**EFFECTS OF SIGNED AND UNSIGNED
SHOCK ON SCHEDULE-CONTROLLED
LEVER PRESSING AND SCHEDULE-INDUCED
LICKING: SHOCK INTENSITY AND BODY WEIGHT**

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Schedule-controlled lever pressing and schedule-induced licking were studied in rats under a multiple fixed-interval fixed-interval schedule of food reinforcement. Following acquisition of stable rates of pressing and licking, a multiple variable-time variable-time schedule of electric-shock delivery was superimposed upon the baseline schedule. In only one component of the multiple schedule, a 5-sec stimulus preceded each shock (signed shock). In the other component shock was unsigned. Several shock intensities (Experiment 1) and body weights (Experiment 2) were studied. Lever pressing and licking were affected similarly by experimental manipulations, although with parametric differences. Depending upon shock intensity and body weight, rates of lever pressing and licking were hardly suppressed, suppressed primarily in the unsigned shock component (differential suppression), or markedly suppressed in both components. Differential suppression during components with signed and unsigned shock and conditioned suppression of responding during the pre-shock stimulus appeared not to be functionally related. Differential suppression depended more on the discriminability of shock-free time, and on shock intensity, body weight, and the type of response than on the "preparatory" behavior preceding shock.

Key words: signed shock, response suppression, differential suppression, lever pressing, schedule-induced licking, rats

The behavioral effects of noxious events depend upon their predictability. Seligman (1968) reported that the rate of food-maintained lever pressing was more readily reduced by unsigned than by signed shock. Unsigned shocks also caused more gastric ulcers. Seligman (1968) interpreted these findings in terms of a safety signal; the presence and absence of the preshock conditioned stimulus (CS) predict shock ("danger") and no shock ("safety"), respectively. During signed shock, most of the session is spent in "safety" whereas with unsigned shock, most of the session is spent in "danger." Presumably, the differential exposure to "danger" and "safety" accounts for the observed differential suppression of responding and the differential occurrence of ulcers.

Seligman's (1968) finding that response rates are suppressed more during unsigned than during signed shocks has been replicated many times (see Hymowitz's 1979 review). Dif-

ferential response suppression has been found with response-independent (Hymowitz, 1977a) and response-dependent (Hymowitz, 1976a) schedules of electric-shock delivery, with lever pressing (Hymowitz, 1973), operant licking (Imada & Okamura, 1975), and schedule-induced licking (Hymowitz, 1977b) as dependent variables, and with several different schedules of food (Hymowitz, 1973) and shock (e.g., Hymowitz, 1976b, 1977a, 1977b) delivery.

The major alternative explanation of differential suppression is Perkins' (1968) "preparedness" hypothesis which argues that preshock stimuli permit animals to "prepare" for shock, thereby lessening its aversiveness and therefore its suppressive function. Whereas the safety-signal hypothesis emphasizes the discriminability of shock-free time, per se, the preparedness hypothesis emphasizes the predictability of shock, per se.

Both "preparation" and "safety" may play a role in differential suppression, and there are data that support each position (Hymowitz, 1979). However, other data are not readily accommodated by either hypothesis. Hymowitz (1977b), for example, studied the effects of signed and unsigned shock on schedule-controlled lever pressing and schedule-induced

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licking (Falk, 1961). At most shock intensities studied, both were suppressed more during unsignaled than during signaled shock. At some intensities, however, schedule-induced licking was suppressed to a comparable degree during signaled and unsignaled shock, whereas lever pressing primarily was suppressed during unsignaled shock. If the animals were sufficiently "prepared" during signaled shock to press, why were they not "prepared" to lick? Similarly, if it was "safe" to press, why was it not "safe" to lick?

It is likely that terms such as "preparation" and "safety" are too molar to adequately describe the performance of animals during signaled and unsignaled shock. Analyses of the behavior of animals in terms of interactions among the variables of which differential suppression is a function may be more informative. To this end, Experiments 1 and 2 extend the analysis to additional variables and compare the effects of these variables on conditioned suppression (suppression of responding during CS presentations, Estes & Skinner, 1941) and differential suppression (more overall suppression during unsignaled than during signaled shock).

Among the variables studied are shock intensity, body weight, signaling of shock, and the nature of the response (schedule-controlled lever pressing and schedule-induced licking). Analysis of conditioned suppression and differential suppression clarifies the relationship between the two forms of suppression and delineates the relative contribution to differential suppression of pre- and postshock factors. To the extent that conditioned and differential suppression are influenced in the same manner by the same experimental variables and to the extent that the occurrence of conditioned suppression reliably predicts the occurrence of differential suppression, the data would suggest that the two forms of suppression are causally related and that preshock factors (e.g., preparatory responses during the CS) contribute significantly to differential suppression. If they are not found to be causally related, one may question the relative importance of preshock compared to postshock factors (e.g., discrimination of shock-free time) in determining differential suppression.

