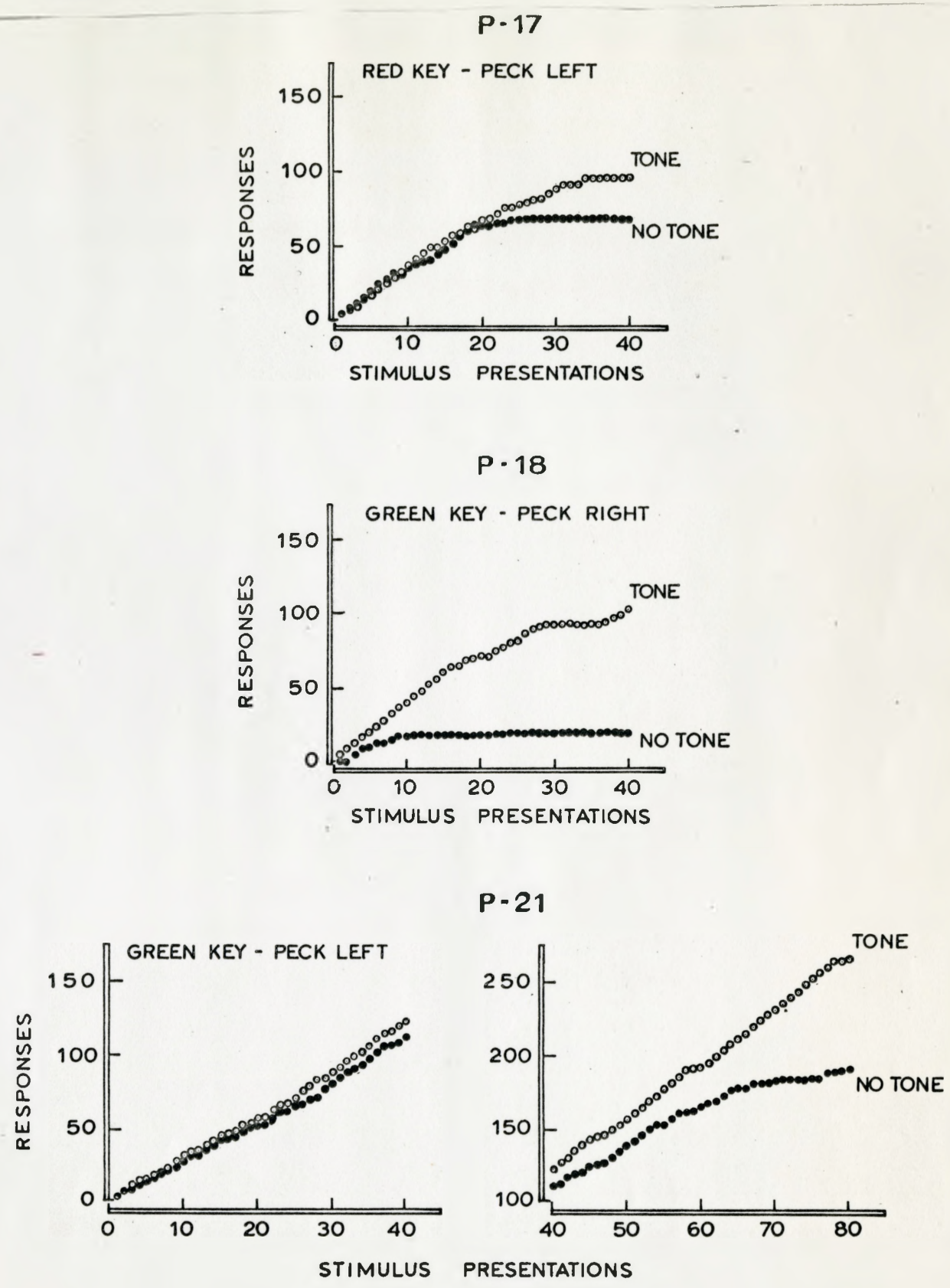
Each of the experimental animals showed more responding on tone trials than on no-tone trials, although the difference was not always large. The control Ss showed, if anything, less responding on trials accompanied by tone. The effect of the tone is therefore not due to disinhibition.

Cumulative response curves for the transfer test stimulus with and without tone are shown for the experimental Ss during the first test session in Figure 3-1.

A paired trial comparison was made for each S similar to the comparison in the first experiment. The actual number of such pairs that show the response on tone trials and no-tone trials was as follows: For P-17, 7 on tone trials and 2 on no-tone trials; for P-18, 22 on tone trials and 0 on no-tone trials; for P-21, 9 on tone trials and 0 on no-tone trials. A binomial test (two tailed) of these frequencies permits rejection of the null hypothesis and

FIGURE 3-1

CUMULATIVE RESPONSES ON EACH TRIAL TYPE FOR FIRST TEST SESSION.



shows that the differences observed for P-18 and P-21 were highly significant ($p < .002$ and $p = .004$ respectively). Although bird P-17 did show slightly more responding to tone trials in the latter part of the extinction test, the differences fall short of conventional levels of statistical significance ($p = .18$).

Second Test Session

In the second test session, all four trial types were presented; i.e., the auditory training stimulus with and without tone, and as in the first test session, and the transfer test stimulus with and without tone. Summary results for this session are given in Table 3-5.

On the auditory training stimulus, which had received no prior extinction, each S showed a high level of responding on tone trials and a much lower level on no-tone trials. Further the response, for the most part, continues to occur on the correct side of the key. The partial exception is P-21 who made relatively frequent errors here and also in the first test session. It is of interest that in spite of considerable prior extinction on the transfer test stimulus, responding to the auditory training stimulus remained strong, and the tone continued to exert an appropriate effect. This result provides further evidence on the lack of inductive continuity between the discriminative

TABLE 3-5

RESULTS FOR THE SECOND TEST SESSION

	Auditory Training Stimulus								Transfer Test Stimulus							
	No-Tone Trials				Tone Trials				No-Tone Trials				Tone Trials			
Bird	Prs	Rsp	RU	Err	Prs	Rsp	RU	Err	Prs	Rsp	RU	Err	Prs	Rsp	RU	Err
P-17	40	32	6	3	40	115	28	6	40	21	3	0	40	28	4	0
P-18	40	10	1	2	40	135	29	11	40	5	0	1	40	25	4	1
P-21	40	2	0	1	40	98	22	14	40	27	4	2	40	100	19	7

responses based on key-color.

The relatively low level of responding to the transfer test stimulus shows the effect of the prior extinction. Nevertheless, all Ss continue to make more responses on tone trials than on no-tone trials. The difference was small in the case of P-17, as it was in the first session, but the difference was clear for the remaining animals.

CONCLUSIONS

The second experiment has shown that training of a kind that led to a transferable conditioned inhibitory function for a stimulus paired with nonreinforcement can also lead to a transferable conditioned excitatory function for a stimulus paired with reinforcement. The positive result is not at all surprising in view of the rather extensive literature showing similar results for the transfer of the effects of S^+. The present experiment is, however, the first to include an appropriate control for disinhibitory effects. It also reveals an interesting division of labor between the tone as a transferable excitatory stimulus for responding and the key-color which continues to govern the differential location of the response.

CHAPTER IV

DISCUSSION

The first experiment showed that when a tone is made a signal for not responding to one visual stimulus it may also function as a signal for not responding to another stimulus. The inhibitory function of the tone transfers from the stimulus on which it was trained to a second stimulus even though the training stimulus (key of one color) and the second stimulus (key of another color) evoke a differential response (peck to the left or right of a divided key). The transfer of inhibitory effect was not complete. More responding occurred in the presence of the tone when the tone was combined with the second stimulus (transfer test stimulus) than when it was combined with the stimulus used for the original go/no-go discrimination training. It was shown that the tone acquired its inhibitory effect as the result of its role as a no-go signal in discrimination training since a tone introduced as a novel stimulus during the test produces no decrement in responding (control for external inhibition).

The above results show that the paradigm used by Pavlov to demonstrate conditioned inhibition can also be used in the case of a discriminated operant with parallel

results. The objections made by Skinner to the Pavlovian demonstration have been met in the present experiments, and it seems doubtful that the objections were correctly taken in the first instance.

The second experiment showed that when a tone is made a signal for responding to one visual stimulus it may also function as a signal for responding to a second stimulus, where, as in the first experiment, the visual stimuli evoke differential responses. The excitatory function of the tone was acquired as a result of its role as a go signal in discrimination training since a tone introduced as a novel stimulus on test produces no increase in responding (control for disinhibition).

Both the first and second experiment show that the signalling function of a feature which differentiates between the reinforcement and nonreinforcement of one stimulus transfers to a second stimulus. The essential difference between the experiments is only in whether the feature serves as a no-go signal or a go signal. If in the "no-go" case the term conditioned inhibition is used, then the parallel in terms of procedure and results suggests the term conditioned excitation in the "go" case.

The use of the term conditioned inhibition or conditioned excitation in operant behavior need not imply an acceptance of Pavlovian theory of the neurology of conditioned inhibition and excitation. The usage simply

recognizes the similarity of the behavioral functions of the stimuli in classical and in operant conditioning. Perhaps the more descriptive terms of "go" signal, and "no-go" signal are less objectionable than references to excitation and inhibition.

A very particular arrangement of stimuli and testing techniques were required for the demonstration of conditioned inhibition and excitation. On the other hand the go/no-go discriminative conditioning procedure used to produce these effects is a very general one. This strongly suggests the possibility that conditioned inhibition and excitation develop in many discriminative conditioning situations.

The question arises as to the status of the transfer test of conditioned inhibition and excitation. The transfer test technique immediately restricts the choice of stimuli to those that can be detached from one context and superimposed to another. This requirement is readily met when the original discrimination training is carried out with stimuli of two different modalities, but when a discrimination is based on the change in a single property or along some continuum it becomes impossible to transfer the difference per se to a new situation. This of course does not mean that conditioned excitation or inhibition are not active in the latter situation, it simply means that, due to the nature of the stimuli, these functions cannot be demonstrated by a transfer test. A second comment on the status of the transfer test is based on the logic under-

lying the test. Pavlov apparently reasoned that any effect which could be transferred must exist in the first place. But what if the inhibitory effect did not transfer? Should one then conclude that it did not exist? Although the transfer technique is a very striking and convincing way of demonstrating the existence of conditioned inhibition and excitation, when it is successful, a failure to demonstrate either of them does not preclude their existence. Therefore, the transfer test should not be taken as defining conditioned inhibition or excitation. The method, nevertheless, was most appropriate for this thesis since we were exploring the applicability of Pavlov's concepts for operant discrimination learning.

