LATENT INHIBITION: A REVIEW AND A NEW HYPOTHESIS

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Abstract. A review of research regarding the deleterious effects of stimulus preexposure upon subsequent learning is presented. The investigations are discussed with respect both to the generality of this phenomenon and variables controlling its magnitude. Complementary experiments are suggested. Theoretical interpretations are critically reviewed. It is concluded that some of the hypotheses are too narrow to explain the existing data, and some of them lead to predictions which are contrary to the existing data. A new hypothesis is proposed suggesting that during the stimulus preexposure phase the subject learns a "zero correlation" between the stimulus, or his own behavior and other environmental contingencies. When new learning contingencies are imposed the subject must first unlearn the "zero correlation" learned during preexposure. This process of unlearning retards the learning of the new contingency.

INTRODUCTION

The effect of repeated stimulus presentations has long been a subject of investigation by physiologists; more recently it has received renewed attention by psychologists. Two lines of physiologically oriented research have been pursued. The first was initiated by Sherrington's (1898) experiment in which he demonstrated the decrement of the flexion reflex (41), to closely spaced stimuli, in the spinal animal. This phenomenon later became known as response habituation and was recently reviewed by Groves and Thompson (20). The second line deals with the electrophysiological effects of repetitive stimulus presentations on evoked po-

tentials and spontaneous cortical activity (40). Both of the areas mention-
ed above share a common characteristic, i.e., they deal with the effect of
a repetitive presentation of a stimulus on the response (behavioral or
electrophysiological) which is elicited by that stimulus. A third area,
which constitutes the subject matter of the present review, deals with the
effect of repetitive stimulus presentations upon subsequent acquisition
of a response to that stimulus. In these studies the assumption is made
that the stimulus does not initially evoke the response, or in other words,
it is not an unconditioned stimulus for the response of interest.

In 1959, Lubow and Moore (30) demonstrated that when sheeps and
goats were preexposed to a stimulus which was subsequently used as CS,
they required more trials to acquire a conditional leg flexion to that
stimulus than to a novel one. Lubow and Moore called this phenomenon
latent inhibition (LI), i.e., the deleterious effect of stimulus preexposures
upon subsequent learning. Strictly speaking, Lubow and Moore (30)
were not the first to study the effect of stimulus preexposure on sub-
sequent learning (18, 19), nor the first to demonstrate the phenomenon
(47). They were, however, the first to demonstrate the phenomenon in
the United States, and with their study began an intensive investigation
of LI.

Latent inhibition was subsequently demonstrated in a variety of
behavioral situations. The first part of this paper is devoted to a review
of the variables which have been studied, and to the range of situations
for which LI has been demonstrated. The second part reviews several
theoretical interpretations of LI, and critically evaluates the evidence
adduced to support them. It is the thesis of this paper that existing
explanations of LI are insufficient on empirical or logical grounds to
account for all the evidence, and a new, more parsimonious hypothesis
is offered.

VARIABLES IN LATENT INHIBITION

Species. Human subjects served for both the first failures to de-
monstrate LI (18, 19) and the first success in demonstrating LI. Grant
et al. (18, 19) used college students, while Sokolov and Paramonova (47)
used children. Subsequent studies (39, 51) confirmed the occurrence of
LI in children and extended those findings to adults as well. As already
mentioned Lubow and Moore (30) demonstrated LI in sheeps and goats
and Lubow (28) replicated this finding in both species. In 1967, Carlton
and Vogel (9) demonstrated the occurrence of LI in rats, and since that
time several other investigators confirmed it using, as did Carlton and
Vogel, the CER paradigm (e.g., 27, 32, 45) and other procedures (2, 10).

Suboski, DiLollo and Gormezano (48) failed to obtain LI in rabbits. However, in subsequent studies rabbits were shown to be as good latent inhibitors as other species (29, 42, 43). Single studies have demonstrated latent inhibition in cats (34) and in mice (36).

The LI effect has been established in a large variety of species. However, the demonstration of LI in submammalian species which may have different learning mechanisms (7) or retention mechanisms (3), has not yet been reported.