The rationale for employing schedule-induced licking and schedule-controlled lever pressing as dependent variables derived from

several considerations. Schedule-induced licking shares with lever pressing many features of a desirable dependent variable (see also Dunham, 1971; Hymowitz, 1979). Both are quantifiable samples of behavior that remain stable from session to session. Each is sensitive to variables such as the frequency of food delivery (Falk, 1961; Freed & Hymowitz, 1972), shifts in reinforcement rate (Jacquet, 1972), and electric shock (e.g., Hymowitz & Freed, 1974). By using two kinds of behavior, operant and adjunctive (cf. Falk, 1971, 1977), as dependent variables, one can extend the generality of the data and identify what effect the nature of the behavior has on response suppression during signaled and unsignaled shock.

GENERAL METHOD

Subjects

Five male, experimentally naive, albino Sprague-Dawley rats, 300 to 350g, served in Experiments 1 and 2. Three (Rats 2, 4, and 6) served as yoked controls, and the others (Rats 1, 3, and 5) as experimental animals. All were housed individually and maintained at 80% of free-feeding weights on Purina Laboratory Rat Chow unless otherwise stated. Water was freely available in the home cage.

Apparatus

Two Grason-Stadler sound-attenuated operant rat chambers, Models 1101, contained a response lever, pellet dispenser, fan, and white masking noise. A stainless-steel spout connected to a graduated cylinder and lickometer located outside the chamber was available to the animal through a slot cut in the rear wall. Programming was accomplished by electromechanical equipment. Counters and cumulative recorders recorded responses. Electric shock to the grid floor was delivered by a Grason-Stadler shock generator, Model 700, and grid scrambler.

Procedure

Following weight reduction to 80% of free-feeding weight and lever-press shaping, lever pressing and licking by the experimental animals were studied for 25 48-min daily sessions under a multiple fixed-interval 40-sec fixed-interval 40-sec (mult FI 40-sec FI 40-sec) schedule of food delivery. The components of the multiple schedule do not assume importance until

the shock is introduced. Eight 6-min components alternated regularly throughout the session. The components were distinguished by turning on (light component) and off (dark component) a houselight and two red jewelled lights above and to the left and right of the lever. The component that initiated the session was alternated daily.

By Session 26, there was no systematic variation in the licking or pressing data and a multiple variable-time 125-sec variable-time 125-sec (VT 125-sec VT 125-sec) schedule of shocks was superimposed upon the baseline food schedule. In one component, a 5-sec stimulus (white noise) was presented on the average of once every 125 sec. Offset of the white noise was simultaneous with shock delivery. In the other component, no stimulus was presented during the 5-sec preshock period. The distribution of shocks ranged from 5 to 245 sec. Shocks could be delivered at any time and were not related to the delivery of food.

Blocks of successive food-and-shock sessions at a constant shock intensity alternated with blocks of food-alone sessions. Shock duration was .5 sec, whereas shock intensity was varied systematically between blocks of shock sessions. Changes in experimental conditions were not initiated until responding stabilized, and there was no systematic variation in the data for at least five successive sessions.

The yoked-control animals received a food pellet whenever the experimental animal earned one, but they were not exposed to the lever-press contingency nor to shock. Like the experimental animals, they ingested the food pellet and engaged in postpellet licking. Disruption of lever pressing by shock and/or changes in body weight of the experimental animal may alter the spacing of food. This could influence postpellet induced licking. Analyses of licking in yoked-control animals made it possible to determine if the disruption of experimental animals' licking behavior was due to a change in the spacing of food or to the other variables.

EXPERIMENT 1'

Procedure

Following weight loss to 80% of free-feeding body weight, lever-press shaping, and acquisition of stable rates of pressing and licking during the mult FI 40-sec FI 40-sec schedule, the

mult VT 125-sec VT 125-sec schedule of shocks was introduced. During the initial food-and-shock sessions, the light component of the multiple schedule was associated with signaled shock and the dark with unsignaled shock. During Reversal, the opposite relations held. Following Reversal, the original conditions (preshock cue in light) were restored. Blocks of food-and-shock sessions alternated with blocks of food-alone sessions. During the initial food-and-shock sessions (preshock cue in light), an ascending and then a descending series of shock intensities were studied. During Reversal, an ascending series of shock intensities was studied after which suppression was redetermined at a lower intensity. Rate of responding was studied under a given shock intensity for at least 10 sessions and until 5 successive sessions occurred in which no systematic variation in licking and pressing was observed. Table 1 shows the order of shock intensities for each animal.

