

LATENT INHIBITION EFFECTS ON THE ACQUISITION OF
AUTOSHAPING IN PIGEONS: HABITUATION OR "LEARNING"?

by

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Latent inhibition refers to the decremental effects of nonreinforced preexposure to a to-be-conditioned stimulus (CS) on subsequent learning. This phenomenon has been demonstrated in a wide variety of species using diverse experimental procedures (see Lubow, 1973, for the most recent review of the literature). Controversy exists however, over how to classify this phenomenon; that is, how it fits into the existing theoretical framework. Is the process underlying the retardation effects of CS preexposure more like an associative process (i.e., learning), or is it a nonassociative process--"merely habituation"? A second question is whether latent inhibition (LI) is explainable by the same process underlying the retardant effects on subsequent learning of exposure to the truly random procedure (see Rescorla, 1969) as proposed by Baker and Mackintosh (1977).

Theorists are divided (or inconsistent) as to whether to conceptualize LI as an associative or learning phenomenon distinct from habituation. The issue stems from the problem of considering habituation as learning. If one assumes learning to be a relatively permanent change in behavior, then habituation is assigned an insecure status because habituation is generally accepted as being more highly susceptible to "spontaneous recovery," as are receptor and effector fatigue (Hilgard & Bower, 1975). LI effects are more long-lived; they can survive a delay of up to 48 hours between CS pre-exposure and the conditioning test (Carlton & Vogel, 1967; Lubow & Siebert, 1969). The fact that habituation can occur

in organisms with no central nervous system tissue (Ratner, 1970) further separates it and multistimulus associative learning which is assumed to be a strictly central process.

Procedural similarities between LI and habituation seem to support the case for the indistinguishability of the two since both are obtained by repeatedly presenting a component stimulus in isolation.¹ In a strict procedural sense the two differ in a trivial way: how and when the effects from exposure to the stimulus are measured. Amount of habituation is measured as a reduction in responding to the stimulus during the habituation training; LI is assessed as retardation in development of stimulus control as measured in a remote test of Pavlovian conditioning.

Some contingency theorists (e.g., Hearst, 1972; Rescorla & Wagner, 1972) hold that LI (as well as habituation) cannot be counted as a learning phenomenon (at least within a Pavlovian theoretical framework) because it qualifies as neither conditioned inhibition (CI) nor conditioned excitation (CE), either procedurally or in its effects on behavior. Procedurally, CI develops from a training procedure involving a negative correlation between a CS and a US; CE results from a positive relationship. In a latent inhibition procedure, a correlation between CS and US is undefined, because the CS is presented in isolation. Behaviorally, the "inhibition" properties implied in the name latent inhibition have been investigated and found to be lacking (Rescorla, 1971; Reiss & Wagner, 1972; Halgren, 1974; Baker & Mackintosh, 1977). Through the use of summation tests,

Rescorla (1971) using a conditioned suppression study in rats, and Reiss and Wagner (1972) using the conditioned eyeblink in rabbits, showed that adding a latently-inhibited stimulus to an established conditioned excitator to form a compound CS does not reduce responding as would be expected if the stimulus was one which possessed conditioned inhibitory properties. These investigators concluded that although CS preexposure leads to retardation of acquisition of a conditioned response in a test of resistance to reinforcement,² the decrement is probably due to a decline in stimulus salience, a nonassociative factor which is neither CE nor CI.

Halgren (1974) is most explicit about the assumption that if something is neither CE nor CI, it is nonassociative, specifically with respect to latent inhibition. Rats preexposed to a stimulus which subsequently played the role of an S⁺ or S⁻ in a successive operant discrimination took longer to learn the task involving the preexposed cue, no matter which role (S⁺ or S⁻) the cue played. According to Halgren, the inescapable conclusion was that latent inhibition must be explained nonassociatively. Either the stimulus is reduced in salience or it becomes less attention-getting. Hearst (1972) also supports the attention-decrement view, relegating the "non-durable effects" of LI to the same level as a novel stimulus' disruptive effect on ongoing conditioning (i.e., external inhibition).

In contrast to Hearst (1972), Rescorla and Wagner (1972) do not evict LI from the class of learning-like phenomena so

uncompromisingly. In their model, CS preexposure could only affect associative learning by decreasing α (the salience parameter), a property of the CS employed. Since α is defined as a constant, they acknowledge the fact that their model cannot account for the effects of latent inhibition. This touches upon the root of the problem which LI brings to the fore for strict contingency theory in particular: The LI effect is an anomaly because if the salience of the stimulus is not allowed to change "inside the organism" as a result of the organism's experience, then the change in salience must be located in the distal stimulus itself, i.e., the latter undergoes a physical change. The fact is that any multistimulus learning theory is incomplete as long as it defines "stimulus" only as a discrete event to the exclusion of "non-events" such as, in the case of latent inhibition, no change in the environment following presentation of a discrete stimulus (i.e., the nominal CS). (Admittedly, the nonoccurrence of a particular event as a stimulus quickly becomes a philosophical issue. See Gibson, 1960, for a more detailed discussion of the problem.)

Mackintosh (1973, 1974, 1975) approaches latent inhibition as a form of "learned irrelevance", thus accounting for the phenomenon as an association between a stimulus and "nothing." This view is compatible with the assumption that a non-event has properties of a stimulus which allow it to enter into an association. According to Mackintosh, there are two kinds of learned irrelevance. First, a subject can learn about the irrelevance of a CS via the truly random treatment (Rescorla, 1969) where the reinforcer (US) has an equal probability of occurring per unit of time regardless of occurrences of the CS.

Second, irrelevance is learned during CS-alone training where the subject is exposed to the CS in the absence of any obvious reinforcement. What is learned is that there is a zero correlation between the CS and US here as well, in the sense that the US is equally likely to (not) occur per unit of time. The only difference between these two is that in the truly random treatment the subject learns that the CS is irrelevant as a signal for a specific US; in the latent inhibition procedure the subject discovers that the CS is relevant to nothing--or at least to no reinforcer. Learning of irrelevance in either case manifests itself as a retarding effect on the subject's later ability to associate the CS with a US in a subsequent test of Pavlovian conditioning (e.g., Mackintosh, 1973; Baker & Mackintosh, 1977). Thus Mackintosh concludes that the explanation for latent inhibition is not to be found in habituation, and no matter what is responsible for truly random and CS preexposure effects, the underlying processes are identical.

Conditioned attention theory proposed by Lubow and his associates takes the strongest position against the habituation interpretation of LI (Lubow, Alek, & Arzy, 1975; Lubow, Schnur & Rifkin, 1976). Conditioned attention theory supposes that CS preexposure leads to learning the specific response³ of inattention via Pavlovian conditioning.

The exposition of the theory (in Lubow et al., 1976) begins with the assumption that attention is a hypothetical construct with the characteristics of a Pavlovian response.

This attentional response (R_A) is conditionable, yet is unlike a typical conditioned response because the CS is capable of eliciting R_A on the first presentation⁴. The function of the US in the conditioning situation is to prevent the R_A from diminishing; that is, conditioning maintains the R_A .⁵ When R_A is maintained over repeated trials it comes to be considered a "conditioned attentional response" (CR_A).

The theory is extended to explain latent inhibition where inattention becomes conditioned in a parallel fashion. During nonreinforced CS preexposure, a stimulus is not followed by a "significant event." The result is a relatively permanent decrement in associability of that stimulus with another stimulus. Assuming that inattention is conditionable, as is any other response amenable to alteration via Pavlovian conditioning, then any manipulation which affects conditioning in the general case should similarly affect the conditioning of inattention during latent inhibition training. Lubow et al. offer two examples: 1) it has been shown that the greater the intensity of the preexposed stimulus, the greater the latent inhibition (Crowell & Anderson, 1972; Schnur & Lubow, 1976); 2) the longer the ITI (intertrial interval) during preexposure, the stronger the latent inhibition effect (Lanz, 1973; Schnur & Lubow, 1976).

This effect of ITI on subsequent conditioning could be the key to identifying the process underlying LI as habituation or learning. Thompson and Spencer (1966) in a review of the habituation literature, state that, "Other things being equal,

the more rapid the frequency of stimulation the more rapid and/or pronounced is habituation" (p. 17). Presumably a long enough ITI permits the response to continually spontaneously recover, resulting in poorer habituation. As mentioned before, the evidence seems to support the claim that latent inhibition effects are more durable (or less susceptible to spontaneous recovery) than habituation, and this difference is emphasized by those who believe the two phenomena have different underlying processes. Thus there exists a situation where a learning interpretation of latent inhibition (conditioned attention theory) and an habituation interpretation predict opposite results. Learning of inattention (according to Lubow et al.) is less efficient with a shorter ITI than with a longer ITI. Conversely (according to Thompson & Spencer), the amount of habituation with a shorter ITI is greater than with a longer ITI. That is, the greater the habituation effect during the stimulus preexposure phase, the greater is the attenuation (the slower is acquisition of the conditioned response) in the subsequent test of Pavlovian conditioning, if LI is nothing more than habituation to the CS.

The idea that ITI manipulations could provide insight into the problem is not new. However, several studies which have measured performance after CS preexposure according to different schedules are methodologically flawed, thus making interpretation difficult. Specific methodological criticisms will be dealt with later. First it is necessary to deal

with Wagner's (1976) "dual process theory" of habituation which makes predictions concerning ITI that are incompatible with those above. A discussion of Wagner's hypothesis and the shortcomings of its data-base will help set the groundwork for criticisms of specific ITI studies in the latent inhibition literature.