Types of learning. Sokolov and Paramonova (47), in their original demonstration of the deleterious effect of stimulus preexposures upon subsequent learning employed the Ivanov–Smolenski method of classical conditioning. Briefly, the method consists of presenting a stimulus, usually a tone, which is followed by a command "raise your hand". After this is repeated a few times the subject will raise his hand to the tone. Subjects preexposed to this tone required more than sixty trials to learn the response, contrasting sharply with two to three trials needed by nonpreexposed subjects. Most studies of LI have employed classical conditioning, involving a variety of responses. Skeletal muscle responses investigated have included leg flexion (e.g., 30), eyelid blinking (e.g., 42, 43) and tail movements (10). The GSR is the only autonomic response studied (51). Finally there is a large number of studies involving fear conditioning in CER situations (e.g., 9, 31, 32), which is probably accompanied by conditioning of both skeletal and autonomic responses.

There are only three studies in which the LI effect has been demonstrated for instrumental conditioning, and all three (1, 34, 36) involved avoidance conditioning.

The deleterious effects of preexposure to the "CS to be" have been demonstrated within the Garcia type of learning paradigm (e.g., 15, 16, 35). In this type of learning the subject is given an opportunity to eat or drink a food with a distinct taste, and is afterward made sick by X-radiation or injection of a drug. The subject's aversion toward the food which was consumed before sickness was induced is considered to be a measure of learning. The preexposure in this type of experiment consists of access to food which is not followed by a manipulation that makes the animal sick. The general finding has been that preexposure to food results in poorer learning, i. e., in less aversion.

The generality of LI across learning situations has not yet been established. All of the above studies, except for Sokolov and Paramonova's (47), utilized clearly aversive motivation. In addition almost all demonstrations of LI have been restricted to classical conditioning. The fact that all experiments with instrumental learning involved avoidance conditioning, which may be thought to be mediated by fear classically

conditioned to the CS, poses the question as to whether the preexposure to the "CS to be" disrupts something else than the process of classical conditioning. Experiments involving instrumental conditioning with appetitive reinforcement would possibly extend the demonstration of LI to instrumental conditioning and to positive reinforcements as well.

Number of preexposures. Although this variable seems to be essential in the study of LI, no systematic function relating the effect of the number of preexposures to the resulting deficit is reported in the literature. There are also no attempts reported in the literature, to determine whether there exists a minimum number of preexposures which will impair learning, and whether this number is stimulus or task related. The number of preexposures have varied widely from one experiment to another, with a minimum of five (19), and a maximum of 1,300 (42, 43) presentations. The minimum number of preexposures reported as producing latent inhibition is 10 (30), while as many as 280 preexposures has failed to produce LI (48).

Although there have been no systematic studies attempting to relate the number of preexposures to the degree of learning impairment, there are comparisons involving different amounts of preexposure (e. g., 28, 42); Lubow (28), using the classical conditioning of leg flexion compared the effects of 0, 20, and 40 preexposures on subsequent learning, and showed that increasing the number of preexposures results in more profound impairment. Siegel (42) confirmed this relationship using eyelid conditioning in rabbits. His comparison involved 0, 100, and 1,300 preexposures. Although a positive relationship between the number of preexposures and the degree of learning impairment seems to be established, more systematic studies are still to be performed.

Interval between preexposure and conditioning. In the response habituation literature the phenomenon of recovery as a function of the time interval between habituation and testing is well established (20). The problem of the effect of the time interval between preexposure and conditioning seems important, therefore, in any attempt to interpret the effects of stimulus preexposure in terms of response (e.g., orienting response) habituation.