An alternative to the transfer test method for investigation of conditioned inhibition is that of employing negative generalization gradients. This technique likewise places certain restrictions on stimuli, such as those of being orthogonal to one another as set forth by Jenkins and Harrison (1962). Once again a question exists as to how one would interpret a failure to show a negative generalization gradient. Would this be proof of no inhibitory control? Would a stimulus which failed to exhibit inhibitory properties in a transfer test situation also fail to show an inhibitory gradient? What effect would it have in a transfer test situation? These are all interesting but as yet unanswered questions pertaining to both testing procedures and their

relationship to one another that have been suggested by the present research.

The reinforcement in the auditory training phase of these experiments was response contingent. Is this a necessary or important factor to the development of transferable excitatory or inhibitory functions? The only relevant experiment for the excitatory case found no difference in the transfer of an excitatory effect when the original training was contingent or noncontingent (Trapold and Fairlie, 1965). The present author is not aware of a parallel experiment for the inhibitory case. It would be valuable to investigate the effectiveness of noncontingent original training in the structure of the present experiment on conditioned inhibition in order to round out the available information on the importance of the response contingencies in discrimination learning.

Given the question of the importance of response contingencies, one is led to focus attention on the function of the response itself in discriminative learning and discriminative transfer. Whether a response is necessary at all for learning is a question which has drawn much interest. The line of experimentation has been to try to show learning without responses. This has proved most difficult. Another approach to the question of the function of the response might be through procedures which employ

contingent and noncontingent reinforcement in training the stimulus. Contingent arrangements naturally lead us to think about the relation between the training response and the testing response. On the other hand, noncontingent original training procedures do not specify any response, and while it cannot be said that no response occurs, since some "superstitious" behavior may be reinforced, it is most likely that such response will be very different from the response used in the transfer test. Although the relation of the response, if any, conditioned in training, to the response involved in the test is quite different in contingent and noncontingent training procedures the limited evidence to date (Trapold and Fairlie, 1965), shows no differences in transfer for contingent and non-contingent training. Perhaps the more manageable experimental question at present is to see if results of this type can be upheld. It may be that we will be able to find out whether the relation between responses has any effect on the amount of transfer long before we can find out if the presence of a response is necessary for learning.

BIBLIOGRAPHY

Bower, G., and Grusec, T. Effect of prior Pavlovian discrimination training upon learning an operant discrimination. J. exp. Anal. Behav., 1964, 7, 401-404.

Bower, G., and Kaugman, R. Transfer across drives of the discriminative effect of a Pavlovian conditioned stimulus. J. exp. Anal. Behav., 1963, 6, 445-448.

Cornell, J. M., and Strub, H. A technique for demonstrating the inhibitory function of S . Psychon. Sci., 1965, 3, 25-26.

Estes, W. K. Discriminative conditioning. I. A discriminative property of conditioned anticipation. J. exp. Psychol., 1943, 32, 152-155.

Estes, W. K. Discriminative conditioning. II. Effects of a Pavlovian conditioned stimulus upon a subsequently established operant response. J. exp. Psychol., 1943, 38, 173-177.

Ferster, C.B. and Skinner, B. F. Schedules of reinforcement. New York: Appleton-Century-Crofts, 1957.

Hanson, H. M. Effects of discrimination training on stimulus generalization. J. exp. Psychol., 1959, 58, 321-334.

Honig, W. K. Generalization of extinction on the spectral continuum. Psychol. Rec., 1961, 11, 269-278.

Honing, W. K., Boneau, C. A., Burstein, K. R., and Pennypacker, H. S. Positive and negative generalization gradients obtained after equivalent training conditions. J. comp. Physiol. Psychol., 1963, 56, 111-116.

Jenkins, H. M. Resistance to extinction when partial reinforcement is followed by regular reinforcement. J. exp. Psychol., 1962, 64, 441-450.

Jenkins, H. M. Generalization gradients and the concept of inhibition. in D. I. Mostofsky ed., Stimulus Generalization, Stanford: Stanford University Press, 1965.

Jenkins, H. M., and Harrison, R. H. Generalization gradients of inhibition following auditory discrimination learning. J. exp. Anal. Behav., 1962, 5, 435-441.

Morse, W. H., and Skinner, B. F. Some factors involved in the stimulus control of operant behavior. J. exp. Anal. Behav., 1958, 1, 103-107.

Pavlov, I. P. Conditioned Reflexes. Translated by G.V. Anrep. New York: Dover, 1927.

Skinner, B. F., The Behavior of organisms: an experimental analysis. New York: Appleton - Century, 1938.

Trapold, M. A., and Fairlie, J. Transfer of discrimination learning based upon contingent and noncontingent training procedures. Psychological Reports, 1965, 17, 239-246.

Trapold, M. A., and Odom, P. B. Transfer of a discrimination and a discrimination reversal between two manipulandum-defined responses. Psychological Reports, 1965, 16, 1213-1221.

Walker, K. C. The effect of a discriminative stimulus transferred to a previously unassociated response. J. exp. Psychol., 1942, 31, 312-321.

Williams, S. B. Transfer of extinction effects in the rat as a function of habit strength. J. comp. Psychol., 1941a, 31, 263-280.

Williams, S. B. Transfer of reinforcement in the rat as a function of habit strength. J. comp. Psychol., 1941b, 31, 281-296.

Wolf, M. M. Some effects of combined S^Ds. J. exp. Anal. Behav., 1963, 6, 343-347.

Youtz, R. E. P. The weakening of one Thorndikian response following extinction of another. J. exp. psychol., 1939, 24, 294-304.

APPENDICES

APPENDIX I

RAW DATA FOR EXPERIMENT 1

Bird P-25. (Experimental group) Conditions of training: Key lighted red - signal to respond right. Key lighted green - signal to respond left. Auditory discrimination training carried out using left side of key (green light). Green key no tone trials - Responses reinforced. Green key tone trials - responses not reinforced. Transfer testing carried out on right side of key (red light). Table shows stimulus presentations and responses during training and testing. Prs: Trial presentations. Rt or Lft Rsp: Right or left responses. Rt or Lft RU: Right or left response units.

		Red Key-No Tone				Red Key-Tone				Green Key-No Tone				Green Key-Tone			
	Day	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp
a	1									87	213	*	0				
b	2	343	264	66	277					74	203	47	27				
c	3	83	181	40	43					49	167	40	9				
	4	50	173	40	10					43	175	40	3				
	5	47	167	40	7					44	166	40	4				
	6	50	169	40	9					53	162	40	10				
d	7	40	118	26	14					40	160	40	0				
	8	40	159	38	1					40	160	40	0				
	9	40	131	32	6					40	154	38	2				
	10	40	158	38	2					40	150	36	4				
	11	40	158	39	1					40	154	36	2				
	12	40	157	38	2					40	160	40	0				
	13	40	159	39	1					40	152	34	6				
	14	40	148	36	4					40	151	37	3				
	15	40	160	40	0					40	155	38	2				
	16	40	156	38	2					40	160	40	0				
	17	40	157	38	0					40	160	40	0				

* Response requirement being advanced from 1 to 4. No measure taken this day.
a Phase 1
b Phases 2, 3 and 4 included in this session.
c Phase 5
d Phase 6

Bird P-25 (Continued)

		Red Key-No Tone				Red Key-Tone				Green Key-No Tone				Green Key-Tone			
	Day	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp
	18	40	152	37	3					40	160	40	0				
	19	40	159	39	1					40	159	39	1				
e	20									40	160	40	0	40	160	40	0
	21									40	160	40	0	40	160	40	0
	22									40	160	40	0	40	160	40	0
	23									40	160	40	0	40	160	40	0
	24									40	160	40	0	40	155	35	0
	25									40	159	39	1	40	121	23	0
	26									40	150	37	3	40	141	31	6
	27									40	153	37	3	40	64	4	1
	28									40	158	38	2	40	43	3	1
	29									40	160	40	0	40	23	1	0
f	30	40	156	39	1					40	157	38	0	40	7	1	0
	31	40	156	37	3					40	157	39	0	40	14	2	0
								EXTINCTION TEST									
g	1	40	125	30	1	40	39	7	1	40	119	28	0	40	10	1	0
	2	40	14	3	0	40	3	0	0	40	31	6	0	40	0	0	0

e Phase 7
f Phase 8
g Phase 9

Bird P-25 Trial by trial behavior on first day of extinction testing. Entries are responses per trial (maximum of 4 possible on each trial). Conditions of training: Key lighted red - signal to respond right. Key lighted green - signal to respond left. Auditory discrimination training carried out using left side of key (green light). Transfer testing carried out on right side of key (red light). Entries in Tone column signify presence or absence of tone on a given trial. 1 signifies tone present. 0 signifies no tone present. R following the number of responses indicates these responses made to right key. L following number indicates responses on left key. Since one incorrect response (pecking to inappropriate side) terminates a trial, there can be only one incorrect response per trial and no correct response can follow it.