The dual process theory is based on a reversal of the ITI effect if habituation is measured in a (non-Pavlovian) remote test. That is, if amount of habituation is measured during habituation training, the shorter ITI has been shown to produce more response decrement. But when habituation effects produced in one phase are measured in a subsequent phase (not involving Pavlovian conditioning, but another test of habituation), subjects which had been exposed to the longer ITI show stronger habituation. A combination of conditioned attention theory for latent inhibition and dual process theory for habituation yield no differential predictions with regard to manipulations of the ITI since by definition LI effects must be measured in a remote test.

The complication introduced by dual process theory may be ignored, however, since the hypothesis was generated from studies using a methodologically-flawed procedure. The theory is for the most part based on a set of experiments in which habituation of the startle response to a tone was measured in rats (Davis, 1970a; Davis, 1970b). In one study (Davis, 1970a), one group of subjects was habituated to a tone which occurred at 2-second fixed intervals; another

group of rats was habituated to the same stimulus which occurred at 16-second fixed intervals. The shorter ITI group habituated to the tone significantly faster, as measured by reduction of the startle response during this phase. In a subsequent phase, all subjects were tested for habituation to tones occurring randomly at 2, 4, 8, and 16-second intervals. The former 16-second group startled less (i.e., evinced more habituation) to stimuli occurring at all ITI lengths compared to the group formerly habituated at the 2-second ITI. From these results, and from the results of another highly similar experiment, Davis and Wagner hypothesized that there are two separable sources of response decrement in habituation: 1) a short-lived effect that is local and refractory-like which shows its effects in an immediate test, and 2) a more persistent effect that varies with respect to overall sequence and which reveals itself in a remote test.

The Davis studies are at best limited to the case of a fixed ITI length, and at worst, they are completely uninterpretable due to their failure to control for temporal conditioning. Ratner (1970), in a review of the habituation literature, lists temporal conditioning as an important source of confounding in studies of habituation. He states,

The effect of temporal conditioning would be to slow the rate of habituation or reduce the amount of habituation in almost inestimable ways. The most common control for temporal conditioning in a conditioning study involves using a variable ITI. (p. 67, emphasis mine)

Because Davis employed a fixed ITI during the first phase in both the 2-second and the 16-second groups, one would

expect less effective habituation for all subjects, but especially for those in the former group where temporal conditioning is stronger. If these subjects were temporally conditioned they would only appear to be more habituated in a simultaneous test. But when these animals were switched to the variable ITI condition in the remote test, the lack of true habituation would reveal itself. Apparently, the 16-second subjects were the only ones actually experiencing habituation as revealed in the variable-ITI remote test. Thus the so-called "reversal effect" is attributable to a temporal conditioning artifact.

Schnur and Lubow (1976) tested the ITI effects on latent inhibition using mice in an escape-avoidance task; Lanz (1973), using the conditioned suppression paradigm in rats, likewise tested the ITI hypothesis. Since retardation was greater with subjects preexposed to the CS-alone schedule with the longer ITI, according to the interpretation of Schnur and Lubow, both experiments produced results lending support to the notion that the process underlying LI and habituation are the same. However, a fixed intertrial interval was employed in the preexposure phase of each of these studies, thus making them subject to the same criticism (by the same logic) as was leveled at the Davis experiments mentioned above: failure to control for temporal conditioning by using variable ITI schedules of different average interstimulus intervals. Thus their conclusions concerning ITI effects are tenuous.

The paradigm selected in the present set of experiments to test the effects of CS preexposure on subsequent conditioning was autoshaping in pigeons. This paradigm was considered appropriate for several reasons. First, the procedure used to produce the autoshaped keypeck response is Pavlovian in nature and thus consistent with the corpus of LI studies which use Pavlovian procedures. Second, autoshaping is an appetative procedure. Although evidence for LI has been reported in many different species, a review of the literature reveals that nearly all of the work done so far has been with aversive situations. In addition, the two studies cited above investigating the ITI effect in LI were done using aversive procedures. It was felt that both the generality of the basic LI phenomenon and its reaction to varying ITI conditions would be extended by using an appetative situation. Third, it was expected that the CS used in autoshaping (i.e., a relatively dimly illuminated keylight) was unlikely to produce any refractory-like effects on the subject (i.e., receptor/effector fatigue) which may cause adjoining presentations of the stimulus to be nonindependent. Thus very short and very long ITI lengths could be compared, without refractory-like effects affecting subjects in the short ITI condition differentially.

Experiment 1

Autoshaping is relatively new to tests of latent inhibition. Therefore it is necessary to diverge from the question of ITI manipulation momentarily to demonstrate that the basic LI effect is obtainable in pigeons using this Pavlovian procedure. LI has been found to occur in pigeons using an autoshaping procedure, but with one exception (Tranberg & Rilling, 1978), the effect has not been shown to be very strong.

Mackintosh (1973) used a CS-only group in an experiment, the main purpose of which was to demonstrate the retarding effect of the truly random treatment on subsequent acquisition of the conditioned keypeck response. Using response rate as a dependent measure, a marginally significant LI effect confined to the first two sessions of training was obtained. Wasserman, Franklin, and Hearst (1974) studied the effects of various CS and/or US relationships on approach/withdrawal behavior in pigeons. A subsequent test of acquisition for various groups which did not receive the paired relationship was conducted. Their CS-alone group evinced no latent inhibition as compared to a *de novo* group. Wasserman and Molina (1975), while primarily looking at the effects of explicitly unpaired CS and US on acquisition, also compared a novel vs. a preexposed stimulus in a within-subjects design. The outcome was no difference in acquisition of responding to the non-novel stimulus in a subsequent two-key test. In a latent learning study, Deeds (Note 1) found a small but statistically significant LI effect in birds which

were preexposed to a CS while nondeprived and then later tested in autoshaping under deprived conditions.

Clearly the first task was to obtain a latent inhibition effect sufficiently robust to survive the ITI manipulation in the schedule of CS preexposure. Therefore in Experiment 1, several factors were given special consideration:

- 1) The salience of the CS was enhanced by using a flashing rather than a steady keylight. It was hoped that stimulus preexposures would be more effective if the subject was more likely to make visual contact with it, thus resulting in a greater number of functional trials provided the bird was oriented generally towards the key.
- 2) A non-optimal autoshaping test schedule was selected which would decrease the likelihood of ceiling effects. Gibbon, Baldock, Gold, Locurto, and Terrace (1977) showed that the speed of acquisition of autoshaped keypecking is a function of the trial length relative to the duration of the ITI. Equivalently, given a constant CS length, acquisition will be slower the shorter the ITI. Here, a VT-24 second ITI and a six-second CS were employed, yielding the relatively unfavorable ratio of 4:1.
- 3) The number of CS preexposures was approximately double that used in most autoshaping studies which report little or no latent inhibition effects.
- 4) Finally, two commonly-used types of control groups were included. It was suspected that the lack of significant LI effects obtained in several of the experiments cited above

was due to assessment of the CS-alone treatment against an inappropriate type of control, i.e., de novo subjects who differ from CS preexposed subjects in two ways. The former are exposed to neither the keylight nor the apparatus between magazine training and the conditioning test. The use of such a control group introduces a possible confound. Therefore a chamber group was included in the present experiment. Chamber subjects are treated identically to CS-alone subjects in all respects except preexposure to the keylight, thus eliminating the possible confound due to differences in amount of exposure to the apparatus.

Method

Subjects. The subjects were 12 experimentally naive mixed-breed pigeons maintained at 75-80% of their ad lib weights throughout the experiment. Between experimental sessions they were housed individually in a colony room which was kept under constant illumination.

Apparatus. Experimental sessions took place in two approximately identical home-made operant chambers constructed from 3/4-in. plywood. Standard relay programming equipment was located in a room adjacent to that in which the experiment was conducted. Internal dimensions of the operant boxes were 32 cm. x 26 cm. x 43.5 cm. (L x W x H). A Grason-Stadler response key was mounted in the center of the aluminum intelligence panel 17.5 cm. above the hardware-cloth floor. The food magazine opening, measuring 5.2 cm. x 6.4 cm., was directly below the response key and 5 cm. above the floor. During a trial the response key was transilluminated by a strobing 555nm (green) stimulus projected from an Industrial Electronics display cell equipped with No. 44 miniature lamps. Noise from the ventilating fan served to mask sound extraneous to the chamber. A 7-watt white house-light covered with a styrofoam shade and mounted in the upper rear corner opposite the wall of the intelligence panel provided constant chamber illumination during a session except during hopper presentations. Food presentations were accompanied by the illumination of a No. 44 miniature lamp in the upper interior of the magazine aperture.

Procedure.

Phase 1: Magazine training ("US alone").

This phase lasted for three days. On the first day, each subject was trained to approach and eat from the grain hopper. Once eating began, the subject was given 40 US presentations (3.5 sec. duration each) per daily session according to a VT-30 sec. schedule.

Phase 2: Differential treatments.

Subjects were randomly assigned to each of three groups (n = 4 per group) corresponding to different treatments which lasted for 12 or 13 days. Birds in the CS Alone (latent inhibition) group were exposed to a strobing 555nm keylight, which served as the CS. The key flashed on and off 30 times within its 6-sec. duration, and such trials occurred 50 times within a 25-min. daily session according to a VT-24 sec. stimulus presentation schedule. The session began and ended in black-out; and except for the occasional presentations of the CS and continuous illumination of the houselight, there were no other programmed events.