Lubow, Markman and Allen (29) studied the effect of a 24 hr interval between preexposure and conditioning. They observed that the interposition of the 24 hr delay decreased the effect of preexposure. On the other hand Siegel (44) reported no decrement with the same time gap. The main difference between these two studies consisted of the number of preexposures. Lubow, Markman and Allen (29) used 40 and 80 preexposures whereas Siegel (44) used 550 preexposures. The time lag may well interact with the amount of preexposure in such a way

that the delay is less effective when the animals are over-preexposed. Thus, it might be expected that short delay effects would appear when small but not large amounts of preexposure are used. James (21) studied the effects of short delays (0, 30, or 60 min) following 20 preexposures. In spite of this small number of preexposures, no evidence of a decrease in LI with delay was obtained. Unfortunately, in this study no data are available on the effects of delays longer than 60 min which may be too short for recovery to appear, even with a small number of preexposures.

The failure to obtain reliable delay effects may be taken as evidence dissociating LI from habituation (11). However, until more systematic studies of delay have been reported, conclusions about the effects of delay in LI, and comparisons with delay effects upon response habituation are premature.

Types of stimuli. A wide variety of stimuli have been used in demonstrating the latent inhibition effect. LI has been demonstrated for auditory stimuli (e.g., 9, 42, 43, 47), visual stimuli (30, 36) and taste stimuli (e.g., 13, 15). Within each modality stimuli differed in several aspects from one study to another. The duration of the stimulus varied from 500 msec in the case of classical conditioning of the eyelid response (e.g., 42, 43) to 2 min in the case of conditioned suppression (38).

Latent inhibition has been demonstrated for stimuli varying in complexity from a continuous tone (e.g., 47) through a series of clicks (27) to an interrupted tone (e.g., 45) within the auditory modality, and from a continuous light (36) to a moving pattern (30) within the visual modality. There have been no direct attempts to compare the LI produced by stimuli of different complexity.

The intensity of the conditioned stimuli varied from one study to another, but not all authors reported the intensity of the stimuli used. Lubow, Markman and Allen (29) studied the effect of variations in tone intensity upon LI in eyeblink conditioning. They found that preexposure and conditioning to tones of 68, 71, 74, and 77 db resulted in no interaction between stimulus intensity and the preexposure vs. no preexposure factor. Crowell and Anderson (11) manipulated stimulus intensity factorially during preexposure, conditioning, and testing in a CER paradigm. Two intensities (70 and 100 db) of white noise were employed. No significant interaction involving preexposure vs. nonpreexposure and stimulus intensity was found. Thus, at present, there is no evidence that stimulus intensity and LI are related by any function.

Stimulus specificity. A question which has received some attention is the specificity of the effects of stimulus preexposure, namely, does preexposure to a stimulus impair subsequent learning to any stimulus

or only to the stimulus which was preexposed. Carlton and Vogel (9) examined this question by preexposing animals to a click and subsequently testing them with a tone. No impairment of learning resulted from this procedure, whereas animals preexposed to the tone and tested with the tone showed a learning deficit. In an analogous experiment Schnur and Ksir (39) demonstrated that human subjects habituated to a tone and tested with a bell, or habituated to the bell and tested with a tone were not impaired in learning, but the LI effect appeared when preexposure and test stimuli were identical. Siegel (43) tested for specificity by preexposing subjects to a tone of one frequency and testing the acquisition of eyelid response to the same or different frequencies of tone. In this way he was able to obtain a generalization gradient of latent inhibition. The animals trained with the stimulus of the same frequency as the one to which they were preexposed demonstrated the strongest impairment. This impairment decreased as the training frequency became more remote from the preexposure frequency.

Stimulus specificity appears to extend beyond the properties of the CS. The fact that the place of preexposure may influence the magnitude of the LI effect was shown by Anderson et al. (4, 5). Subjects habituated outside the conditioning chamber were less impaired in subsequent conditioning. This suggests the necessity of treating the preexposure as if it involved a compound of the "CS to be" and environmental stimuli.