Trial	Key Color	Tone	Responses
1	green	0	4L
2	red	0	4R
3	red	1	4R
4	red	1	4R
5	green	1	0
6	red	0	4R
7	green	0	4L
8	red	0	4R
9	red	1	1R
10	green	1	0
11	green	0	4L
12	green	1	0
13	red	0	4R
14	red	1	0
15	green	0	4L
16	green	0	4L
17	red	0	4R
18	red	1	1R
19	green	1	0
20	green	0	4L
21	red	1	0
22	green	1	0
23	green	0	0
24	red	0	4R
25	red	1	4R
26	green	0	4L
27	green	1	0
28	green	0	0
29	red	0	4R
30	red	1	4R
31	green	1	0
32	red	0	4R
33	red	1	0
34	red	0	4R

Bird P-25 (Continued)

Trial	Key Color	Tone	Responses
35	green	0	4L
36	red	1	1R
37	green	1	0
38	green	0	4L
39	green	1	0
40	red	0	4R
41	green	1	0
42	green	0	4L
43	red	0	4R
44	red	1	0
45	green	1	0
46	green	0	4L
47	red	1	0
48	green	0	4L
49	red	0	4R
50	green	1	0
51	red	0	4R
52	red	1	0
53	green	1	0
54	green	0	4L
55	red	1	0
56	green	1	0
57	red	0	4R
58	red	1	2R
59	green	1	0
60	green	0	0
61	red	0	0
62	green	0	0
63	red	0	0
64	red	1	0
65	green	1	0
66	green	0	0
67	green	1	0
68	green	0	0
69	red	0	0
70	red	1	0
71	green	1	0
72	red	0	0
73	red	1	0
74	green	1	0
75	green	0	0
76	red	0	0
77	red	0	0
78	red	1	0
79	green	1	4L
80	red	1	4R
81	green	1	0
82	green	0	4L

Bird P-25 (Continued)

Trial	Key Color	Tone	Responses
83	green	1	0
84	red	0	4R
85	red	1	2R
86	green	0	0
87	green	0	4L
88	green	1	0
89	green	1	0
90	red	0	0
91	red	1	0
92	green	0	4L
93	red	0	4R
94	green	1	1L
95	green	0	4L
96	red	0	4R
97	red	1	4R
98	red	0	4R
99	red	1	1R
100	green	1	0
101	green	0	4L
102	green	1	0
103	green	0	4L
104	red	0	4R
105	red	1	0
106	green	1	0
107	red	1	0
108	red	0	2R
109	green	1	0
110	green	0	4L
111	red	1	0
112	green	1	1L
113	green	0	4L
114	red	0	4R
115	red	1	0
116	green	1	0
117	green	0	4L
118	red	1	0
119	green	1	0
120	red	0	4R
121	red	0	4R
122	green	1	1L
123	green	0	4L
124	red	1	0
125	green	1	0
126	green	0	1L
127	red	0	4R
128	red	1	0
129	green	1	0
130	green	0	4L

Bird P-25 (Continued)

Trial	Key Color	Tone	Responses
131	red	0	4R
132	red	1	4R
133	green	0	4L
134	red	1	2R 1L
135	green	1	2L
136	red	0	4R
137	red	0	4R
138	green	0	4L
139	green	0	2L
140	red	0	4R
141	green	1	0
142	red	1	0
143	green	0	4L
144	red	1	0
145	green	1	0
146	red	0	4R
147	red	1	0
148	green	1	1L
149	red	0	2R 1L
150	green	0	0
151	red	1	0
152	green	1	0
153	red	0	4R
154	green	0	4L
155	red	0	4R
156	red	1	0
157	green	0	4L
158	red	1	1R
159	red	0	4R
160	red	1	0

Bird P-25 (Experimental group) Intertrial responses (ITR's) emitted during experiment.

Day	Right ITR's	Left ITR's
1	0	175
2	45	108
3	36	66
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
12	0	0
13	0	2
14	0	1
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	1	0
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0
26	0	0
27	0	0
28	0	0
29	0	0
30	0	0
31	0	0
EXTINCTION TEST		
1	0	1
2	0	0

Bird P-27. (Experimental group) Conditions of training: Key lighted red - signal to respond left. Key lighted green - signal to respond right. Auditory discrimination training carried out using left side of key (red light). Red key no tone trials - responses reinforced. Red key tone trials - responses not reinforced. Transfer testing carried out on right side of key (green light). Table shows stimulus presentations and responses during training and testing. Prs: Trial presentations. Rt or Lft Rsp: Right or left responses. Rt or Lft RU: Right or left response units.

		Red Key-No Tone				Red Key-Tone				Green Key-No Tone				Green Key-Tone			
Day		Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
a	1	28	84	*	0												
b	2	40	92	22	18												
c	3	167	242	40	127					159	185	40	119				
	4	72	182	40	32					59	164	40	19				
	5	69	172	40	29					74	191	40	34				
	6	56	163	40	16					78	178	40	38				
	7	45	164	40	5					58	180	40	16				
d	8	40	144	28	12					40	125	35	5				
	9	40	120	28	12					40	140	34	6				
	10	40	126	29	11					40	143	34	6				
	11	40	138	32	8					40	132	32	8				
	12	40	116	25	15					40	138	33	7				
	13	40	118	25	15					40	118	29	11				
	14	40	101	23	17					40	159	37	3				

---

* Response requirement being advanced from 1 to 4. No measure taken this day.
a Phase 1
b Phase 2
c Phases 3, 4 and 5 included in this session.
d Phase 6

Bird P-27 (Continued)

	Red Key-No Tone				Red Key-Tone			
Day	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp
15	40	141	33	7	40	125	31	9
16	40	143	32	8				
17	40	96	21	19				
18	40	103	23	17				
19	40	114	26	14				
20	40	131	28	12				
21	40	131	29	11				
22	40	112	25	15				
23	40	142	33	7				
24	40	146	33	7				
25	40	131	30	10				
26	40	116	27	13				
27	40	122	29	11				
28	40	139	31	9				
29	40	109	25	15				
30	40	153	37	3				
31	40	122	29	11				
32	40	122	28	11				
e 33	40	147	34	6	40	144	33	7
34	40	157	38	2	40	135	32	8
35	40	153	37	3	40	125	28	12
36	40	127	29	11	40	131	30	10
37	40	144	34	6	40	128	28	11
38	40	127	30	10	40	117	26	14
39	40	128	31	9	40	131	30	10
40	40	128	29	11	40	130	29	11

e Phase 7

Green Key-No Tone			Green Key-Tone			
Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
40	125	31	9				
40	146	36	4				
40	130	31	9				
40	151	36	4				
40	151	37	3				
40	137	34	6				
40	144	35	5				
40	136	32	8				
40	141	35	5				
40	149	37	3				
40	145	36	4				
40	142	35	5				
40	131	32	8				
40	156	39	1				
40	152	38	1				
40	151	37	3				
40	157	38	2				
40	159	37	3				

Bird P-27 (Continued)

	Red Key-No Tone				Red Key-Tone				Green Key-No Tone				Green Key-Tone			
Day	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
41	40	121	29	3	40	116	27	7								
42	40	139	34	6	40	131	31	8								
43	40	132	32	8	40	135	32	8								
44	40	136	32	8	40	148	34	6								
45	40	146	35	5	40	151	30	4								
46	40	127	30	10	40	128	30	10								
47	40	137	33	7	40	136	31	9								
48	40	151	37	3	40	146	35	5								
49	40	159	39	1	40	144	33	7								
50	40	148	34	6	40	140	32	7								
51	40	147	33	7	40	138	32	6								
52	40	152	35	5	40	57	10	6								
53	40	137	32	8	40	92	13	8								
54	40	159	39	1	40	72	10	9								
55	40	153	35	5	40	47	3	6								
56	40	145	33	7	40	68	6	6								
57	40	159	39	1	40	73	10	3								
58	40	158	38	2	40	42	5	3								
59	40	159	39	1	40	41	1	3								
60	40	160	40	0	40	53	7	3								
61	40	152	36	3	40	44	5	2								
62	40	151	37	3	40	75	10	10								
63	40	151	37	3	40	78	10	1								
64	40	153	37	3	40	43	4	5								
65	40	160	40	0	40	36	3	2								
66	40	154	37	3	40	55	8	3								
67	40	157	39	1	40	41	4	3								
68	40	149	36	3	40	20	0	2								

Bird P-27 (Continued)

		Red Key-No Tone				Red Key-Tone				Green Key-No Tone				Green Key-Tone			
	Day	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
	69	40	158	38	2	40	15	2	0								
	70	40	158	38	2	40	40	3	0								
f	71	40	158	38	2	40	41	4	0	40	132	33	7				
	72	40	158	38	2	40	26	2	0	40	141	35	5				
	73	40	153	37	3	40	23	3	0	40	153	38	2				
							EXTINCTION TEST										
g	1	40	152	36	1	40	6	0	1	40	143	32	2	40	38	3	1
	2	40	22	2	0	40	0	0	0	40	7	0	0	40	0	0	0

f Phase 8
g Phase 9

Bird P-27 Trial by trial behavior on first day of extinction testing. Entries are responses per trial (maximum of 4 possible on each trial). Conditions of training: Key lighted red - signal to respond left. Key lighted green - signal to respond right. Auditory discrimination training carried out using left side of key (red light). Transfer testing carried out on right side of key (green light). For further description of entries see similar table for Bird P-25.