Birds in the Chamber group received daily sessions equal in length to those of the CS Alone group but there were no keylight presentations. Members of the Hold group were merely weighed daily. Feeding for all birds occurred in their home cages.

Phase 3: Autoshaping test.

This phase began on the day immediately after the last day of differential training. On the first day of acquisition all

birds were introduced to the chamber with the food hopper up to insure that they would again start eating from the magazine. Once the bird ate for 3 seconds the hopper was manually let down and re-presented two more times independently of the bird's behavior. Once eating was re-initiated in this manner the session proper started. The first day of testing lasted for 200 trials if a bird did not acquire the conditioned response. If a subject did satisfy the acquisition criterion before 200 trials occurred, it was given 40 more trials before terminating the session. An individual trial consisted of the 6-sec. flashing CS (identical to the CS to which the CS Alone group was exposed), followed by a 3.5-sec. presentation of the US. Such trials occurred according to a VT-24 sec. schedule. On all days except the first, a 20-min session consisted of 40 CS-US paired presentations. For three days subjects were held between days 1 and 2 of the autoshaping test phase to allow them to return to deprivation weight. Subjects were given autoshaping training daily until each reached steady state, defined as 36 out of 40 trials with at least one response during the CS for three consecutive days.

Results and Discussion

During Phase 2, CS Alone birds pecked the key more on average than Chamber birds (see Table 1); pecking neither systematically increased nor decreased over days for any subject. Eighty-five per cent of CS Alone birds' responding occurred during the interstimulus interval; 75% would have been expected by chance if responding was randomly distributed in CS and non-CS time. This seems to indicate that, since most pecking was to the unlit key, these birds were simply more active than Chamber birds.

Results of the autoshaping test are in Table 1. Acquisition is defined as the number of trials to the first of three consecutive trials with at least one peck per trial. The Chamber group acquired the keypeck response fastest (median = 64.0 trials). CS Alone birds were the slowest (median = 189.0 trials), and the Hold group was not as slow as the CS Alone group, although they were retarded (median = 141.5 trials). An overall Kruskal-Wallis analysis of variance on ranks revealed a statistically significant treatment effect ($H = 12.86$; $p < .008$). However, because of the one aberrant point in the CS Alone group (subject #764), the difference between the CS Alone and the Chamber groups was not statistically significant in a pair-wise comparison. Bird #764 pecked much more than any of the others during nonreinforced keylight presentations, and this may be related to the fact that he also began autopecking quickly. There were no group differences at steady-state (days 2 through 5) as measured by the number of trials with at least one response.

Table Caption

Table 1: Data for All Subjects in Each Group for Total Number of Responses in Differential Training, Number of Days in Differential Training, and Number of Trials to Reach Acquisition Criterion.

Group	Subj.	Total Pecking in Differential Train	Days in Differential Train	Trials to Acquisition
CS Alone	750	4	12	207
	755	16	12	171
	759	72	13	222
	764	152	13	55
	Median	44.0		185.5
Chamber	768	0	12	63
	767	2	12	35
	756	3	13	66
	758	8	13	65
	Median	2.5		64.0
Hold	751	-	12	86
	757	-	12	101
	769	-	13	182
	753	-	13	245
	Median	-		141.5

It is important to note that if the Hold group was used as the standard (i.e., control group) against which to compare the effects of CS preexposure, such a comparison between Hold (i.e., de novo) subjects and CS Alone subjects would not have revealed a latent inhibition effect. A possible explanation for slower acquisition in Hold subjects (relative to Chamber subjects) is that during magazine training the context (e.g., the interior of the apparatus) gained excitatory value because of its association with reinforcement in the absence of more reliable predictors of the US. The Hold group, having had no exposure to the apparatus in the differential treatment phase, was reintroduced to the still-excitatory context upon reaching the acquisition test. Excitatory contextual cues initially competed with the CS for stimulus control over responding, thus retarding the acquisition of pecking directed towards the keylight, now a much more valid predictor of the US than the context alone. The Chamber group was not retarded because the excitatory properties of contextual stimuli were extinguished following magazine training by exposing subjects to the apparatus in the absence of reinforcement. Tomie (1976) showed that US-alone training followed by holding subjects in the (same) apparatus eliminates the retardation in a subsequent auto-shaping test. Therefore the proper control group to show latent inhibition using the autoshaping preparation is the Chamber group which differs from the CS Alone group only with respect to keylight preexposure.

Experiment 2

In Experiment 1, data for individual subjects indicated that a sufficiently strong LI effect was obtainable which might survive the further manipulation of the intertrial interval during CS preexposure. In Experiment 2, two experimental conditions were compared across variable ITI conditions. CS-alone groups, preexposed to the CS according to stimulus presentation schedules of various densities, were compared to one another to determine the effect of ITI length per se, bearing on the question of whether LI is habituation or learning. A set of truly random treatment conditions was also included. Truly random groups were matched to CS-alone groups at each level of ITI length, according to the CS presentation schedule for the former condition. This was done for two reasons: 1) to test whether truly random groups, varied across ITI, behave in a parallel fashion to subjects receiving latent inhibition training, and 2) the ITI manipulation across truly random groups would provide a test of the assumption that learned irrelevance is an associative type of learning. Both questions have important implications for Mackintosh's theory of learned irrelevance. As discussed previously, learning about irrelevance ought to be more efficient when the CS and, necessarily the US, are presented at the longer, rather than the shorter, ITI. In a subsequent test of Pavlovian conditioning, subjects having had the more effective experimental conditions to learn irrelevance ought to acquire the conditioned response more slowly.

If latent inhibition is due to learning the response of inattention (as proposed by Lubow et al.), then CS-preexposed groups would be expected to behave similarly across ITI lengths to their truly random counterparts. The longer ITI length is more conducive to learning the response of inattention. Likewise, as inferred from Mackintosh's theory, these conditions are also expected to be more conducive to learning about irrelevance.

Consistent with the argument presented earlier (p. 7), Figure 1 describes two possible outcomes. For ease of exposition, assume that the truly random treatment really does produce learned irrelevance. In both Figures 1-a and 1-b,

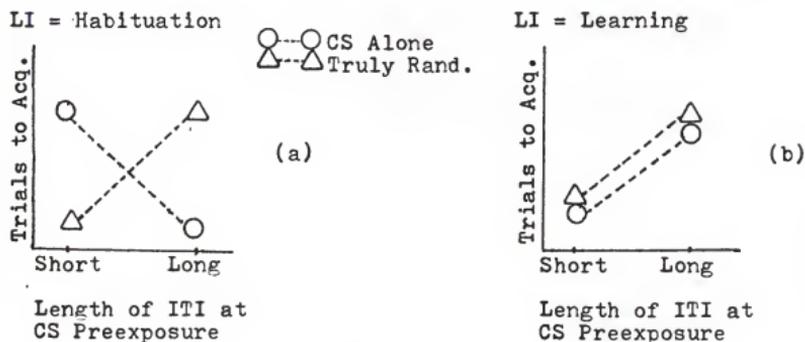


Figure 1

Predicted attenuation of acquisition of a CR for the two truly random and two LI groups in a remote test of Pavlovian conditioning.

this is manifested as faster learning (fewer trials to some acquisition criterion) in subjects preexposed to shorter ITI lengths, and slower learning in subjects experiencing the longer ITI schedule as measured in a remote test (consistent

with the Lubow et al. assertion that learning efficiency in general is a direct function of ITI length). Figure 1-a would be the expected pattern of results if the process underlying the LI phenomenon is habituation. Here the curve for CS-alone preexposed groups at long and short ITI schedules crosses the truly random ("learning") curve indicating that habituation is a different process from learning. Figure 1-b shows the expected outcome if LI as well as truly random effects are due to learning (of inattention or irrelevance).

The degree of attenuation in learning is expected to be greater across all levels of ITI for the truly random groups than for corresponding CS-alone groups (Mackintosh, 1973; Baker & Mackintosh, 1977). In terms of specific predictions, this should only influence the vertical displacement of the hypothetical truly random curves without affecting their slopes.

Three levels of different average ITI lengths were chosen: 24, 36, and 72 seconds. The middle level was also the average ITI length to be used in the autoshaping test phase. Thus, CS-alone and truly random groups receiving pretreatment according to the 36-second schedule permitted the assessment of attenuation of acquisition without the highly likely influence of generalization decrement due to switching CS presentation schedules upon reaching the Pavlovian phase.

Gibbon et al. (1977) demonstrated in autoshaping that the speed of acquisition of the conditioned keypeck response is a logarithmic function of the ratio of ITI length to trial length. The ITI lengths were determined from their equation which describes this relationship, such that the two extreme

ITI lengths were "behaviorally equidistant" from the intermediate one (as measured by median number of trials to acquisition). This was done for the purpose of controlling the amount of generalization decrement experienced by subjects undergoing a schedule change from the preexposure phase to the testing phase. That is, contamination in the form of a diluted retardation effect was expected to be equal in groups preexposed to the short ITI schedule and tested at the intermediate ITI schedule, as in groups preexposed to the longer ITI schedule and tested at the intermediate schedule, in the Pavlovian phase.

Method

Subjects. The subjects were 56 experimentally naive White Carnaux pigeons maintained at 75-80% of their ad lib weights throughout the experiment, and were housed as in Experiment 1.

Procedure.

Magazine training: Preliminary training consisted of teaching birds to eat from the food hopper. Procedurally, it was identical to Phase 1 of Experiment 1.

Phase 1: Differential treatment.