Physiological manipulations. LI seems to be a very useful paradigm for the neuropsychologist, since it provides him with the possibility of studying the S-O part of the S-O-R relationship. This paradigm permits the study of the input processes without the influence of response perseveration which is often observed in the investigations of brain lesioned subjects. In view of this it seems unfortunate that there are only two studies on the effect of brain lesions and two studies on the effect of drugs on LI. Hippocampal and septal lesions have been interpreted either as producing response perseveration, i.e., a deficit in the inhibition of motor responses (33), or as producing a more general deficit in inhibition (23). The two possibilities have been tested with the LI paradigm for both hippocampal (2) and septal (Weiss, Friedman and McGregor, in preparation) animals. In neither case did lesioned animals display any change in the rate of conditioning as a result of preexposure to the stimulus, thus demonstrating that the response perseveration hypothesis is incomplete.

Scopolamine has also been described as affecting inhibitory processes (e.g., 8). Testing this hypothesis involved difficulties similar to those encountered by investigators of the hippocampal and septal functions. Vogel and Carlton (50) used the LI paradigm to test the generality of

the inhibition hypothesis. Rats under the action of scopolamine were preexposed to the "CS to be" and subsequently trained without a drug with the result that LI was drastically reduced. The interpretation of these results is complicated by the fact that scopolamine has been described as producing state dependent learning. The design utilized by Vogel and Carlton is open to such an interpretation. Oliverio (36) performed an experiment which ruled out this possibility; in his study subjects who were both preexposed and trained while drugged manifested a disruption of scopolamine-produced learning facilitation in a two way avoidance situation.

   Negative results. Considering the total number of studies in which latent inhibition has been demonstrated, the fact that only three negative reports have been published is impressive. Grant et al. (18, 19) were the first to study the effect of preexposure to the "CS to be" on subsequent learning. In both studies they reported no differences in learning between the preexposed and non preexposed groups. In view of the general paucity of parametric studies in LI the existing negative reports are difficult to explain. Nevertheless, Siegel (42) reported a difference in the degree of the LI effect with different amounts of preexposure. Grant and coworkers in their 1948 study (19) used only five preexposures, and in their 1951 study (18) they used one group with five and one group with ten preexposures. These amounts of preexposure might well be insufficient for detecting LI. The absence of LI in the study of Suboski et al. (48), using the nictitating membrane response, can by no means be explained by an insufficient amount of preexposure. Their rabbits received 280 preexposures to the "CS to be". It is interesting to note that both preexposed and non-preexposed rabbits required over 500 trials to achieve an 80% performance level. The task was therefore extremely difficult in comparison with other studies. The number of trials necessary to achieve a 90% criterion was 68.2 in Siegel's study (42), and an 80% performance level was achieved in about 60 trials in Lubow's study (28). An interesting theoretical possibility occurs. It seems possible that for tasks for which the learning of the association is difficult, the initial learning trials may act as preexposure to the CS. While there is no direct support for this hypothesis, some indirect evidence exists that decremental processes may occur prior to incremental processes in classical conditioning. Bass and Hull (6) conditioned the GSR to a touch stimulus using shock as UCS. They reported the value of GSR as it was registered trial by trial. In successive initial trials the value of the GSR systematically decreased from its original high value evoked by a novel touch stimulus, although in this procedure the UCS followed the CS on every trial. This may indicate that the response which was being

conditioned declined in spite of an ongoing process of conditioning, and only with continued conditioning did it begin to reappear in the form of a conditioned response. Task difficulty may be due in part to such a decremental process via latent inhibition which would augment the retardation of acquisition due to associative difficulty alone. In Suboski's study, poor acquisition may have been accompanied by the development of latent inhibition in both preexposed and nonpreexposed groups, thus attenuating experimentally manipulated treatment differences. If this interpretation is correct, then it would be predicted that LI should occur with Suboski et al.'s procedure when task difficulty is reduced by, for example, using a shorter interstimulus interval than employed in their study (600 msec).

HYPOTHESES

Considering the relatively short history of research in LI, a surprisingly large number of interpretations of the phenomenon have been suggested. The present section reviews and critically evaluates these hypotheses.