Trial	Key Color	Tone	Responses
1	red	0	4L
2	green	0	1L
3	green	1	4R
4	green	1	2R
5	red	1	0
6	green	0	4R
7	red	0	4L
8	green	0	4R
9	green	1	3R
10	red	1	0
11	red	0	4L
12	red	1	0
13	green	0	4R
14	green	1	0
15	red	0	4L
16	red	0	4L
17	green	0	4R
18	green	1	4R
19	red	1	0
20	red	0	4L
21	green	1	1R
22	red	1	0
23	red	0	4L
24	green	0	4R
25	green	1	1R
26	red	0	4L
27	red	1	0
28	red	0	4L
29	green	0	4R
30	green	1	2R
31	red	1	1L
32	green	0	4R
33	green	1	2R
34	green	0	4R
35	red	0	4L
36	green	1	4R
37	red	1	0
38	red	0	4L
39	red	1	0
40	green	0	4R

Bird P-27 (Continued)

Trial	Key Color	Tone	Responses
41	red	1	1R
42	red	0	4L
43	green	0	4R
44	green	1	3R
45	red	1	0
46	red	0	4L
47	green	1	1R
48	red	0	4L
49	green	0	4R
50	red	1	0
51	green	0	4R
52	green	1	0
53	red	1	0
54	red	0	4L
55	green	1	0
56	red	1	1L
57	green	0	4R
58	green	1	1R
59	red	1	0
60	red	0	4L
61	green	0	4R
62	red	0	1R
63	green	0	4R
64	green	1	3R
65	red	1	0
66	red	0	4L
67	red	1	0
68	red	0	4L
69	green	0	4R
70	green	1	0
71	red	1	0
72	green	0	4R
73	green	1	1R
74	red	1	0
75	red	0	4L
76	green	0	4R
77	green	0	4R
78	green	1	0
79	red	1	0
80	green	1	1R
81	red	1	0
82	red	0	4L
83	red	1	0
84	green	0	4R
85	green	1	1R
86	red	0	4L
87	red	0	4L
88	red	1	0

Bird P-27 (Continued)

Trial	Key Color	Tone	Responses
89	red	1	0
90	green	0	4R
91	green	1	0
92	red	0	4L
93	green	0	4R
94	red	1	0
95	red	0	4L
96	green	0	4R
97	green	1	1R 1L
98	green	0	4R
99	green	1	0
100	red	1	0
101	red	0	3L
102	red	1	0
103	red	0	4L
104	green	0	4R
105	green	1	0
106	green	0	4R
107	red	1	0
108	red	0	4L
109	green	1	0
110	red	1	0
111	red	0	4L
112	green	0	4R
113	green	1	2R
114	red	1	0
115	red	0	4L
116	green	1	0
117	red	1	1L
118	green	0	4R
119	green	0	2R
120	red	1	0
121	red	0	4L
122	green	1	0
123	red	1	0
124	red	0	4L
125	green	0	2R
126	green	1	0
127	red	1	0
128	red	0	4L
129	green	0	2R
130	green	1	0
131	red	0	4L
132	green	1	0
133	red	1	0
134	green	0	4R
135	green	0	4R
136	red	0	4L
137	red	0	4L

Bird P-27 (Continued)

Trial	Key Color	Tone	Responses
138	green	0	4R
139	red	1	1L
140	green	1	1R
141	red	0	4L
142	green	1	0
143	red	1	1L
144	green	0	3R 1L
145	green	1	0
146	red	1	0
147	green	0	4R
148	red	0	4L
149	green	1	0
150	red	1	0
151	green	0	3R
152	red	0	2L 1R
153	green	0	4R
154	green	1	0
155	red	0	2L
156	green	1	0
157	green	0	0
158	green	1	0
159	red	1	0
160	green	1	0

Bird P-27 (Experimental group) Intertrial responses (ITR's) emitted during experiment.

Day	Right ITR's	Left ITR's
1	0	7
2	0	0
3	6	24
4	0	0
5	3	0
6	2	0
7	0	0
8	3	0
9	0	0
10	0	0
11	0	0
12	0	0
13	0	0
14	0	0
15	0	0
16	0	0
17	0	1
18	0	0
19	0	1
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0
26	0	0
27	0	0
28	0	0
29	0	0
30	0	0
31	1	0
32	1	0
33	0	0
34	0	0
35	0	0
36	1	0
37	0	0
38	0	0
39	0	0
40	0	0
41	0	0
42	0	0
43	0	0
44	0	1
45	0	0
46	0	0
47	1	0
48	1	1
49	2	0
50	1	0
51	1	1
52	0	0
53	0	0
54	0	0
55	0	1
56	4	3
57	0	1
58	0	0
59	5	3
60	1	2
61	0	1
62	1	1
63	8	6
64	0	0
65	0	2
66	5	11
67	0	2
68	1	0
69	1	0
70	0	0
71	2	0
72	1	0
73	0	0

EXTINCTION TEST

1	2	0
2	0	0

Bird P-30. (Experimental group) Conditions of training: Key lighted red - signal to respond left. Key lighted green - signal to respond right. Auditory discrimination training carried out using right side of key (green light). Green key no tone trials - responses reinforced. Green key tone trials - responses not reinforced. Transfer testing carried out on left side of key (red light). Table shows stimulus presentations and responses during training and testing. Prs: Trial presentations. Rt or Lft Rsp: Right or left responses. Rt or Lft RU: Right or left response units.

		Red Key-No Tone				Red Key-Tone				Green Key-No Tone				Green Key-Tone			
Day		Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
a	1									120	375	*	20				
	2									52	155	38	13				
b	3	67	194	48	13					13	40	10	3				
	4	36	88	22	14					21	64	16	5				
	5	80	167	40	40					59	193	40	18				
	6	61	166	40	21					51	186	40	11				
	7	60	181	40	8					59	193	40	8				
	8	46	168	40	5					58	194	40	17				
c	9	40	138	36	8					40	153	36	3				
	10	40	147	36	4					40	138	28	4				
	11	40	151	36	4					40	154	36	1				
	12	40	158	38	1					40	147	36	3				
	13	40	158	38	1					40	151	35	4				
	14	40	158	38	1					40	145	35	5				
	15	40	156	38	2					40	151	36	4				
	16	40	148	35	1					40	138	31	3				
	17	40	159	39	0					40	154	35	3				

* Response requirement being advanced from 1 to 4. No measure taken this day.
a Phase 1 and 2 included in this session.
b Phases 3,4 and 5 included in this session.
c Phase 6

Bird P-30 (Continued)

		Red Key-No Tone				Red Key-Tone			
Day		Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp
	18	40	157	38	2				
	19	40	155	36	4				
	20	40	158	38	2				
	21	40	151	35	5				
	22	40	159	39	1				
	23	40	153	35	3				
	24	40	158	38	2				
d	25								
	26								
	27								
	28								
	29								
	30								
	31								
	32								
	33								
	34								
	35								
	36								
	37								
	38								
	39								
	40								
	41								
e	42	40	148	37	3				

d Phase 7
e Phase 8

Green Key-No Tone				Green Key-Tone			
Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
40	149	35	3				
40	154	38	2				
40	153	36	2				
40	146	35	4				
40	153	35	3				
40	152	35	2				
40	151	35	3				
40	152	36	4	40	152	36	3
40	154	37	3	40	148	33	6
40	139	32	8	40	145	32	0
40	157	38	2	40	157	37	1
40	137	25	15	40	128	26	14
40	157	37	3	40	157	37	3
40	153	36	4	40	152	35	4
40	132	28	12	40	145	31	8
40	152	35	5	40	141	27	13
40	154	36	1	40	145	32	5
40	155	36	3	40	157	34	4
40	149	33	4	40	145	35	4
40	158	39	0	40	156	39	0
40	153	33	0	40	123	27	1
40	158	38	0	40	26	2	0
40	146	35	3	40	5	0	0
40	159	39	1	40	2	0	1
40	143	32	4	40	5	1	1

Bird P-30 (Continued)

Day	Red Key-No Tone				Red Key-Tone				Green Key-No Tone				Green Key-Tone			
	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
43	40	146	33	5					40	153	37	1	40	6	0	0
44	40	148	33	5					40	137	32	4	40	5	1	0
							EXTINCTION TEST									
f 1	40	112	24	6	40	62	7	0	40	132	31	2	40	9	2	1
2	40	9	2	0	40	5	1	0	40	40	10	0	40	0	0	0

f Phase 9

Bird P-30 Trial by trial behavior on first day of extinction testing. Entries are responses per trial (maximum of 4 possible on each trial). Conditions of training: Key lighted red - signal to respond left. Key lighted green - signal to respond right. Auditory discrimination training carried out using right side of key (green light). Transfer testing carried out on left side of key (red light). For further description of entries, see similar table for Bird P-25.

Trial	Key Color	Tone	Responses
1	red	0	1R
2	green	0	4R
3	green	1	0
4	green	1	0
5	red	1	2L
6	green	0	4R
7	red	0	4L
8	green	0	4R
9	green	1	0
10	red	1	1L
11	red	0	4L
12	red	1	4L
13	green	0	4R
14	green	1	0
15	red	0	4L
16	red	0	4L
17	green	0	4R
18	green	1	0
19	red	1	3L
20	red	0	4L
21	green	1	0
22	red	1	3L
23	red	0	4L
24	green	0	4R
25	green	1	0
26	red	0	4L
27	red	1	4L
28	red	0	4L
29	green	0	4R
30	green	1	0
31	red	1	2L
32	green	0	4R
33	green	1	0
34	green	0	4R
35	red	0	4L
36	green	1	0
37	red	1	2L
38	red	0	1L 1R
39	red	1	4L
40	green	0	4R

Bird P-30 (Continued)

Trial	Key Color	Tone	Responses
41	red	1	2L
42	red	0	4L
43	green	0	4R
44	green	1	0
45	red	1	0
46	red	0	4L
47	green	1	0
48	red	0	4L
49	green	0	4R
50	red	1	2L
51	green	0	4R
52	green	1	0
53	red	1	0
54	red	0	4L
55	green	1	0
56	red	1	2L
57	green	0	4R
58	green	1	0
59	red	1	3L
60	red	0	3L
61	green	0	4R
62	red	0	4L
63	green	0	4R
64	green	1	0
65	red	1	0
66	red	0	0
67	red	1	0
68	red	0	4L
69	green	0	4R
70	green	1	0
71	red	1	0
72	green	0	4R
73	green	1	0
74	red	1	2L
75	red	0	3R
76	green	0	1L
77	green	0	4R
78	green	1	0
79	red	1	4L
80	green	1	0
81	red	1	1L 1R
82	red	0	4L
83	red	1	1L
84	green	0	4R
85	green	1	4R
86	red	0	4L
87	red	0	1R
88	red	1	4L

Bird P-30 (Continued)

Trial	Key Color	Tone	Responses
89	red	1	4L
90	green	0	4R
91	green	1	0
92	red	0	1R
93	green	0	2R
94	red	1	0
95	red	0	4L
96	green	0	4R
97	green	1	0
98	green	0	4R
99	green	1	4R
100	red	1	0
101	red	0	4L
102	red	1	4L
103	red	0	4L
104	green	0	4R
105	green	1	0
106	red	1	0
107	green	1	0
108	green	0	1L
109	red	1	1L
110	red	0	4L
111	green	1	0
112	red	1	2L
113	red	0	4L
114	green	0	4R
115	green	1	0
116	red	1	0
117	red	0	1L 1R
118	green	1	0
119	red	1	3L
120	green	0	4R
121	green	0	4R
122	red	1	2L
123	red	0	2L
124	green	1	1L
125	red	1	0
126	red	0	2L 1R
127	green	0	4R
128	green	1	0
129	red	1	0
130	red	0	4L
131	green	0	4R
132	green	1	0
133	red	0	4L
134	green	1	0
135	red	1	0

Bird P-30 (Continued)

Trial	Key Color	Tone	Responses
136	green	0	2R
137	green	0	4R
138	red	0	1L
139	red	0	0
140	green	0	0
141	red	1	0
142	green	1	0
143	red	0	0
144	green	1	0
145	red	1	0
146	green	0	0
147	green	1	0
148	red	1	0
149	green	0	0
150	red	0	0
151	green	1	0
152	red	1	0
153	green	0	4R
154	red	0	0
155	green	0	0
156	green	1	0
157	red	0	1L
158	green	1	0
159	green	0	2R
160	green	1	0

Bird P-30 (Experimental group) Intertrial responses (ITR's) emitted during experiment.