Subjects were randomly assigned to each of seven groups ($n = 8$ per group) corresponding to the different treatments which lasted for 10 daily sessions. The Chamber control group, like the Chamber group in Experiment 1, was merely kept in the illuminated experimental chamber for about 35 minutes per day with the session beginning and ending in blackout. There were three groups of birds which received nonreinforced exposure to the keylight (CS Alone). Within a session the CS Alone 4:1 group was exposed 50 times to the 6-sec. flashing green keylight on an average of once every 24 seconds (ITI range = 12 to 34 sec.). The CS Alone 6:1 group also received 50 illuminated keylight trials with an average ITI of 36 seconds (range = 12 to 60 sec.); CS Alone 12:1 differed only in that its average ITI was 72 seconds long (range = 12 to 132 sec.). Three Truly Random groups (Truly Random 4:1, 6:1, and 12:1) corresponded to the three CS Alone groups with the exception that along with the 50

keylight exposures, they also received 50 3.5 sec. grain hopper (US) presentations, equally likely to occur regardless of occurrences of the CS. Thus, the 4:1, 6:1, and 12:1 group designations refer to the ITI/Trial duration ratios 24:6, 36:6, and 72:6. The ratio was varied by keeping the trial length constant and varying the length of the ITI across groups.

Pecks to the key were recorded for birds in all groups during this phase. The Chamber and CS Alone groups received daily feedings in their home cages for these 10 days.

Phase 2: Autosshaping test.

Twenty-four hours after the last session of differential treatment all birds were tested for speed of acquisition of autosshaping. The same procedure as used in Experiment 1 to re-establish eating was employed at the beginning of the test session. During autosshaping the CS was presented for 6 sec., and simultaneous with CS offset the US was presented for 3.5 sec. The average ITI length was 36 sec. (6:1 ITI/Trial ratio). On the first day of testing each bird received 200 CS-US pairings. Subjects were held in their home cages for the next three days to regain 75% weight.

On subsequent test days, a session consisted of 50 CS-US trials. Each bird was continued in this phase until it completed nine post-acquisition sessions. Acquisition was again defined as three consecutive trials with a peck. Unlike Experiment 1, in Experiment 2 an arbitrary cut-off score was assigned to subjects who did not begin responding on the first test day. If any bird failed to respond within the first 200

trials on the first day of testing, it automatically received a score of 200 for its "number of trials to the first peck" score. If it pecked but failed to reach criterion, it was assigned a score of 200 for the criterion measure only.⁶ All keypecking was recorded on an event recorder during this phase.

The design of the experiment is depicted in Figure 2.

		ITI/Trial Duration in Phase 1		
		4:1	6:1	12:1
Truly Random				
	CS Alone			
	Chamber	X		X

Figure 2
Design of Experiment 2.

It was an incomplete factorial design, as it was logically impossible to include Chamber groups at different ITI/Trial duration ratios. (There were no trials for these subjects in the differential treatment phase.) It may be conceptualized as an experiment embedded within an experiment. The three cells of the middle column (headed "6:1") provide a test of

basic Truly Random and CS Alone effects without contamination due to changing CS presentation schedule (from Phase 1 to Phase 2). The other four cells provide a test of the effects of short (4:1) and long (12:1) ITI lengths during differential treatment, as measured in the autoshaping test employing the intermediate CS presentation schedule.

Results and Discussion

Analyses were performed on initial measures of acquisition performance in order to test predictions about amount of retardation attributable to 1) type of treatment (Chamber, CS Alone, and Truly Random) and, 2) how CS Alone and Truly Random effects were influenced by density of stimulus presentation schedules in Phase 1. In addition, post-acquisition performance was examined to determine if CS Alone and Truly Random treatments affected steady-state response rate.

Phase 1: Differential Training.

In Experiment 1 there was a tendency for birds who pecked the key during differential training to acquire the conditioned response in the Pavlovian phase faster than birds who pecked very little or not at all before the acquisition test. The issue of whether or not a specific response was learned before entering the acquisition test was relevant in this experiment as well. Did birds who had prior experience with the CS learn a specific approach-type response to the key which facilitated the acquisition of pecking the illuminated key during autoshaping trials? A significant negative correlation between the total number of pecks counted over the 10 days of differential training and the number of trials to acquisition in the autoshaping test, $r = -.23$, $p < .05$ (see Table 2), indicated that specific learning may have occurred in Phase 1. That is, subjects who were already pecking before the CS-US contingency was introduced learned to peck sooner once the contingency phase was initiated. Of the 56

Table Caption

Table 2: Data for All Subjects in Each Group for Number of Responses in Differential Training (Phase 1), Number of Trials to the First Peck, Number of Trials to Acquisition Criterion, and Number of Days to Reach Acquisition Criterion in Phase 2.

Phase 2

Phase 1

Group	Subj. No.	Phase 1		Phase 2		
		Differential Train Trial	Pecking in TrainITI	Trials to First Peck	Trials to Acquisition	Days to Acquisition
CS Alone 4:1	802	0	1	53	59	1
	817	1	1	62	74	1
	923	0	0	41	84	1
	957	0	10	110	110	1
	956	8	1	138	138	1
	926	1	3	113	144	1
	913	3	2	152	177	1
	914	0	0	169	183	1
	Mean			104.75	121.12	
	CS Alone 6:1	903	4	1	22	24
910		0	0	37	37	1
812		0	0	37	40	1
905		0	0	31	103	1
963		0	2	109	118	1
805		0	0	121	126	1
924		0	0	115	126	1
958		0	1	120	126	1
Mean				74.00	87.50	
CS Alone 12:1		814	0	0	40	40
	917	5	1	42	42	1
	922	0	2	65	69	1
	927	0	1	86	98	1
	962	0	0	119	126	1
	818	0	0	119	130	1
	908	0	0	116	176	1
	911	0	0	200	200	3
	Mean			98.37	110.12	

		Phase 1			Phase 2		
Group	Subj. No.	Pecking in Differential Train. Trial	Trials to First Peck	Trials to Acquisition	Days to Acquisition		
Truly Random 4:1	918	77	30	87	1		
	806	1	99	99	1		
	803	3	82	107	1		
	954	0	138	138	1		
	807	0	162	171	1		
	919	0	163	194	1		
	820	0	200	200	8		
	951	0	200	200	4		
	Mean		134.25	149.50			
Truly Random 6:1	904	1	59	67	1		
	959	0	70	81	1		
	952	2	95	95	1		
	920	0	144	150	1		
	916	0	160	190	1		
	960	0	9	200	2		
	906	0	73	200	3		
	955	0	200	200	3		
	Mean		101.25	147.87			
Truly Random 12:1	950	2	45	47	1		
	902	47	63	63	1		
	801	0	80	87	1		
	921	0	86	93	1		
	811	1	137	137	1		
	925	0	152	200	2		
	953	0	200	200	3		
	907	0	200	200	4		
	Mean		120.37	128.37			

Phase 1

Phase 2

Group	Subj. No.	Pecking in Differential Train Trial	Pecking in ITI	Trials to First Peck	Trials to Acquisition	Days to Acquisition
Chamber	813	-	55	17	20	1
	816	-	334	22	22	1
	915	-	2	17	25	1
	901	-	50	3	27	1
	809	-	0	29	29	1
	912	-	0	25	34	1
	961	-	7	1	37	1
	819	-	20	166	200	1
	Mean			35.00	49.25	

subjects, only seven made 20 or more responses, counting both pecks which occurred during the CS and during the intertrial interval. Four of these subjects were in the Chamber group which never was exposed to the CS in this phase. For the other three birds, pecking was approximately of equal density per unit of time during CS and non-CS time. Thus, although amount of responding in Phase 1 was related to speed of acquisition in Phase 2, because pecking in the former phase seemed to be unrelated to whether or not the key was lit it is unlikely that birds were specifically learning to respond to the CS. However, exactly when ITI pecks occurred was not measured, and it is possible that birds pecked just after CS offset in the Truly Random and CS Alone groups. For this reason, the possibility of specific learning during differential training cannot be dismissed altogether.

Phase 2: Acquisition of Autoshaping.

When the contingency phase was introduced 24 hours after the final day of differential treatment, Chamber birds tended to autopeck sooner than subjects in any of the other six groups. Number of trials to the first peck for individual subjects is shown in Table 2. There was no statistically significant effect to indicate that CS Alone and Truly Random subjects were more retarded than Chamber subjects in acquiring the conditioned response using this measure. Because several birds in all groups pecked on a single early trial and then failed to respond again until many trials later, a more stable measure, the number of trials to the first of three consecutive trials with at least one peck per trial (see Table 2), was