Competing response. The initial explanation offered by Lubow and Moore (30) was that their subjects learned a competing motor response during the preexposure and this response prevented effective learning of the response which was to be conditioned, namely, leg flexion. A possible competing response was thought to be leg extension to be CS. To test their hypothesis Lubow and Moore arranged the stimuli so that they were evoking leg flexion during preexposure rather than leg extension. In spite of this manipulation they obtained once again a deficit in learning as a result of stimulus preexposure. This experiment did not rule out the possibility that there is another competing response which was learned during preexposure phase, however, it is difficult to think of a specific motor response which would interfere with such a wide variety of responses for which LI has been demonstrated.

Additional negative evidence concerning the competing response hypothesis was obtained by Rescorla (38) in a study specifically designed to test a different hypothesis, that the habituated stimulus has inhibitory properties. In Rescorla's Experiment 1, it was shown that preexposure to tone resulted in retardation of fear conditioning in the CER paradigm. Experiment 2 was designed to test the effect of tone preexposure upon the development of conditional inhibition. In this paradigm, reinforcement is paired with CS when presented alone but not when CS is compounded with another stimulus. In Rescorla's study a light stimulus was followed by shock, while the combination of light with tone was unre-

inforced. An experimental group was preexposed to tone, and a control group was not. After conditioned fear was established in both groups with light–shock combination, conditioned inhibition training began.

The control subjects developed a decrease of fear to the combination of tone with light, while the subjects preexposed to the tone did not react differentially to tone vs. tone–light combinations. If retardation of acquisition of fear in the first experiment were due to the learning of a competing response to the stimulus during preexposure, one would expect that this competing response would weaken the fear reaction to the tone-light compound and thus facilitate the formation of discrimination. Contrary to this prediction, Rescorla found that preexposure to tone impaired the development of conditional inhibition. This finding provides strong evidence against a competing response hypothesis.

Habituation of alpha responses. As defined by Kimble (24), the alpha response is the "original response to the conditioned stimulus" (p. 477) in classical conditioning. As already mentioned, all experiments in which LI has been demonstrated either involved classical conditioning or at least could be thought of as involving mediation via classically conditioned fear. Therefore, Lubow, Markman and Allen (29) hypothesized that the LI effect may well be a result of the habituation of alpha responses during preexposure. Lubow et al. tested this hypothesis by preexposing the animals to stimuli of different intensities. The assumption was that animals preexposed to stimuli of higher intensities should emit more alpha responses during the phase of preexposure, and thus display greater alpha response habituation. As a consequence, the learning of the group preexposed to a higher intensity of stimulation should be relatively more impaired than the learning of the group preexposed to a weaker stimulus. In terms of the statistical analysis, if the learning deficit which followed the preexposure was due to the habituation of alpha responses, one would expect a significant interaction of stimulus intensity with preexposure. This interaction was not found to be significant. Unfortunately, the interpretation of this experiment is obscured by the fact that in the acquisition phase the stimuli were as intense as they were in the preexposure phase. The absence of an interaction may be explained by stimulus intensity dynamism which could act in such a way as to facilitate the habituated responses more at higher intensities than at lower ones. This would result in the masking of the interaction which might possibly be observed if all groups were tested with a stimulus of the same intensity following preexposure to stimuli of different intensities.

Domjan and Siegel (13) approached the same problem by directly measuring the alpha responses during the preexposure phase and de-

monstrating that additional preexposure to the CS has an increasingly deleterious effect on eyelid conditioning in rabbits. This effect was evident when the number of preexposure trials exceeded the number necessary to habituate the alpha responses. This last experiment suggests that although alpha response habituation may have its role in the observed LI effect, there is more to this effect than the habituation of observed alpha responses. It should be noted that the alpha response interpretation requires that prior to conditioning the CS elicits the response to be conditioned. While this is true for a number of responses (e. g., eyeblink, GSR), other classically conditioned responses, such as salivation, are typically suppressed below baseline by the presentation of a novel stimulus. Accordingly, the hypothesis would predict the absence of LI in such cases. At present, no studies of LI have been reported in which the CR is suppressed by novel stimulation.