Day	Right ITR's	Left ITR's
1	507	106
2	0	1
3	21	16
4	2	2
5	4	3
6	1	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
12	0	0
13	0	0
14	0	0
15	0	0
16	1	2
17	2	1
18	0	0
19	1	0
20	1	0
21	1	0
22	1	1
23	0	0
24	0	0
25	1	0
26	0	0
27	0	0
28	0	0
29	0	0
30	0	0
31	0	0
32	2	0
33	4	0
34	0	0
35	0	0
36	1	0
37	1	0
38	0	2
39	2	1
40	1	0
41	2	0
42	3	0
43	0	0
44	2	4

Day	Right ITR's	Left ITR's
	EXTINCTION TEST	
1	1	2
2	0	0

Bird S-24 (Control Group) Conditions of training. Key lighted red - signal to respond left. Table shows stimulus presentations and responses during training and testing. Prs: Trial presentations. Rt or Lft Rsp: Right or left responses. Rt or Lft RU: Right or left response units.

		Red Key-No Tone				Red Key-Tone			
Day		Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp
a	1	43	50	*	0				
b	2	74	191	40	33				
	3	41	163	40	1				
	4	44	170	40	4				
c	5	40	145	34	6				
	6	40	158	38	2				
	7	40	158	38	2				
	8	40	159	39	1				
	9	40	160	40	0				
	10	40	160	40	0				
	11	40	159	39	0				
	12	40	160	40	0				
	13	40	157	39	1				
	14	40	157	35	0				
	15	40	159	39	0				
	16	40	157	39	1				
	17	40	158	38	0				
	18	40	154	34	2				
	19	40	160	40	0				
	20	40	157	37	1				
	21	40	160	40	0				

a Phase 1
b Phase 2 with correction procedure.
c Phase 2 continued, correction procedure discontinued.
* Response requirement being advanced from 1 to 4. No measure taken this day.

Bird S-24 (Continued)

Red Key-No Tone

Day	Prs	Lft Rsp	Lft RU	Rt Rsp
22	40	157	38	1
23	40	160	40	0
24	40	159	39	1
25	40	158	38	0
26	40	157	37	1
27	40	159	39	1
28	40	159	39	0
29	40	156	33	5
30	40	156	38	1
31	40	160	40	0
1	40	148	34	1
2	40	24	5	1

Red Key-Tone

Prs	Lft Rsp	Lft RU	Rt Rsp

EXTINCTION TEST

40	146	34	0
40	32	5	0

Bird S-24 (Control group) Intertrial responses (ITR's) emitted during experiment.

Day	Right ITR's	Left ITR's
1	8	54
2	0	3
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
12	0	0
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
24	0	1
25	0	0
26	0	0
27	0	0
28	0	2
29	0	1
30	0	1
31	1	0
EXTINCTION TEST		
1	0	0
2	0	0

Bird P-60 (Control Group) Conditions of training: Key lighted green - signal to respond right. Table shows stimulus presentations and responses during training and testing. Prs: Trial presentations. Rt or Lft Rsp: Right or left responses. Rt or Lft RU: Right or left response units.

		Green Key-No Tone				Green Key-Tone			
	Day	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
a	1	41	41	*	0				
	2	83	166	40	0				
	3	40	160	40	0				
b	4	67	205	40	24				
	5	43	168	40	1				
c	6	40	156	39	1				
	7	40	160	40	0				
	8	40	148	36	4				
	9	40	160	40	0				
	10	40	159	39	0				
	11	40	160	40	0				
	12	40	159	39	0				
	13	40	160	40	0				
	14	40	153	38	2				
	15	40	156	39	1				
	16	40	114	28	1				
	17	40	156	39	0				
	18	40	157	39	1				
	19	40	160	40	0				
	20	40	153	38	2				
	21	40	159	39	0				

* Response requirement being advanced from 1 to 4. No measure taken this day.
a Phase 1
b Phase 2 with correction procedure.
c Phase 2 correction procedure discontinued.

Bird P-60 (Continued)

Green Key-No Tone

Day	Prs	Rt Rsp	Rt RU	Lft Rsp
22	40	160	40	0
23	40	160	40	0
24	40	160	40	0
25	40	160	40	0
26	40	157	39	1
27	40	157	39	0
28	40	158	39	0
1	40	71	16	4
2	40	13	3	0

Green Key-Tone

Prs	Rt Rsp	Rt RU	Lft Rsp

EXTINCTION TEST

40	68	14	2
40	4	0	0

Bird P-60 (Control group) Intertrial responses (ITR's) emitted during experiment.

Day	Right ITR's	Left ITR's
1	0	0
2	0	0
3	43	0
4	2	1
5	0	0
6	0	4
7	0	1
8	0	0
9	1	0
10	0	0
11	1	1
12	0	0
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	1
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0
26	0	0
27	0	0
28	0	0
EXTINCTION TEST		
1	0	2
2	0	0

Bird P-100 (Control Group) Conditions of training: Key lighted green - signal to respond left. Table shows stimulus presentations and responses during training and testing. Prs: Trial presentations. Rt or Lft Rsp: Right or left responses. Rt or Lft RU: Right or left response units.

		Green Key-No Tone				Green Key-Tone			
Day		Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp
a	1	59	60	*	0				
b	2	40	159	39	0				
	3	41	163	40	1				
c	4	40	159	35	4				
	5	40	158	38	2				
	6	40	157	35	5				
	7	40	151	35	5				
	8	40	99	21	19				
d	9	74	196	40	33				
	10	52	178	40	12				
	11	50	190	40	10				
	12	76	204	40	36				
	13	64	204	40	24				
	14	45	175	40	5				
	15	53	179	40	14				
	16	47	186	40	7				
	17	47	176	40	7				
	18	51	184	40	11				
	19	49	181	40	9				
	20	51	182	40	11				
	21	63	198	40	23				

* Response requirement being advanced from 1 to 4. No measure taken this day.
a Phase 1
b Phase 2 with correction procedure.
c Phase 2 correction procedure discontinued.
d Phase 2 correction procedure reinstituted.

Bird P-100 (Continued)

Day	Green Key-No Tone Prs	Lft Rsp	Lft RU	Rt Rsp	Green Key-Tone Prs	Lft Rsp	Lft RU	Rt Rsp
22	52	180	40	12				
e 23	40	143	31	9				
24	40	140	31	5				
25	40	151	33	6				
26	40	156	38	1				
EXTINCTION TEST								
1	40	151	35	5	40	157	37	3
2	40	135	27	4	40	109	22	3

e Phase 2 correction procedure discontinued.

Bird P-100 (Control group) Intertrial responses (ITR's) emitted during experiment.

Day	Right ITR's	Left ITR's
1	0	43
2	3	2
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	1	0
11	0	0
12	0	0
13	0	0
14	0	0
15	0	0
16	1	0
17	0	0
18	0	0
19	0	0
20	0	1
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0
26	0	0
EXTINCTION TEST		
1	0	1
2	0	0

APPENDIX II

RAW DATA FOR EXPERIMENT 2

Bird P-17 (Experimental group) Conditions of training: Key lighted red - signal to respond left. Key lighted green - signal to respond right. Auditory discrimination training carried out using right side of key (Green light). Green key no tone trials - responses not reinforced. Green key tone trials - responses reinforced. Transfer testing carried out on left side of key (Red light). Table shows stimulus presentations and responses during training and testing. Prs: Trial presentations. Rt or Lft Rsp: Right or left responses. Rt or Lft RU: Right or left response units.