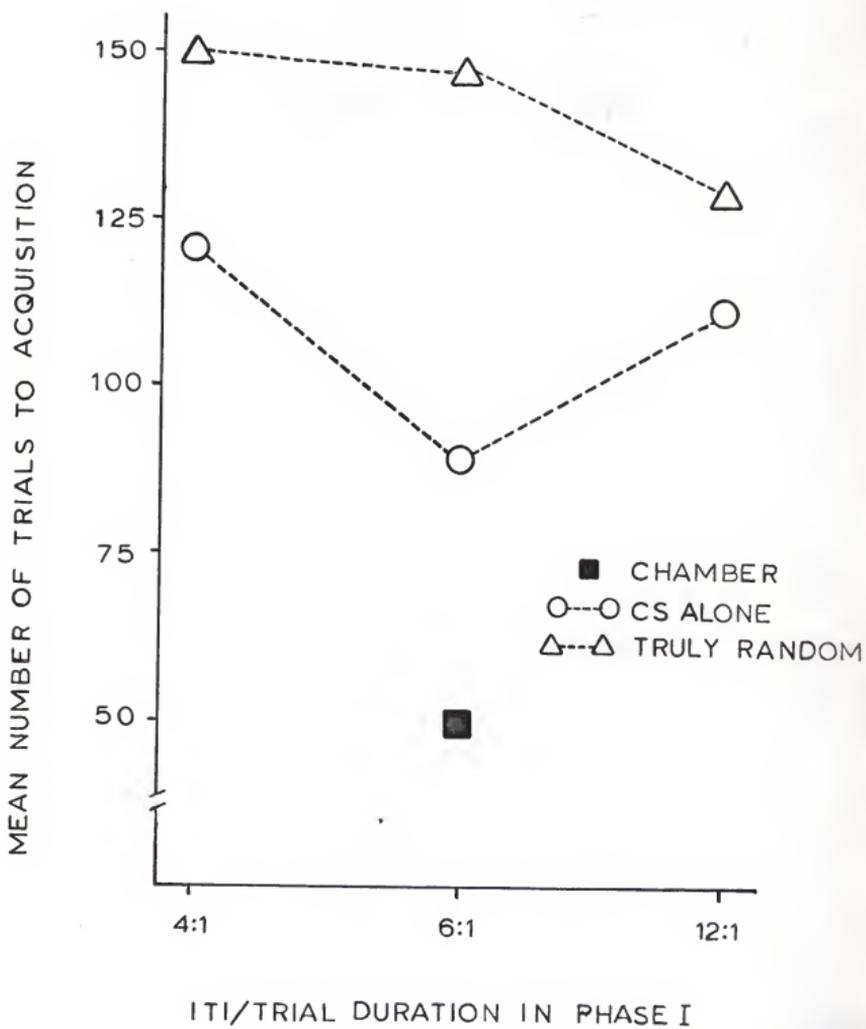
considered the criterion for acquisition, as was the case in Experiment 1. Figure 3 contains the means for all groups on this measure.

Since a demonstration of the basic LI effect in this experiment was a prerequisite for demonstrating effects of different ITI levels, a priori contrasts were conducted comparing the Chamber group to the three CS Alone groups on the acquisition measure. Thereafter group comparisons involving acquisition measures exclude the Chamber group to make a complete factorial (Conditions x Ratio) design (see Figure 2). The a priori contrasts showed no significant LI effect in the CS Alone 6:1 group, but Chamber vs. CS Alone 4:1 and CS Alone 12:1 did reveal that CS preexposure had a retarding effect on acquisition ($\underline{t} = -2.57$; $\underline{p} < .05$, and $\underline{t} = -2.19$; $\underline{p} < .05$, for the respective comparisons).

In the conditions x ratio analysis (excluding Chamber), an analysis of variance revealed a statistically significant main effect of conditions, $F(1,42) = 4.95$; $\underline{p} < .05$, indicating that the Truly Random groups were more severely retarded in acquisition than the CS Alone groups. There was neither a significant main effect nor a significant interaction due to the ITI manipulation. The mean number of trials to reach acquisition for the CS Alone and Truly Random 4:1 and 12:1 groups are presented in Table 3. There was a trend towards more severe attenuation with the shorter (4:1) ITI, than in the longer (12:1) ITI. This was true for both conditions,

Figure Caption

Figure 3: Mean Number of Trials to Reach the Acquisition Criterion for All Groups in the Phase 2 Autoshaping Test.



indicating parallelism. In the context of specific predictions

	ITI/Trial Duration	
	4:1	12:1
Truly Random	149.50	128.37
CS Alone	121.12	110.12

Table 3

Mean number of trials to reach acquisition for CS Alone and Truly Random conditions at short (4:1) and long (12:1) ITI lengths.

made earlier, this outcome tends to favor a habituation interpretation for both types of "learned irrelevance." An implication from this trend is that LI and truly random effects have common underlying processes, but that the process underlying truly random effects could be habituation was unexpected. Again, this trend towards an habituation interpretation was not supported statistically.

Except for one more test (to be discussed later), the CS Alone 4:1, CS Alone 12:1, Truly Random 4:1, and Truly Random 12:1 groups were excluded from all subsequent statistical analyses.

Once any subject met the acquisition criterion, whether on the first day of testing or within subsequent daily sessions (see Table 2 for the actual number of days it took each subject to satisfy the acquisition criterion), the within-trial response rate was calculated for the first 40 post-acquisition trials, in blocks of five trials. Figure 4 (panel a) shows

Figure Caption

Figure 4: Mean CS Peck Rate During the Phase 2 Autoshaping Trials, (a) for the Forty Trials Immediately Following the Point of Reaching the Acquisition Criterion (in five-trial blocks) and, (b) for the Nine Autoshaping Test Days.

b

■ CHAMBER
 ○ CS ALONE 6:1
 △ TRULY RANDOM 6:1

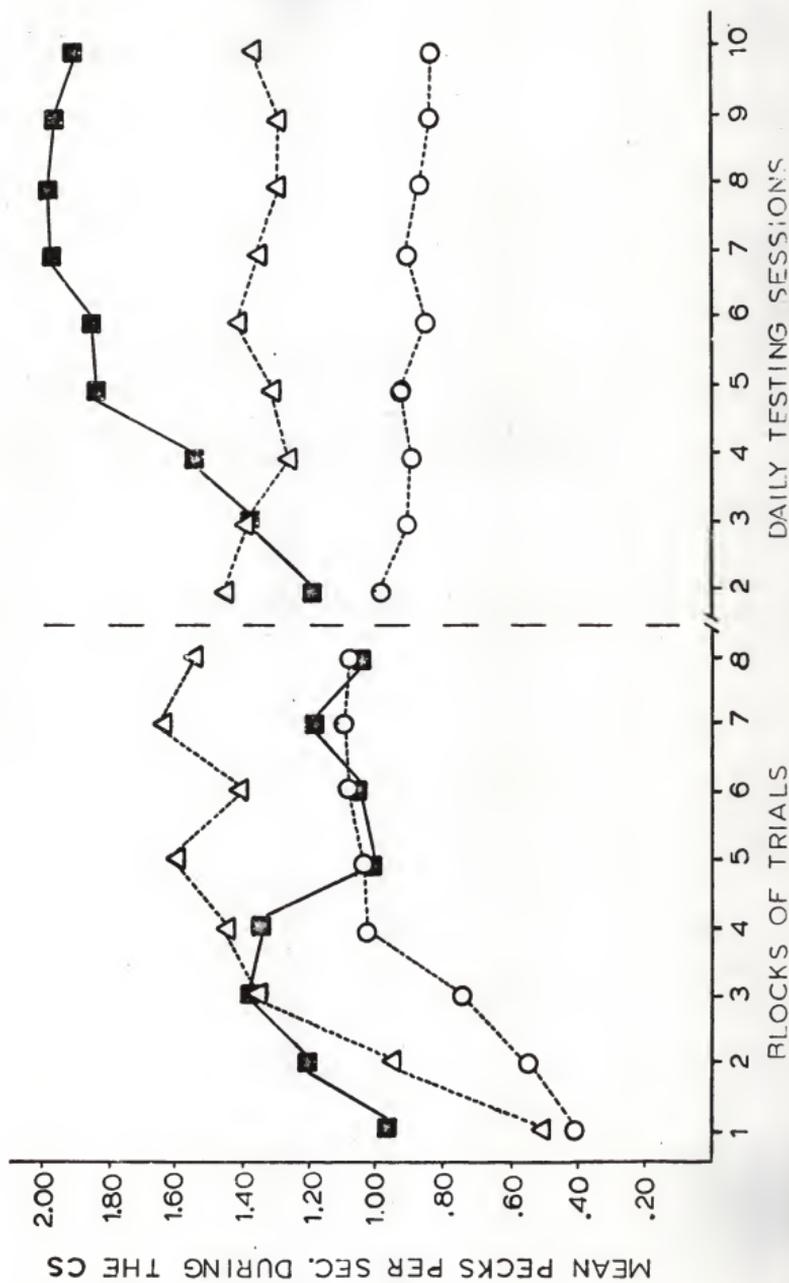
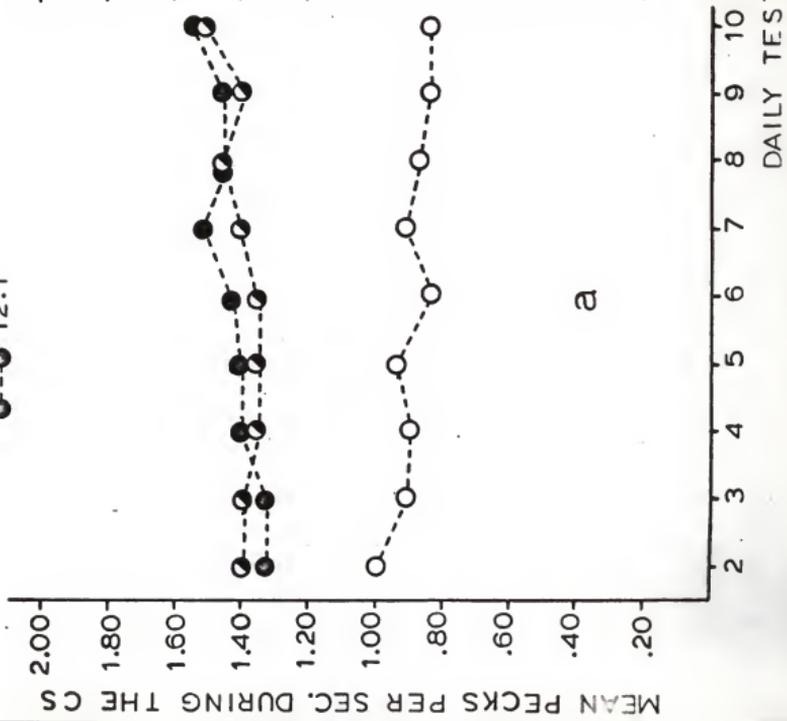


Figure Caption

Figure 5: Comparison of Experimental Groups' CS Peck Rate at Asymptote. (a) CS Alone Groups at the Three ITI/Trial Ratios, and (b) Truly Random Groups at the Three ITI/Trial Ratios.