RESULTS AND DISCUSSION

Each experimental animal acquired the characteristic scalloped pattern of lever press-

Table 1
Order of Shock Intensities (mA) in Experiment 1¹

Rat 1		Rat 3		Rat 5	
Intensity (mA)	Sessions/ Conditions	Intensity (mA)	Sessions/ Conditions	Intensity (mA)	Sessions/ Conditions
Cue in Light					
.16	10	.16	11	.16	11
.2	12	.2	10	.2	10
.25	10	.25	10	.25	10
.3	15	.3	10	.3	20
.4	23	.4	12	.4	.2
.5	10	.5	10	.5	10
.6	10	.6	20	.6	19
.8	15	.8	11	.8	10
.6	13	.6	10	.6	18
.4	13	.4	10	.4	10
.25	10	.25	10	.25	10
Reversal (Cue in Dark)					
.25	10	.25	11	.25	10
.4	15	.4	10	.4	10
.6	11	.6	13	.6	10
.8	12	.8	10	.8	10
.4	10	1.0	15	.4	10
		.6	10		
Cue in Light					
.3	10	.3	13	.3	10
.6	13	.6	15	.6	10
				.8	10

¹Each block of shock sessions at a constant shock intensity was preceded by a block of food-alone sessions.

ing until food delivery, followed by ingesting the food pellet and rapid licking. The yoked-control animals similarly engaged in licking bouts after eating. Average session fluid consumption for the final three food-alone sessions preceding the initial introduction of shock was 35, 36, and 14 milliliter for Rats 1, 3, and 5, respectively. Mean water intake for Rats 2, 4,

and 6, the yoked-control animals, for the same sessions was 27, 30, and 31 milliliter per session.

Figures 1 and 2 show, for each experimental animal, the mean overall rate of lever pressing and licking in the components associated with signaled and unsignaled shock in Experiment 1. Calculation of overall response rates did not include responses emitted in the 5-sec preshock periods. Data points are means for the final three sessions of each experimental condition.

During baseline, high rates of lever pressing and licking were maintained in both components of the multiple schedule (Figures 1 and 2). Comparable rates of licking were maintained by the experimental and yoked-control animals, suggesting that lever pressing probably did not significantly interfere or compete with schedule-induced licking in the experimental animals.

Despite differences in the animals' sensitivity to shock, performance of the experimental animals was quite similar. Rat 1 revealed differential suppression of licking and pressing rates when .4 mA shock was introduced (Figures 1 and 2). Milder shock intensities (.16 to .3 mA) had relatively little effect on response rates, whereas the highest intensity to which this animal was exposed (.8 mA) markedly reduced response rates in both components. Differential suppression for Rat 1 at .4, .5, and .6 mA reflected the greater suppression of pressing and licking during unsignaled than during signaled shock. These findings held for the ascending and the descending series of shock intensities, and differential suppression was found both when the preshock stimulus was presented in the light component and when it was presented in the dark component (Reversal) (Figures 1 and 2). During Reversal (cue in dark) differential lever-press suppression was most marked during redetermination at .4 mA. When the original experimental conditions were reintroduced, differential suppression of licking and pressing was observed at .6 mA.

The data for Rat 3 were similar, except that differential suppression of licking was not found until .6 mA shock and differential suppression of pressing was not observed until .5 mA shock. During Reversal (cue in dark), licking was suppressed more during unsignaled than during signaled .6 mA shock, but differential suppression of lever pressing was not observed for Rat 3 until redetermination of sup-

Fig. 1. Mean overall rate of lever pressing for each animal during the components associated with signaled (unfilled symbols) and unsignaled (filled symbols) electric-shock delivery in Experiment 1. The data points are means for the final three sessions of each experimental condition. Parentheses indicate data points for the descending series of shock intensities. Shock intensity is plotted on a log scale.

Fig. 2. Mean overall rate of schedule-induced licking for each animal during the components associated with signaled (unfilled symbols) and unsignalled (filled symbols) electric-shock delivery in Experiment 1. The data points are means for the final three sessions of each experimental condition. Parentheses indicate data points for the descending series of shock intensities. Shock intensity is plotted on a log scale.

pression at .6 mA. Prior to that point, pressing was more suppressed in the signaled-shock component, reflecting the marked control over responding by stimuli previously associated with unsignalled shock. Differential suppression was observed at .3 mA when the cue was

once more presented in the light component (Figures 1 and 2).

Rat 5 revealed differential suppression of licking with shock intensities as low as .3 mA. The differential suppression was due to an increase in the rate of licking during the component associated with signaled shock as well as a decrease during unsignalled shock. Lever pressing at this shock intensity remained unchanged in both components, indicating that licking rates may increase without competing with lever pressing and that one behavior may be differentially suppressed while another is relatively unaffected. Differential suppression of lever pressing was not observed until .5 mA shock, and was due to a decrease in pressing during unsignalled shock, not to an increase during signaled shock.