		Red Key-No Tone				Red Key-Tone				Green Key-No Tone				Green Key-Tone			
Day		Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
a	1													112	202	*	0
b	2													212	169	31	181
	3													200	163	73	128
	4													67	109	28	76
	5													152	187	40	100
	6													70	116	40	30
	7													49	180	40	8
c	8	58	174	40	18												
d	9	80	166	40	40									77	162	40	36
	10	54	163	40	12									135	173	40	75
	11	66	170	40	26									82	171	40	42
	12	60	208	40	20									70	178	40	30
	13	67	198	40	27									76	169	40	36
e	14	40	158	32	8									40	126	25	15
	15	40	172	36	4									40	116	25	15

* Response requirement being advanced from 1 to 4. No measure taken this day.

a Phase 1

b Phase 2

c Phase 3

d Phases 4 and 5 included in this session.

e Phase 6

Bird P-17 (Continued)

		Red Key-No Tone			Red Key-Tone			
Day	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp
16	40	122	25	15				
17	40	98	20	20				
18	40	132	26	14				
19	40	130	24	14				
20	40	83	17	23				
21	40	137	27	13				
f 22	55	195	40	15				
g 23	40	159	33	7				
24	40	156	35	5				
25	40	140	29	11				
26	40	134	27	13				
27	40	140	29	11				
28	40	148	31	9				
h 29								
30								
31								
32								
33								
34								
35								

f Returned to Phase 5
g Phase 6
h Phase 7

Green Key-No Tone				Green Key-Tone			
Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
				40	119	26	14
				40	158	34	1
				40	152	33	7
				40	158	34	6
				40	164	35	5
				40	166	34	6
				42	166	40	2
				40	160	40	0
				40	159	36	4
				40	158	39	1
				40	159	39	1
				40	158	38	2
				40	158	38	2
40	156	37	3	40	159	39	1
40	133	29	5	40	158	38	2
40	140	32	0	40	160	40	0
40	109	22	16	40	116	28	10
40	124	31	9	40	151	37	3
40	52	9	0	40	159	37	3
40	5	0	0	40	160	40	0

Bird P-17 (Continued)

		Red Key-No Tone				Red Key-Tone				Green Key-No Tone				Green Key-Tone			
Day		Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
	36									40	4	0	0	40	159	39	1
i	37	40	106	22	18					40	12	1	1	40	144	36	3
	38	40	147	33	7					40	7	1	0	40	159	39	1
	39	40	159	34	6					40	23	1	2	40	149	36	4
						EXTINCTION											
j	1	40	157	35	4												
						EXTINCTION TEST											
k	1	40	68	13	1	40	96	20	4								
l	2	40	21	3	0	40	28	4	0	40	32	6	3	40	115	28	6

i Phase 8
j Phase 9
k Phase 10
l Phase 11

Bird P-17 Trial by trial behavior on first day of extinction testing. Entries are responses per trial (maximum of 4 possible on each trial). Conditions of training: Key lighted red - signal to respond left. Key lighted green - signal to respond right. Auditory discrimination training carried out using right side of key (green light). Transfer testing carried out on left side of key (red light). Only red key trials were presented on the first day of extinction testing. Entries in Tone column signify presence or absence of tone on a given trial. 1 signifies tone present. 0 signifies no tone present. R following the number of responses indicates these responses made to right key. L following number of responses indicates responses on left key. Since one incorrect response (pecking to inappropriate side) terminates a trial, there can be only one incorrect response per trial and no correct response can follow it.

Trial	Tone	Responses	Trial	Tone	Responses
1	0	4L	33	0	4L
2	1	4L	34	1	4L
3	1	1R	35	1	4L
4	0	4L	36	1	1L
5	0	3L	37	0	0
6	1	4L	38	1	4L
7	0	4L	39	1	1L
8	0	4L	40	0	0
9	1	4L	41	1	4L
10	0	4L	42	1	0
11	1	4L	43	0	1L
12	0	4L	44	1	3L 1R
13	0	4L	45	0	1L
14	0	1R	46	0	1L
15	1	4L	47	1	4L
16	0	4L	48	1	0
17	1	4L	49	1	2L
18	1	4L	50	0	0
19	0	2L	51	0	0
20	0	1L	52	1	2L
21	0	1L	53	1	2L 1R
22	1	4L	54	0	1L
23	0	4L	55	0	0
24	1	4L	56	1	0
25	0	4L	57	0	0
26	1	4L	58	1	4L
27	0	4L	59	0	0
28	1	4L	60	1	1L 1R
29	1	4L	61	1	4L
30	0	4L	62	0	0
31	0	4L	63	1	0
32	1	0	64	0	0

Bird P-17 (Continued)

Trial	Tone	Responses
65	0	0
66	1	0
67	0	0
68	1	4L
69	0	0
70	1	0
71	1	0
72	0	0
73	1	0
74	0	0
75	0	0
76	1	0
77	0	0
78	1	0
79	1	0
80	0	0

Bird P-17 (Experimental group) Intertrial responses (ITR's) emitted during experiment.

Day	Right ITR's	Left ITR's
1	12	1
2	49	137
3	99	43
4	6	0
5	17	5
6	7	2
7	4	1
8	4	2
9	1	5
10	2	1
11	3	2
12	0	1
13	4	3
14	0	1
15	4	0
16	1	0
17	0	0
18	2	0
19	2	0
20	1	0
21	1	0
22	0	0
23	0	0
24	0	0
25	1	1
26	0	0
27	0	0
28	0	0
29	0	0
30	0	1
31	0	0
32	2	1
33	0	0
34	0	0
35	0	0
36	0	0
37	0	0
38	0	0
39	0	0

Day	Right ITR's	Left ITR's
	EXTINCTION	
1	0	0
	EXTINCTION TEST	
1	2	0
2	6	1

Bird P-18. (Experimental group) Conditions of training: Key lighted red - signal to respond left. Key lighted green - signal to respond right. Auditory discrimination training carried out using left side of key (red light). Red key no tone trials - responses not reinforced. Red key tone trials - responses reinforced. Transfer testing carried out on right side of key (green light). Table shows stimulus presentations and responses during training and testing. Prs: Trial presentations. Rt or Lft Rsp: Right or left responses. Rt or Lft RU: right or left response units.

		Red Key-No Tone			Red Key-Tone				Green Key-No Tone				Green Key-Tone			
Day		Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
a	1					82	208	*	0								
b	2					102	236	55	47								
	3					44	162	41	2								
d	4									40	133	32	8				
e	5									77	180	40	36				
f	6					61	171	40	19	51	167	40	11				
	7					59	170	40	18	48	165	40	8				
	8					69	171	40	29	51	163	40	11				
	9					69	173	40	24	51	165	40	11				
	10					45	160	40	5	50	163	40	10				
	11					46	172	40	5	50	170	40	10				
g	12					40	147	34	6	40	143	33	7				
	13					40	136	33	7	40	136	32	8				
	14					40	159	39	1	40	140	33	7				
	15					40	156	38	2	40	144	35	5				

* Response requirement being advanced from 1 to 4. No measure taken this day.

a Phase 1
b Phase 2
d Phase 3
e Phase 4
f Phase 5
g Phase 6

Bird P-18 (Continued)

		Red Key-No Tone				Red Key-Tone			
Day		Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp
16						40	145	36	4
17						40	135	33	7
18						40	146	36	4
19						40	124	28	8
20						40	135	30	5
21						40	135	31	9
22						40	138	32	8
23						40	127	28	12
24						40	90	14	27
25						40	128	29	11
26						40	136	32	8
27						40	103	21	19
28						40	104	21	19
29						40	98	19	20
h 30						48	170	40	8
i 31						40	123	28	12
32						40	136	30	10
33						40	127	27	12
j 34		40	133	29	11	40	150	35	5
35		40	109	25	15	40	123	27	13
36		40	136	29	11	40	142	34	6
37		40	147	34	6	40	147	33	7
38		40	138	32	8	40	133	27	13
39		40	138	31	9	40	134	32	8

h Returned to Phase 5
i Phase 6
j Phase 7

Green Key-No Tone				Green Key-Tone			
Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
40	147	36	4				
40	160	40	0				
40	152	37	3				
40	152	36	1				
40	131	27	3				
40	151	37	3				
40	130	28	3				
40	140	30	4				
40	133	30	10				
40	153	37	2				
40	139	33	7				
40	139	31	10				
40	144	36	4				
40	142	33	6				
44	164	40	3				
40	157	37	3				
40	152	37	3				
40	144	31	2				

Bird P-18 (Continued)

		Red Key-No Tone			Red Key-Tone			
Day	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp
40	40	134	30	10	40	139	33	7
41	40	139	31	9	40	141	33	6
42	40	102	19	22	40	121	22	18
43	40	137	28	12	40	130	28	12
44	40	146	32	8	40	144	34	6
45	40	134	30	10	40	151	36	4
46	40	141	33	7	40	148	38	2
47	40	112	21	19	40	149	36	4
48	40	110	19	20	40	118	25	12
49	40	98	16	21	40	140	32	7
50	40	67	6	13	40	129	27	13
51	40	39	5	7	40	139	32	8
52	40	36	4	6	40	128	27	12
53	40	16	3	2	40	152	37	3
54	40	13	0	4	40	139	29	10
55	40	30	5	6	40	141	31	9
56	40	6	1	0	40	147	36	4
57	40	17	2	1	40	144	30	10
58	40	13	1	1	40	149	36	5
k 59	40	41	6	3	40	112	26	6
l 60								
m 61	40	8	1	2	40	149	24	16
62	40	0	0	0	40	125	27	13
63	40	3	0	1	40	129	27	12

k Phase 8
l Returned to Phase 4
m Phase 8

Green Key-No Tone				Green Key-Tone			
Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
40	39	4	7				
40	156	38	2				
40	131	27	6				
40	146	32	3				
40	132	26	2				

Bird P-18 (Continued)

		Red Key-No Tone			Red Key-Tone				Green Key-No Tone				Green Key-Tone			
Day		Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
64		40	2	0	0	40	137	29	11	40	152	34	2				
65		40	0	0	0	40	124	26	14	40	155	35	0				
66		40	3	0	0	40	127	25	14	40	148	33	2				
										EXTINCTION							
n	1									40	160	40	0				
	2									40	95	19	4				
	3									20	51	11	2				
										EXTINCTION TEST							
o**	1									40	20	3	3	40	103	21	8
p	2	40	10	1	2	40	135	29	11	40	5	0	1	40	25	4	1

** Phase 10 occurred on same day as last session of Phase 9.
n Phase 9
o Phase 10
p Phase 11

Bird P-18 Trial by trial behavior on first day of extinction testing. Entries are responses per trial (maximum of 4 possible on each trial). Conditions of training: Key lighted red - signal to respond left. Key lighted green - signal to respond right. Auditory discrimination training carried out using left side of key (red light). Transfer testing carried out on right side of key (green light). Only green key trials were presented on the first day of extinction testing. For further description of entries see similar table for Bird P-17.