CS Alone

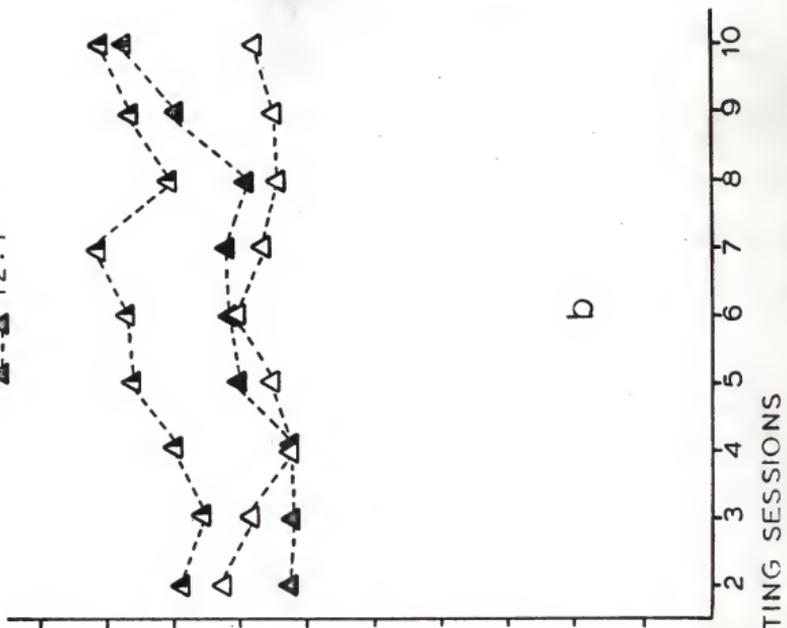
- 4:1
- 6:1
- 12:1



a

Truly Random

- △---△ 4:1
- △---△ 6:1
- ▲---▲ 12:1



b

the CS peck rate in these early acquisition trials for Chamber, CS Alone 6:1 and Truly Random 6:1 groups. A groups x blocks-of-trials analysis of variance yielded a significant main effect for blocks, $F(7, 147) = 5.74$; $p < .01$, and a groups x blocks interaction, $F(14, 147) = 2.22$; $p < .05$. Rate of responding in both the CS Alone 6:1 and Truly Random 6:1 groups started low but increased over trials; Chamber birds began pecking at a high rate and remained relatively high, though erratic, over blocks of trials.

Phase 2: Post-acquisition Autopecking.

As birds continued in the autoshaping condition, response rates during trials were observed for possible differences in rates at asymptote.

The anticipated degradation of the treatment effect in subjects experiencing generalization decrement (i.e., the four 12:1 and 4:1 CS Alone and Truly Random groups) had begun to appear by the first 40 trials of acquisition. Waning of the effects became even more apparent in the nine daily testing sessions following acquisition. Figure 5 (panels a and b) compares the different ITI/Trial duration ratio groups within each condition for these sessions. Response rates during the CS evinced little depression in these groups. The difference between changed and unchanged schedule birds is especially noticeable in the CS Alone groups.

Peck rate during a trial was analyzed over the nine sessions of autoshaping training for the Chamber, CS Alone 6:1 and Truly Random 6:1 groups. A conditions x days analysis

of variance revealed a significant main effect for days, $F(8, 168) = 2.031$; $p < .05$, and a significant conditions \times days interaction, $F(16, 168) = 4.17$; $p < .01$. Neuman-Keuls post-hoc comparisons showed that the Chamber and CS Alone groups differed significantly from one another in the last five daily sessions. Figure 4 (panel b) shows this effect. Comparing early acquisition trials (Figure 4, panel a) with later autoshaping sessions (Figure 4, panel b), it appears that both the Truly Random and CS Alone groups reached their respective asymptotic rates within the first 40 trials after regular responding was established. The Chamber subjects' rates, on the other hand, continued to climb over daily sessions, and the group differences reported above were due to this steady climb in control subjects rather than a decrease in rate for the CS Alone subjects.

The finding that Truly Random subjects did not differ significantly from the Chamber subjects in asymptotic peck rate (Figure 4, panel b) is problematic. First, it is not consistent with past research comparing Truly Random and LI effects. Previous studies have shown the former to be much more detrimental to acquisition than the latter (Mackintosh, 1973; Baker & Mackintosh, 1977). Second, in this experiment, it implies that the degree of retardation in initial acquisition is not continuous with amount of depression of response rate in later sessions. It seems as though acquisition and later response rate are not comparable measures. Differences between Truly Random 6:1 and CS Alone 6:1 groups were not significant, so the implications for this apparent discrepancy

remain a moot point.

As can be seen in Table 4 (daily CS peck totals), subjects number 903, 924, 805, and 963 in the CS Alone 6:1 group and subjects 906, 916, 920, and 955 in the Truly Random 6:1 group were decreasing in measured number of pecks to the key over days. None of the birds in the Chamber group followed this pattern. Figure 6 shows the mean proportion of trials with pecks within each 50-trial session over days, for all seven groups. Here it can be seen that there was pecking, on average, on 80% or more of the trials throughout all post-acquisition daily testing sessions. Truly Random subjects in the 4:1 group (top panel) show a decline in the last few days, and in the 6:1 group (middle panel) they decline sooner and more markedly. CS Alone 6:1 subjects also fall off in responding using this gross measure. (Statistical tests were not conducted on these data.) Unsystematic visual observations indicated that subjects in both Truly Random and CS Alone groups began head-bobbing (i.e., making pecking motions just short of the key) some time after the first day of post-acquisition training. Missed trials and low response rate within trials in the two 6:1 experimental groups combined to produce a low asymptotic pecking rate, due in part to off-key pecking. A satisfactory explanation of why head-bobbing seemed to occur exclusively in the CS Alone 6:1 and Truly Random 6:1 groups eludes the author at this time. Whatever its cause, head-bobbing and its consequential depression of response rate, seemed to be a more or less permanent effect on the autopecking response topography. Several birds in each

Table Caption

Table 4: Daily CS Peck Totals. Data for Individual Subjects.

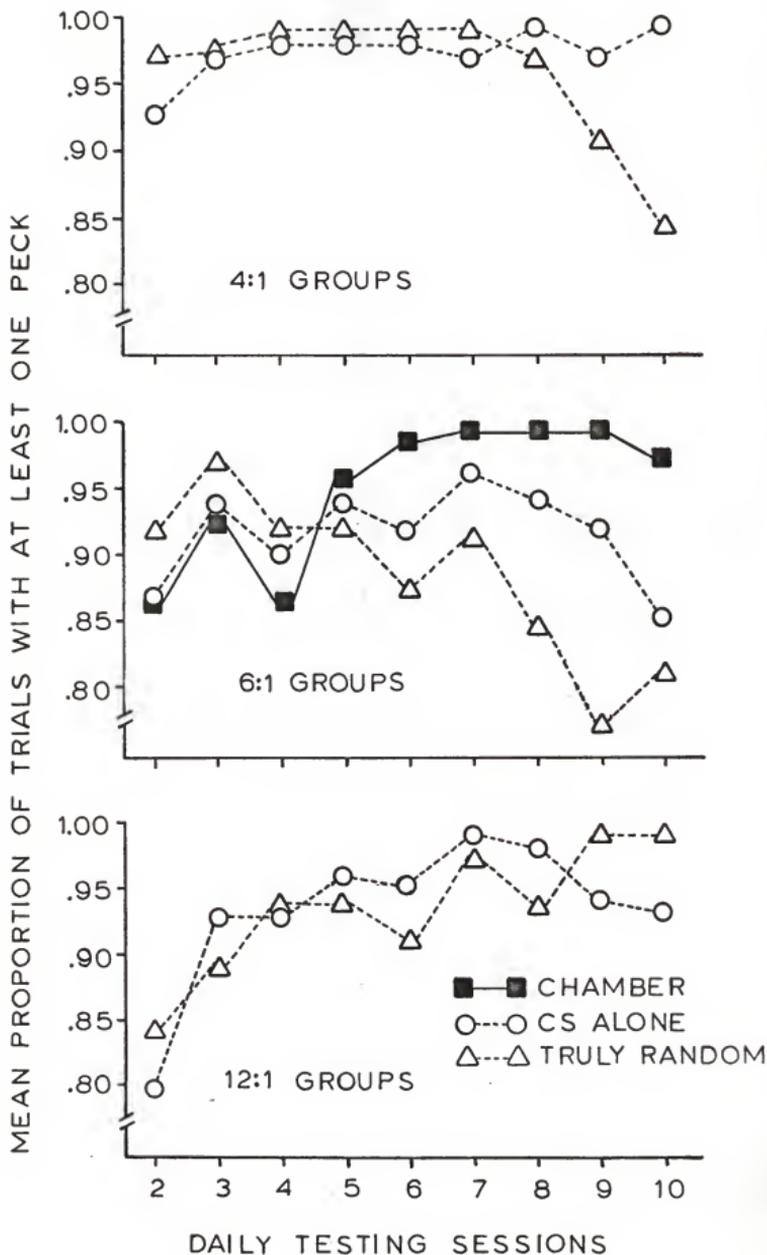
Group	Subj. No.	Daily Testing Sessions														
		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Chamber	809	202	384	540	575	525	562	585	558	473						
	813	624	665	681	676	699	691	655	647	654						
	901	742	694	776	850	804	803	811	826	816						
	915	214	259	353	476	483	482	674	660	534	239	251	455	293	411	431
	819	338	442	582	797	765	887	848	863	920	654	862	915	855	923	857
	961	328	464	193	476	620	771	828	775	821						
	961	50	63	222	181	260	214	127	113	104						
	912	297	280	360	351	324	310	230	269	244						
	Mean	356	406	463	548	560	590	595	589	571						
	CS Alone 6:1	905	141	147	172	186	205	269	295	307	416	394	292	298	238	262
910		82	121	183	234	269	218	295	250	171	100	109	102	200	201	163
903		219	108	38	67	42	60	69	52	7	150	79	56	34	33	34
924		682	533	516	496	477	417	333	300	344	330	277	301	352	366	418
805		168	153	126	117	132	148	111	113	103						
812		437	396	389	437	317	397	316	353	322						
958		67	107	201	189	155	177	172	146	146						
963		548	589	515	515	455	508	490	463	381						
Mean		293	269	267	280	256	274	260	248	236						
Truly Random 6:1		952	428	428	397	423	454	455	442	427	429	226	149	105	61	31
	906	277	268	213	200	147	111	86	57	57	179	111	72	89	78	93
	916	78	100	53	52	27	48	34	30	32	180	234	170	167	200	107
	904	435	442	420	350	447	390	420	396	292	468	417	511	433	376	340
	920	655	334	380	442	518	458	445	442	455						
	955	28	26	17	4	5	8	2	3	1						
	959	858	998	933	968	1022	1071	983	985	969						
	960	683	696	641	691	749	671	671	724	967						
Mean	430	411	382	391	421	401	385	383	400							