Preexposed stimulus as an inhibitor. The concept of latent inhibition suggests possible inhibitory properties of the preexposed stimulus. James (21) postulated such an inhibitory factor, and the acquisition of inhibitory properties by the stimulus has been recently tested experimentally (37, 38). The development of conditional inhibition has been systematically analyzed by Konorski and his associates (for a reviev see Konorski, 25) who suggested that conditioned inhibitors are drive specific; i.e., their inhibitory properties are manifested only when tested under the motivational conditions in which they were developed. Accordingly, it seems unlikely that a preexposure procedure would transform new stimuli into general conditional inhibitors. This expectation is supported by experimental evidence (37, 38). As mentioned previously, Rescorla demonstrated that it is more difficult to transform a preexposed stimulus into an inhibitor than it is to transform a novel stimulus into an inhibitor. Another experiment reported by Rescorla (38) involved the so called summation procedure in which after an animal has been trained to respond to one stimulus, a second stimulus is compounded with it; the second stimulus is considered to have inhibitory properties if development of inferior responding to the compound is demonstrated. In Rescorla's experiment, a preexposed stimulus exhibited this property to a lesser extent than a novel one. Reiss and Wagner (37), in a similar experiment utilizing the conditioned eyelid response, confirmed Rescorla's findings. According to these results, latent inhibition can not be explained by a conditioned inhibition mechanism.

Reduced attention. That LI is due to reduced attention resulting from preexposure seemed a viable conclusion to researchers from its first demonstration (47). The concept of reduced attention has often been used when other interpretations of differences resulting from experimental

manipulations are difficult to make. As Terrace (49) put it "Attention is typically used in those situations in which a stimulus or some element of a stimulus does not reliably control a response" (p. 287). The concept of attention does not yield easily to verification. Domjan (12, 13) tested the hypothesis using the Garcia type of learning paradigm. Instead of preexposing the subjects to the "CS to be" only, he preexposed them in such a way that they had to make choices between the "CS to be" (saccharin) and water. The maintained preference for saccharin observed during preexposure implied no reduction in attention. Nevertheless, after pairing saccharin with lithium chloride-induced sickness, preexposed subjects showed less saccharin aversion than nonpreexposed subjects. This finding contradicts the hypothesis that preexposure results in the impairment of learning by reducing attention to the stimulus. Although this may be the case in more traditional learning situations, it seems not to hold for sickness induced aversion.

Rescorla (38) proposed that stimulus preexposure results in poorer learning by reducing stimulus salience. It seems difficult to distinguish between stimulus salience and attention to a stimulus. If stimulus salience is understood as the ability of a stimulus to evoke attentional reactions, then the stimulus salience hypothesis is identical to the attentional hypothesis discussed above. On the other hand, if stimulus salience means stimulus associability, then the use of the term merely constitutes another way of describing the phenomenon. The question requiring explanation is really why does a preexposed stimulus impair the process of association formation.

Habituation of the orienting reaction. The habituation of the orienting reaction as a factor responsible for LI has been postulated by Sokolov (46). In some respects this hypothesis may be considered another variation of the attentional hypothesis. Sokolov postulated that the existence of an orienting reaction to the CS may be a necessary condition for the closure of the conditional link. If the orienting reaction were habituated during preexposure the formation of a conditional response would be impaired. Sokolov (46) reviewed experiments demonstrating the habituation of the orienting response during the preexposure of a stimulus. However, sensitivity of the orienting response to disinhibition (e.g., 17) suggests that it is not a sufficient explanation for cases where long lasting effects of stimulus preexposure are observed. Moreover, Sokolov (46) states that during discrimination learning the orienting response to the negative CS disappears, just as it disappears during preexposure. One would then expect that the stimulus which has been used as a negative CS in one task would tend to retard learning of a new task; that this is not the case has been documented (26). Finally, Weiss,

Friedman and McGregor (in preparation) found that septal lesions did not impair the habituation of the orienting response as measured by the stimulus-produced suppression of ongoing drinking behavior, whereas the LI effect was abolished in rats with septal lesions. Thus, septal lesions dissociated LI from the habituation of the orienting response. This suggests that the hypothesis of extinction or habituation of the orienting response is inadequate.