Trial	Tone	Responses	Trial	Tone	Responses
1	0	0	41	1	0
2	0	0	42	1	4R
3	1	4R	43	0	0
4	0	4R	44	0	0
5	1	4R	45	1	3R
6	1	4R	46	1	3R 1L
7	0	4R	47	0	1R 1L
8	0	1R	48	0	0
9	0	4R	49	1	1R
10	1	4R	50	0	1R
11	0	0	51	1	4R
12	1	4R	52	0	0
13	0	2R	53	1	4R
14	1	4R	54	0	0
15	1	4R	55	1	2R
16	0	2R	56	0	0
17	0	0	57	1	1L
18	0	1R	58	1	0
19	1	4R	59	1	0
20	0	0	60	0	0
21	1	4R	61	1	0
22	1	4R	62	0	0
23	0	0	63	1	0
24	1	4R	64	1	0
25	0	0	65	0	0
26	1	4R	66	1	0
27	0	0	67	0	0
28	1	4R	68	1	0
29	1	4R	69	0	0
30	0	0	70	0	0
31	1	4R	71	0	0
32	0	0	72	1	2R 1L
33	0	0	73	0	0
34	1	4R	74	1	3R 1L
35	1	1L	75	1	1R 1L
36	0	0	76	0	0
37	1	4R	77	1	4R
38	1	1L	78	0	0
39	0	0	79	0	0
40	1	1L	80	0	0

Bird P-18 (Experimental group) Intertrial responses (ITR's) emitted during experiment.

Day	Right ITR's	Left ITR's
1	9	64
2	1	4
3	0	0
4	2	9
5	0	0
6	0	5
7	0	1
8	3	18
9	0	1
10	0	1
11	0	3
12	0	0
13	0	0
14	0	0
15	0	0
16	20	7
17	0	4
18	4	2
19	4	1
20	4	2
21	0	0
22	0	0
23	1	1
24	14	2
25	0	0
26	0	0
27	0	0
28	0	0
29	0	0
30	0	0
31	0	0
32	0	2
33	0	0
34	0	0
35	0	1
36	0	0
37	0	0
38	0	0
39	0	0
40	0	0
41	0	0
42	0	1
43	0	0
44	0	0
45	0	0
46	0	0
47	0	0
48	0	0
49	1	1
50	0	0
51	0	0
52	0	2
53	0	0
54	0	1
55	0	1
56	0	0
57	0	0
58	0	0
59	1	5
60	0	0
61	0	0
62	0	0
63	2	0
64	0	0
65	0	0
66	0	0
EXTINCTION		
1	1	0
2	0	0
3	0	0
EXTINCTION TEST		
1	0	0
2	0	0

Bird P-21. (Experimental group) Conditions of training: Key lighted red - signal to respond right. Key lighted green signal to respond left. Auditory discrimination carried out using right side of key (red light). Red key no tone trials - responses not reinforced. Red key tone trials - responses reinforced. Transfer testing carried out on left side of key (green light). Table shows stimulus presentations and responses during training and testing. Prs: Trial presentations. Rt or Lft Rsp: Right or left responses. Rt or Lft RU: Right or left response units.

		Red Key-No Tone			Red Key-Tone				Green Key-No Tone				Green Key-Tone			
Day		Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp
a	1									44	216	*	0				
b	2									98	279	54	44				
	3									49	180	40	9				
c	4					91	183	40	51								
	5					92	161	40	39								
	6					146	244	40	106								
	7					99	187	40	53								
	8					70	223	40	30								
d	9					195	169	40	155								
	10					65	176	40	25								
e	11					107	276	40	67	294	399	40	254				
	12					49	176	40	9	77	202	40	37				
f	13					40	127	29	13	40	101	20	20				
	14					40	127	28	12	40	71	11	28				
	15					40	130	25	15	40	97	19	21				

* Response requirement being advanced from 1 to 4. No measure taken this day.

a Phase 1
b Phase 2
c Phase 3
d Phase 4
e Phase 5
f Phase 6

Bird P-21 (Continued)

		Red Key-No Tone				Red Key-Tone			
	Day	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
	16					40	142	28	12
	17					40	123	21	19
	18					40	119	17	23
	19					40	111	12	28
	20					40	103	21	19
g	21					73	186	40	33
	22					83	205	40	43
	23					63	195	40	23
	24					58	170	40	18
	25					59	189	40	19
	26					49	170	40	9
h	27					40	143	31	9
	28					40	136	29	11
	29					40	133	29	11
	30					40	148	34	6
i	31	40	131	29	11	40	145	31	9
	32	40	135	30	10	40	143	28	12
	33	40	140	32	8	40	148	29	11
	34	40	130	16	14	40	130	14	16
	35	40	107	11	29	40	121	12	18
	36	40	133	24	14	40	143	25	15
	37	40	133	21	19	40	142	25	15
	38	40	140	22	18	40	139	22	18
	39	40	147	27	13	40	137	18	22

g Phase 5 reinstituted.
h Phase 6 resumed.
i Phase 7

Green Key-No Tone

Prs	Lft Rsp	Lft RU	Rt Rsp
40	86	16	24
40	76	14	26
40	107	22	18
40	106	19	21
40	96	18	22
139	205	40	53
92	208	40	50
77	203	40	37
95	234	40	55
74	198	40	34
46	169	40	6
40	146	34	6
40	156	37	2
40	155	38	2
40	153	37	2

Green Key-Tone

Prs	Lft Rsp	Lft RU	Rt Rsp

Bird P-21 (Continued)

	Red Key-No Tone				Red Key-Tone				Green Key-No Tone				Green Key-Tone			
Day	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp
40	40	147	31	9	40	147	29	11								
41	40	149	33	6	40	138	24	16								
42	40	142	30	10	40	136	30	10								
43	40	135	28	12	40	142	29	11								
44	40	140	31	9	40	135	24	16								
45	40	156	33	7	40	151	25	15								
46	40	147	30	10	40	147	28	12								
47	40	121	20	20	40	157	31	9								
48	40	104	16	23	40	139	23	17								
49	40	134	29	11	40	151	30	10								
50	40	152	35	5	40	155	31	9								
51	40	100	21	5	40	156	36	4								
52	40	44	10	1	40	159	38	1								
53	40	109	18	17	40	115	22	18								
54	40	35	7	4	40	151	21	19								
55	40	3	0	4	40	149	28	12								
56	40	35	6	4	40	157	37	3								
57	40	49	5	9	40	155	34	6								
58	40	14	2	1	40	157	38	2								
59	40	38	7	0	40	159	36	4								
60	40	15	3	3	40	144	32	8								
61	40	9	1	2	40	157	36	4								
62	40	9	2	1	40	148	29	11								
63	40	14	3	3	40	155	30	10								
64	40	20	3	4	40	158	31	9								
65	40	90	17	9	40	152	28	12								
66	40	38	4	13	40	158	38	2								
67	40	54	10	6	40	153	30	10								
68	40	78	13	4	40	158	34	6								

Bird P-21 (Continued)

	Red Key-No Tone				Red Key-Tone				Green Key-No Tone				Green Key-Tone			
Day	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp
69	40	61	12	4	40	159	34	6								
70	40	52	9	8	40	156	33	7								
71	40	118	25	5	40	157	34	6								
72	40	92	20	0	40	157	38	2								
73	40	46	9	7	40	151	30	10								
74	40	24	2	4	40	152	30	10								
75	40	20	2	2	40	147	31	9								
76	40	11	1	0	40	143	22	18								
77	40	15	2	0	40	144	28	11								
78	40	12	0	1	40	152	31	9								
79	40	0	0	0	40	153	26	14								
80	40	10	0	2	40	144	27	13								
81	40	13	2	3	40	142	18	22								
82	40	18	3	3	40	139	22	18								
83	40	22	4	4	40	136	22	18								
84	40	18	3	2	40	158	32	8								
85	40	47	8	4	40	158	30	10								
86	40	34	3	4	40	151	26	14								
87	40	74	13	5	40	145	26	14								
88	40	20	1	4	40	153	33	7								
89	40	13	2	1	40	157	35	5								
j 90	40	31	3	6	40	150	26	14	40	49	5	35				
91	40	30	6	3	40	154	34	6	40	75	14	26				
92	40	9	1	4	40	156	35	5	40	91	19	20				
93	40	22	3	4	40	102	17	19	40	101	23	16				

j Phase 8

Bird P-21 (Continued)

		Red Key-No Tone				Red Key-Tone				Green Key-No Tone				Green Key-Tone			
Day		Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp
94		40	22	3	3	40	121	26	13	40	114	27	13				
95		40	10	2	3	40	148	22	18	40	147	34	5				
96		40	7	0	2	40	149	32	8	40	129	29	10				
97		40	20	4	1	40	147	27	13	40	120	26	14				
98		40	5	0	1	40	154	29	11	40	133	30	10				
99		40	12	2	1	40	153	33	7	40	81	14	22				
100		40	9	2	0	40	133	26	14	40	137	33	7				
101		40	5	0	1	40	144	24	15	40	136	33	6				
102		40	1	0	2	40	143	28	12	40	141	34	6				
										EXTINCTION							
k	1									40	122	27	10				
	2									40	96	22	17				
	3									40	93	20	12				
										EXTINCTION TEST							
l**	1									80	191	36	23	80	266	63	18
m	2	40	2	0	1	40	98	22	14	40	27	4	2	40	100	19	7

** Phase 10 occurred on same day as last session of Phase 9.
k Phase 9
l Phase 10
m Phase 11

Bird P-21 Trial by trial behavior on first day of extinction testing. Entries are responses per trial (maximum of 4 possible on each trial). Conditions of training: Key lighted red - signal to respond right. Key lighted green - signal to respond left. Auditory discrimination carried out using right side of key (red light). Transfer testing carried out on left side of key (green light). Only green key trials were presented on the first day of extinction testing. For further description of entries, see similar table for Bird P-17.