Group	Subj. No.	Daily Testing Sessions									
		2	3	4	5	6	7	8	9	10	
CS Alone 4:1	802	546	538	485	523	547	598	621	568	612	
	817	749	769	785	767	793	790	810	792	819	
	913	176	162	191	235	169	133	219	289	515	
	914	776	861	813	775	760	782	809	775	827	
	923	527	556	497	494	440	417	334	255	246	
	926	38	162	139	156	195	226	258	180	202	
	956	188	33	67	25	39	32	12	18	16	
	957	329	259	297	315	323	397	442	463	381	
	Mean	416	417	409	411	408	422	438	417	452	
	CS Alone 12:1	814	761	799	820	797	849	847	875	881	901
		818	259	297	450	475	476	532	483	463	531
908		9	59	97	109	188	239	205	86	56	
917		176	144	161	236	199	176	161	149	151	
922		477	473	520	675	754	884	824	841	789	
927		727	730	676	511	398	272	171	263	406	
911		402	374	385	327	313	424	430	419	388	
Mean		421	396	423	422	430	458	437	438	466	

Group	Subj. No.	Daily Testing Sessions								
		2	3	4	5	6	7	8	9	10
Truly Random 4:1	803	480	418	368	455	366	507	141	615	666
	806	698	718	775	802	802	844	842	816	857
	807	342	399	387	400	452	334	106	75	15
	820	743	787	830	821	819	815	815	801	838
	918	574	433	451	581	604	754	706	510	660
	919	157	211	250	306	356	452	523	553	580
	951	29	13	4	3	0	1	1	0	0
	954	675	615	719	747	766	708	725	747	737
	Mean	462	449	473	514	521	552	482	515	544
	Truly Random 12:1	801	589	633	617	607	596	582	627	573
811		675	641	548	608	579	629	640	646	660
902		935	941	834	861	1119	1117	931	1089	1112
907		75	59	65	61	55	81	74		
921		482	421	593	706	704	685	757	760	745
925		51	68	128	137	148	143	137	117	44
950		227	240	267	272	225	176	114	117	44
953		0	4	0	3	4	9	1	2	2
Mean		379	376	381	407	429	428	410	472	525

Figure Caption

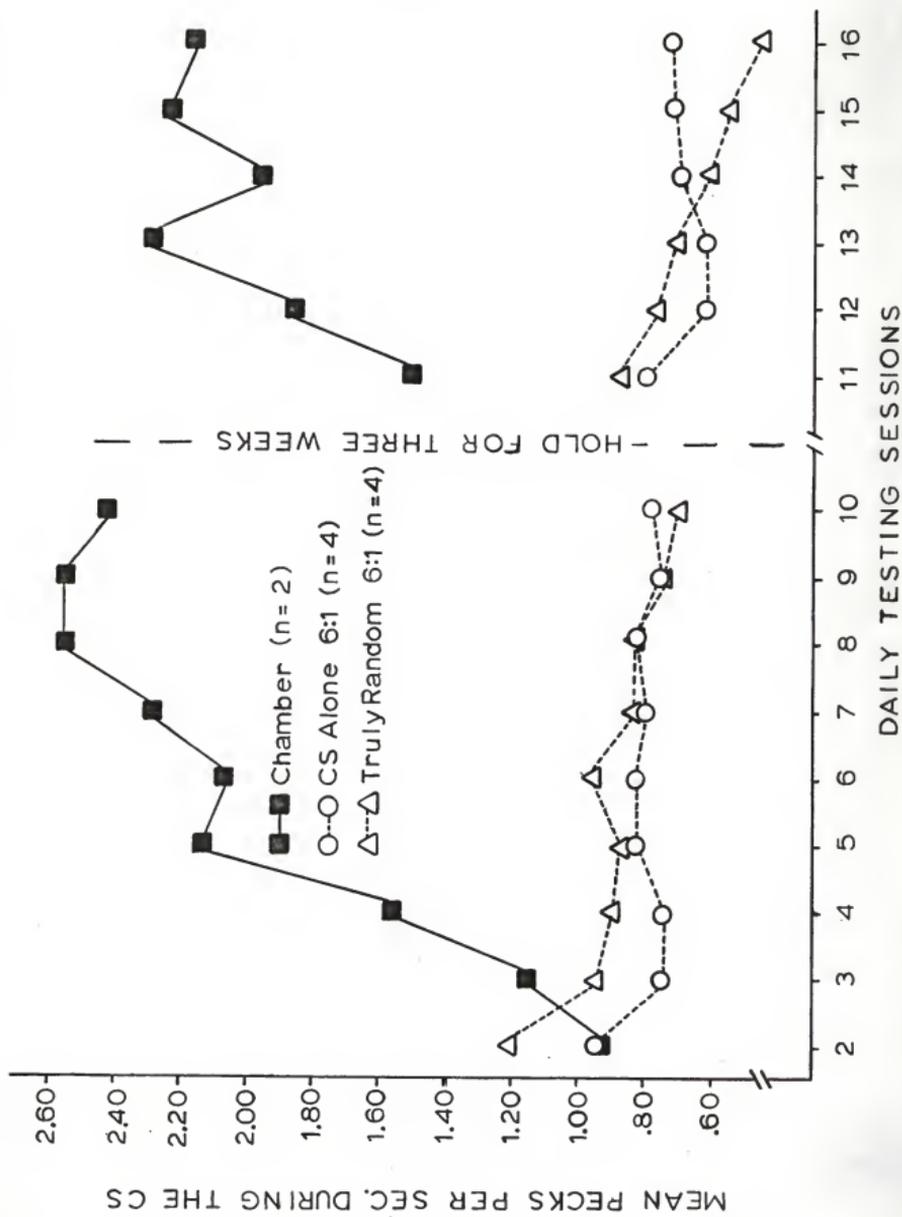
Figure 6: Mean Proportion of Trials During Which at Least One Pecking Response Occurred, for All Groups.



of the Chamber, CS Alone 6:1, and Truly Random 6:1 groups, after having completed all phases of the experiment as officially described in the procedure section, were held for a three-week period. Following this break, these birds were again deprived to experimental weight, and were again subjected to 50-trial autoshaping test sessions identical to sessions experienced before the holding period. Figure 7 contains the data for these subjects. As can be seen, the mean CS peck rate in days 2 through 10 for this small subset of birds was fairly representative of the groups to which they belonged. After the holding period, in sessions 11 through 16, birds rapidly recovered their old asymptotic rates--Chamber birds climbed to high pecking rates and Truly Random and CS Alone subjects continued to peck largely off-target (as confirmed by unsystematic visual observation). Although no statistical tests were attempted with these data, the figure serves as testimony to the enduringness of the treatment effect.

Figure Caption

Figure 7: Mean CS Peck Rate in Phase 2 Autoshaping Test Sessions for a Subset of Subjects.



General Discussion

The results of Experiments 1 and 2 lend support to the claim that LI is a general phenomenon: retardation due to CS preexposure was demonstrated twice in pigeons using the autoshaping paradigm. It is important that the LI effect was reconfirmed in an appetative Pavlovian procedure because the corpus of LI literature is over-represented by studies using aversive procedures. Part of the reason for the successful demonstration of the LI effect was apparently due to employing a highly salient CS (a flashing keylight) during the preexposure phase and to using an acquisition test designed to avoid ceiling effects which would have masked the retardation effects. Although these parameters were not directly assessed for their comparative efficacy, subsequent experiments may be conducted to test the assertion that these parameters were relevant.