Learning of a "zero correlation". It appears that the LI phenomenon is comfortably handled by none of the preceding hypotheses. Those interpretations vary mainly in their emphasis upon input or output mechanisms, i.e., they view stimulus preexposure as altering either stimulus or response strengths. The hypothesis advanced here differs in that it views the effects of preexposure as purely associative in nature. Specifically, it assumes that an important part of "what is learned" is the *correlation* that exists among events central to the learning process, i.e., among stimulus-stimulus or response-stimulus events. The sign of the correlation is defined in terms of the learned predictive relations between the events. Thus, in classical conditioning, a positive correlation exists when CS predicts US, a negative correlation exists when CS predicts the absence of US, and a zero correlation exists when CS does not predict either the occurrence or nonoccurrence of US. Similarly, in the instrumental learning situation, a correlation exists when a response bears a predictive relationship to the occurrence or nonoccurrence of a stimulus event, while a zero correlation exists when no contingency holds between the response and the stimulus event.   ,

According to this hypothesis, latent inhibition is due to the learning of a zero correlation, during the preexposure period, between "CS to be" and other stimulus events in both classical conditioning and instrumental learning, as well as learning of a zero correlation between "CS to be" and the response in the instrumental paradigm. When, in the subsequent acquisition phase, CS and US, or CS and response become correlated, the preexposed subject must first unlearn the zero correlation before the new correlation (either positive or negative) may be learned. Thus, latent inhibition results from retardation in learning a new contingency.

The zero correlation hypothesis is consistent with the body of findings on LI reviewed herein. It also yields new predictions concerning the effects of preexposure manipulations. For instance, it predicts that during preexposure, response-independent of "CS to be" should retard subsequent avoidance learning to a greater extent than response-contingent termination of the stimulus. This prediction follows from the fact that the learning of a zero correlation between the response and CS

termination is prevented in the latter, but not in the former procedure. The prediction was tested in a two-way shuttle avoidance task (Weiss and Friedman, in preparation). Signalled avoidance learning was compared among three groups of rats which received different preexposure treatments. Subjects in Group RT received 30 presentations of CS (white noise) which terminated either after a crossing response or 2 min, whichever came first. Subjects in Group YT were yoked to Group RT subjects, and received the same number and pattern of CS presentations, but independent of their behavior. Group NP spent the same amount of time in the apparatus as the other groups, but received no CS preexposure. Subsequent acquisition of avoidance was found to be significantly poorer in Group YT than in Groups NP and RT which did not differ significantly from each other. Thus, when the learning of a zero correlation between the response and CS termination was prevented, no latent inhibition occurred.

The zero correlation learning hypothesis may be extended to include cases of preexposure to US as well as CS. Accordingly, it would be expected that US preexposure would result in the learning of a zero correlation between US and other environmental events, which would retard acquisition of a response based upon non-zero CS-US correlation. In a parallel fashion, a learned zero correlation between the response and US would also be expected to retard acquisition in instrumental learning. It has been reported that US preexposure results in impairment of subsequent conditioning with that US (22, 45). The deleterious effect of food-US preexposure upon the acquisition of key pecking in pigeons reported by Engberg, Hanson, Welker, and Thomas (14) is also congruent with the hypothesis.

SUMMARY

1. A review of research regarding the deleterious effects of stimulus preexposure upon subsequent learning is presented. The investigations are discussed with respect both to the generality of this phenomenon and variables controlling its magnitude. Complementary experiments are suggested.

2. Theoretical interpretations are critically reviewed. It is concluded that some of the hypotheses are too narrow to explain the existing data, and some of them lead to predictions which are contrary to the existing data.

3. A new hypothesis is proposed suggesting that during the stimulus preexposure phase the subject learns a "zero correlation" between the stimulus, or his own behavior, and other environmental contingencies.

When new learning contingencies are imposed, the subject must first unlearn the "zero correlation" learned during preexposure. This process of unlearning retards the learning of the new contingency.

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