Trial	Tone	Responses	Trial	Tone	Responses
1	1	4L	41	0	1R
2	0	4L	42	1	4L
3	0	4L	43	0	1R
4	1	4L	44	1	4L
5	1	4L	45	1	1R
6	1	3L 1R	46	0	4L
7	0	1L 1R	47	0	4L
8	1	1R	48	1	4L
9	1	3L 1R	49	0	1R
10	0	3L	50	1	4L
11	1	1L 1R	51	0	4L
12	0	4L	52	0	1R
13	1	4L	53	1	4L
14	1	4L	54	1	4L
15	1	4L	55	0	4L
16	0	1R	56	0	1R
17	0	4L	57	0	4L
18	0	1R	58	1	1R
19	1	2L 1R	59	1	4L
20	1	1L 1R	60	0	4L
21	0	4L	61	1	4L
22	0	2L 1R	62	0	4L
23	1	4L	63	0	3L 1R
24	0	4L	64	1	4L
25	1	4L	65	1	2L 1R
26	1	4L	66	0	3L
27	0	1R	67	1	4L
28	0	4L	68	1	4L
29	1	1R	69	0	4L
30	0	2L 1R	70	0	4L
31	0	4L	71	1	4L
32	1	1R	72	1	4L
33	0	1R	73	0	4L
34	1	4L	74	1	1R
35	1	1R	75	0	4L
36	1	4L	76	0	4L
37	0	1R	77	1	4L
38	0	4L	78	0	1R
39	1	1R	79	1	4L
40	0	3L 1R	80	0	4L

Bird P-21 (Continued)

Trial	Tone	Responses
81	1	4L
82	1	4L
83	0	1R
84	0	4L
85	1	4L
86	1	4L
87	0	2L 1R
88	1	4L
89	1	1R
90	0	1R
91	1	1R
92	0	4L
93	1	4L
94	1	4L
95	1	4L
96	0	1R
97	0	1L 1R
98	0	4L
99	1	4L
100	1	4L
101	0	4L
102	0	4L
103	1	4L
104	0	4L
105	1	4L
106	1	4L
107	0	4L
108	0	4L
109	1	4L
110	0	3L
111	0	0
112	1	4L
113	0	4L
114	1	4L
115	1	1L 1R
116	1	1R
117	0	4L
118	0	0
119	1	4L
120	0	1L 1R
121	0	4L
122	1	4L
123	0	2L
124	1	4L
125	1	4L
126	0	1L
127	0	4L
128	1	4L
129	0	3L
130	1	4L
131	0	1L
132	0	0
133	1	4L
134	1	4L
135	0	3L
136	0	0
137	0	0
138	1	4L
139	1	4L
140	0	1L
141	1	4L
142	0	2L
143	0	0
144	1	4L
145	1	4L
146	0	0
147	1	4L
148	1	4L
149	0	0
150	0	1L
151	1	4L
152	1	4L
153	0	0
154	1	4L
155	0	3L
156	0	1R
157	1	1L
158	0	1L
159	1	1L
160	0	1L

Bird P-21 (Experimental group) Intertrial responses (ITR's) emitted during experiment.

Day	Right ITR's	Left ITR's
1	98	114
2	9	20
3	0	0
4	4	7
5	0	0
6	2	8
7	30	62
8	2	3
9	0	10
10	0	0
11	1	0
12	2	1
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	1
24	0	0
25	0	0
26	0	0
27	0	0
28	0	0
29	0	0
30	0	0
31	0	1
32	0	0
33	0	0
34	0	1

Note: Following Day 34 of training no further ITR's were emitted by this bird throughout his training, extinction and extinction testing.

Bird P-97 (Control Group) Conditions of training: Key lighted green - signal to respond right. Table shows stimulus presentations and responses during training and testing. Prs: Trial presentations. Rt or Lft Rsp: Right or left responses. Rt or Lft RU: Right or left response units.

		Green Key-No Tone				Green Key-Tone			
	Day	Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
a	1	32	49	*	0				
	2	40	70	*	0				
b	3	62	188	40	22				
	4	69	183	40	29				
	5	51	169	40	11				
	6	46	167	40	5				
	7	65	173	40	20				
	8	44	166	40	4				
	9	44	166	40	4				
c	10	40	151	37	3				
	11	40	159	38	2				
	12	40	152	37	3				
	13	40	147	34	6				
	14	40	153	33	6				
d	15	58	190	40	18				
	16	78	219	40	37				
	17	48	172	40	8				
	18	57	191	40	11				
	19	62	189	40	19				
	20	47	167	40	5				
	21	42	164	40	1				

* Response requirement being advanced from 1 to 4. No measure taken this day.

a Phase 1

b Phase 2 with correction procedure.

c Phase 2 correction procedure discontinued.

d Phase 2 correction procedure reinstituted.

Bird P-97 (Continued)

Day	Green Key-No Tone Prs	Rt Rsp	Rt RU	Lft Rsp	Green Key-Tone Prs	Rt Rsp	Rt RU	Lft Rsp
e 22	40	153	37	2				
23	40	150	34	5				
24	40	152	35	3				
25	40	156	37	2				
26	40	149	33	5				
27	40	145	33	2				
				EXTINCTION				
1	40	157	37	0				
				EXTINCTION TEST				
1	40	127	25	1	40	127	23	5
2	40	7	1	1	40	3	0	0

e Phase 2 correction procedure discontinued.

Bird P-97 (Control group) Intertrial responses (ITR's) emitted during experiment.

Day	Right ITR's	Left ITR's
1	0	0
2	105	4
3	0	0
4	2	1
5	0	0
6	0	1
7	0	1
8	2	2
9	1	1
10	1	2
11	0	2
12	2	6
13	2	1
14	1	1
15	3	2
16	2	4
17	1	0
18	2	0
19	1	0
20	1	1
21	1	0
22	1	0
23	2	0
24	0	1
25	0	0
26	1	1
27	0	3
EXTINCTION		
1	2	1
EXTINCTION TEST		
1	0	1
2	0	0

Bird P-99 (Control Group) Conditions of training: Key lighted red - signal to respond left. Table shows stimulus presentations and responses during training and testing. Prs: Trial presentations. Rt or Lft Rsp: Right or left responses. Rt or Lft RU: Right or left response units.

		Red Key-No Tone				Red Key-Tone			
Day		Prs	Lft Rsp	Lft RU	Rt Rsp	Prs	Lft Rsp	Lft RU	Rt Rsp
a	1	45	46	*	0				
	2	41	111	*	0				
b	3	61	167	40	13				
	4	66	167	40	24				
	5	45	163	40	5				
c	6	40	160	40	0				
	7	40	160	40	0				
	8	40	156	39	1				
	9	40	156	39	1				
	10	40	156	39	1				
	11	40	160	40	0				
	12	40	148	37	3				
	13	40	156	39	1				
	14	40	160	40	0				
	15	40	156	39	1				
	16	40	160	40	0				
	17	40	156	39	1				
	18	40	160	40	0				
	19	40	156	39	1				
	20	40	160	40	0				
	21	40	160	40	0				

* Response requirement being advanced from 1 to 4. No measure taken this day.
a Phase 1
b Phase 2 with correction procedure.
c Phase 2 correction procedure discontinued.

Bird P-99 (Continued)

Day	Red Key-No Tone Prs	Lft Rsp	Lft RU	Rt Rsp	Red Key-Tone Prs	Lft Rsp	Lft RU	Rt Rsp
22	40	160	40	0				
23	40	158	38	2				
24	40	159	39	1				
25	40	154	37	3				
			EXTINCTION					
1	40	134	33	1				
2	40	126	30	4				
3	20	28	6	1				
			EXTINCTION TEST					
** 1	40	35	8	1	40	20	5	0
2	40	4	0	0	40	3	0	0

** Day 1 of extinction test occurred on same day as last session of 20 extinction trials.

Bird P-99 (Control group) Intertrial responses (ITR's) emitted during experiment.

Day	Right ITR's	Left ITR's
1	0	4
2	0	23
3	60	771
4	4	7
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
12	0	0
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0
EXTINCTION		
1	0	0
2	0	3
3	0	0
EXTINCTION TEST		
1	1	2
2	0	0

Bird S-48 (Control Group) Conditions of training: Key lighted red - signal to respond right. Table shows stimulus presentations and responses during training and testing. Prs: Trial presentations. Rt or Lft Rsp: Right or left responses. Rt or Lft RU: Right or left response units.

		Red Key-No Tone				Red Key-Tone			
Day		Prs	Rt Rsp	Rt RU	Lft Rsp	Prs	Rt Rsp	Rt RU	Lft Rsp
a	1	72	44	*	2				
	2	45	121	*	6				
	3	64	127	*	33				
b	4	49	170	40	9				
	5	44	169	40	4				
c	6	40	135	29	11				
d	7	64	188	40	24				
	8	56	192	40	16				
	9	48	169	40	8				
	10	56	184	40	16				
	11	70	212	40	30				
	12	78	227	40	38				
	13	91	237	40	50				
	14	149	358	40	109				
e	15	43	168	40	1				
	16	42	164	40	2				
f	17	92	251	40	52				
	18	70	220	40	30				
	19	47	165	40	7				
	20	65	204	40	22				
	21	56	164	40	16				

* Response requirement being advanced from 1 to 4. No measure taken this day.
a Phase 1
b Phase 2 with correction procedure.
c Phase 2 correction procedure discontinued.
d Phase 2 correction procedure reinstituted.
e Returned to phase 1 with correction procedure.
f Phase 2 with correction procedure.

Bird S-48 (Continued)

Day	Red Key-No Tone Prs	Rt Rsp	Rt RU	Lft Rsp	Red Key-Tone Prs	Rt Rsp	Rt RU	Lft Rsp
g 22	40	127	27	11				
23	40	132	31	9				
24	40	139	31	9				
25	40	141	32	8				
				EXTINCTION				
1	40	121	26	12				
2	40	109	22	18				
3	40	134	31	9				
				EXTINCTION TEST				
1	80	156	34	5	80	95	18	11
2	40	27	5	3	40	26	5	4

g Phase 2 correction procedure discontinued.

Bird S-48 (Control group) Intertrial responses (ITR's) emitted during experiment.

Day	Right ITR's	Left ITR's
1	0	0
2	35	40
3	0	0
4	0	0
5	1	1
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	1	0
12	0	0
13	0	0
14	2	1
15	0	0
16	0	1
17	0	0
18	0	0
19	0	0
20	0	0
21	1	0
22	0	0
23	0	0
24	0	0
25	0	0
EXTINCTION		
1	0	0
2	0	0
3	0	0
EXTINCTION TEST		
1	0	0
2	0	0