Experiment 1 indicated the proper control group to employ in the LI paradigm in autoshaping. Here it was demonstrated that a de novo group (the Hold group) suffered retardation (attributable to blocking from excitatory contextual cues) comparable to the retardation suffered by subjects receiving latent inhibition (CS Alone) training and is therefore an inadequate control. This finding has implications for studies of LI in autoshaping which have found minimal or no effects when comparing CS preexposed groups to inappropriate de novo controls (e.g., Wasserman et al., 1974; Deeds, 1977).

In Experiment 2 an attempt was made to determine whether LI belongs to the class of learning or habituation phenomena by manipulating the ITI length during the preexposure phase. Acquisition in CS-alone groups was compared to acquisition in truly random groups following preexposure to short, intermediate, and long ITI lengths. The basic LI effect was found to be significant in two out of three groups of birds preexposed to the keylight alone (CS Alone 4:1 and CS Alone 12:1), as compared to a Chamber control group. There was also a statistically significant difference in amount of retardation of acquisition between CS Alone and Truly Random subjects with the latter condition showing slower acquisition. However, there were no group differences due to the ITI manipulation, thus leaving the question of how to interpret LI effects unanswered by an ITI test. Trends in the data were towards an habituation interpretation for both LI and truly random types of "learned irrelevance." Specifically, CS Alone and Truly Random groups preexposed to the CS according to shorter ITI schedules tended to acquire the conditioned response more slowly than CS Alone and Truly Random groups preexposed at the longer ITI.

Previous experiments have demonstrated just the opposite effect with regard to latent inhibition. Lanz (1973), and Schnur and Lubow (1976) found that CS preexposure according to longer ITI schedules produces greater attenuation (stronger LI effects) in subsequent learning. Both studies used aversive

Pavlovian conditioning procedures and fixed intertrial intervals, whereas the present experiment employed appetitive conditioning and manipulated variable rather than fixed ITI lengths. Either difference in procedures could have contributed to the apparent discrepancy in results. Perhaps the attainment of significant ITI effects is limited to the use of a fixed intertrial interval. If shown to be the case, this would be unfortunate because interpretation of ITI effects obtained under these conditions would be obscured by contamination from temporal conditioning as was argued in the introduction of this paper. It is possible that without the confound of temporal conditioning, ITI effects may not exist.

Experiment 2 showed that LI and truly random treatments, in subjects not undergoing a CS schedule change from differential training to test, produced long-lasting depression in response rate lasting up to sixteen days in some subjects (Figure 7). The enduringness of the CS preexposure effect alone, without confirmation from predictions concerning ITI effects, should be enough to classify LI as a learning phenomenon which has relatively permanent effects on behavior. Even if the depression of peck rate was due primarily to head-bobbing in the non-Chamber subjects (thus weakening the argument for loss of stimulus control by the keylight) the possibility that LI and truly random treatments affect response topography alone is not an uninteresting finding. Autopecking is a unique type of Pavlovian response; although produced by Pavlovian procedures, it is much like an "operant" response because it is skeletal and directed

(Hearst, 1977). Differential effects on the directedness of the response due to CS-alone and truly random pretreatment may provide more insight to the autoshaping phenomenon itself.

Conclusion

The two experiments confirmed that LI is obtainable in the autoshaping Pavlovian paradigm in pigeons. Experiment 2 showed no reliable ITI effects when a variable ITI was employed. Therefore, no conclusion could be drawn about whether LI is habituation or learning from a manipulation of the ITI in training; however, failure to obtain ITI differences under conditions where the ITI is variable places serious limitations on the generality of other studies of LI which have obtained such effects only under fixed ITI conditions.

The long-lasting effects of CS preexposure on response rate in autoshaping in the CS Alone 6:1 group calls for a re-evaluation of the latent inhibition effect as a transitory phenomenon which typically manifests itself during the first few trials of acquisition only. However, the enduringness of the effect and its role with regard to maintenance of stimulus control must be qualified. The reduction in response rate could have been due more to effects on the topography of the auto-shaped keypeck response than to stimulus control.

Steady-state response rate during the CS trials needs to be examined. Amount of head-bobbing needs to be measured as well as pecks which make contact with the key in order to determine the extent of loss of stimulus control by the CS in LI and truly random groups. If no inferred differences in stimulus

control are found with this different, more sensitive measure, then differential effects of CS-alone and truly random treatments on the topography of responding remains as an interesting problem, or an aggravation, for investigators who plan to use the autoshaping paradigm to study behavioral processes.

Reference Notes

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Footnotes

¹In the LI paradigm, this manipulation is called CS preexposure because the component stimulus will later play the role of the conditioned stimulus in a Pavlovian task. In the habituation paradigm, the type of stimulus is one which initially evokes a measurable unconditioned response (startle, flexion, etc.), i.e., the type of stimulus employed as a US in Pavlovian conditioning.

I will not complicate the argument by bringing up extinction which in isolation is procedurally identical to LI and habituation. By definition, extinction presupposes prior conditioning.

²Rilling (1977) lists five ways of measuring inhibitory stimulus control:

- (1) resistance to reinforcement;
- (2) resistance to extinction;
- (3) combined cues or summation test;
- (4) generalization gradients;
- (5) stimulus reduction or advance procedure.

Resistance to reinforcement (1) is the usual way to measure LI as well as CI effects. However, (2) can also be used as evidence for LI as well as CI as demonstrated by Lubow, Markham, and Allen (1968). To the author's knowledge neither generalization gradients (4) nor the advance procedure (5) have been employed as tests in latent inhibition experiments.

³Learning of a specific compatible/incompatible response had at one time been used as the only sort of explanation which

could qualify as "associative" in early arguments over the process underlying latent inhibition. That learning of specific skeletal responses could be involved was dismissed (Lubow & Moore, 1959; Baker & Mackintosh, 1977) and is no longer put forth as an explanation.

⁴How the CS differs from the typical unconditioned stimulus (US) in the Pavlovian paradigm is not explained. Usually the CS is initially "neutral"; the US evokes an unconditioned response from the offset.

⁵Although not stated by Lubow et al., they seem to intend that a reinforcer functions in a "Guthrian sense" where the US causes a change in the stimulus situation, preserving the response which last occurred, i.e., the attentional response.

⁶This arbitrary cut-off score was used rather than actual number of pecks to criterion because of gross differences between deprivation conditions at, for example, trial 200 vs. trial 201 in the next experimental session occurring three days later.

LATENT INHIBITION EFFECTS ON THE ACQUISITION OF
AUTOSHAFING IN PIGEONS: HABITUATION OR "LEARNING"?

by

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Two experiments were conducted to test the effects of CS preexposure (latent inhibition) in the autoshaping paradigm with pigeons. In the first experiment a group of birds experiencing CS preexposure and two types of control groups (Chamber and Hold) were compared. All groups first received "US-alone" pretraining in the form of magazine training. Following this, CS Alone subjects were exposed to presentations of a keylight which was to later serve as the CS in a test of acquisition of the autoshaped keypeck response. Chamber subjects were held in the experimental apparatus during this phase; Hold subjects were kept in their home cages, receiving no experimental treatment. All three groups were then tested for acquisition of autoshaping. Results showed that both Hold and CS Alone groups were retarded in acquisition relative to the Chamber group. Experiment 1 demonstrated that the basic latent inhibition effect was obtainable using pigeons as subjects, and aided in determining what type of control group was appropriate for studying the effect (i.e., Chamber). Magazine training (US-alone treatment) was responsible for contextual conditioning which blocked control by the CS in autoshaping training, retarding acquisition in the Hold group almost as much as CS preexposure.

The second experiment attempted to determine whether the latent inhibition phenomenon could be classified as learning or as habituation by way of manipulating the length of the intertrial interval during the differential training phase in CS Alone and Truly Random groups. Three CS Alone groups

experienced CS preexposure according to 4:1, 6:1, and 12:1 ITI/Trial duration ratios for 10 days. Three Truly Random groups received corresponding CS preexposure schedules but also received presentations of grain which were uncorrelated with the keylight within these sessions. A Chamber group was held in the apparatus during its 10 daily sessions. Acquisition and steady-state performance were tested in auto-shaping using a 6:1 ITI/Trial duration ratio. The basic latent inhibition effect appeared in CS Alone groups 4:1 and 12:1 (but not in the 6:1 group), as these subjects were significantly retarded in acquiring the conditioned response relative to the Chamber group. The Truly Random groups were also retarded in acquisition, significantly more so than each corresponding CS Alone group. There were no differential effects due to differing ITI schedules. During post-acquisition autoshaping training, CS Alone 6:1 subjects pecked significantly less within trials than subjects in the Chamber group. The reduction in response rate in the latent inhibition group appeared to be due to excessive head-bobbing (pecks just short of the key) rather than loss of stimulus control.

It was not demonstrated conclusively whether LI qualifies as learning or habituation. Acquisition trends across various ITI groups suggested that LI and truly random effects may both be due to habituation. The relatively enduring depression of response rate evinced by CS Alone subjects in post-acquisition autoshaping is open to interpretation because of the observed effect on response topography. Loss of stimulus

control by the CS was not assessable with the procedure employed because amount of head-bobbing was not directly measured.

The conclusion from these experiments is that truly random treatment and CS preexposure both retard acquisition and the latter has long-lasting effects on the autoshaped keypeck response as it is conventionally measured.