A similar pattern of responding held for Rat 5 during the Reversal condition. Differential suppression of licking was due to an increase in licking during signaled shock as well as a decrease during unsignalled shock. Differential suppression of lever pressing was due to a greater reduction in pressing during unsignalled shock (Figure 1). When the CS again was presented in the light component, responding once more was suppressed more during dark, unsignalled shock than during light, signaled shock (Figures 1 and 2).

The differential suppression of licking was not due to a greater change in the spacing of food during unsignalled than signaled shock. Otherwise, yoked-control animals would have revealed similar differences in licking in the dark and light components. As Figure 2 shows, yoked animals maintained similar rates of licking in both components, although licking rates sometimes decreased in both components.

Figure 3 shows cumulative records of the performance of Rat 1 during several experimental conditions. During baseline (upper panel), high rates of pressing and licking were maintained in both components, and eating was followed immediately by licking. Mild, .25 mA shock had little, if any, effect. More intense shock, however, disrupted lever pressing and licking, with most of the behavior occurring during signaled shock. As in previous studies (Hymowitz, 1976b), the disruption of licking was due both to the shortening of some, and omission of other, postpellet licking bouts.

Figure 4 shows the rate of licking and press-

Fig. 3. Representative cumulative records for Rat 1 of responding during baseline (upper panel), .25 mA, .60 mA, and .80 mA electric-shock delivery. Vertical movement of the response pen represents licks; the downward pip of the response pen, pellets; resetting of the response pen, shocks; and downward movement of the event pen, lever presses. The response pen also reset to the bottom of the scale after 550 licks. "L" indicates the component associated with the light.

ing during the 5-sec CS for signaled shock and during comparable 5-sec preshock periods for unsignaled shock. The rate of pressing and licking during the 5-sec period preceding un-

signaled shock closely reflects the overall rates of responding in that component shown in Figures 1 and 2. The rate of pressing and licking during the CS for signaled shock was much lower than rates in the absence of the CS (compare Figures 1, 2, and 4), indicating conditioned suppression during the CS.

For each animal, conditioned suppression of licking and lever pressing depended upon the intensity of shock. Conditioned suppression was observed at shock intensities below that required to produce differential response suppression. Conditioned suppression of licking and pressing was observed at .2 mA for Rat 1. For Rat 3, conditioned suppression of lever pressing was observed at .3 mA and of licking at .4 mA. For Rat 5, intensities of .2 and .16 mA produced conditioned suppression of lever pressing and licking, respectively (Figure 3).

During Reversal (Figure 4), conditioned suppression was observed for lever pressing and for licking as soon as the CS was presented (Figure 4). Differential suppression was not observed for either response until the animals had more exposure to the schedule and higher shock intensities were introduced (Figures 1 and 2). These findings suggest (1) that conditioned suppression is not a sufficient condition for differential suppression, (2) that the threshold for conditioned suppression is lower than for differential suppression, and (3) that, under these circumstances, conditioned suppression was independent of the discriminative stimuli that distinguished the components, whereas differential suppression probably was dependent upon the correlated stimuli. During the initial blocks of food-and-shock sessions, the light was associated with signaled shock-free time and the dark, with unsignaled shock. During Reversal, light was associated with unsignaled shock and dark, with signaled, shock-free time. Differential suppression did not occur until the animal had sufficient exposure to these new contingencies. This analysis is compatible with Seligman's (1968) safety-signal hypothesis.

EXPERIMENT 2

Experiment 2 extends the analyses of conditioned suppression and differential suppression to variations in body weight. No data on the effects of food deprivation on differential suppression have been published, although

Fig. 4. Mean rate of lever pressing (circles, left vertical axis) and licking (triangles, right vertical axis) for each animal during 5-sec CS (unfilled symbols) preceding signaled shocks and during 5-sec preshock periods (filled symbols) in the case of unsignaled shocks. The data points are means for the final three sessions of each condition. The parentheses indicate data points for the descending series of shock intensities. Shock intensity is plotted on a log scale.

conditioned suppression during the CS is very much influenced by degree of food deprivation (Millenson & de Villiers, 1972).

Procedure

Following 10 food-alone sessions under the mult FI 40-sec FI 40-sec schedule of food delivery, the rate of licking and pressing for Rats 1, 3, and 5 was studied under the mult VT 125-sec VT 125-sec shock schedule. Rats 1 and 5 were exposed to .30 mA shock, and Rat 3, to .5 mA shock. Rats 2, 4, and 6 again served as yoked controls.

Animals were then systematically exposed to several changes in body weight, 0% change, 15% increase, and 25% increase. Although the values correspond to 80%, 92%, and 100% of free-feeding weight, the actual deprivation is much greater considering the animals' potential for growth since the start of the study. Responding was studied at each body weight for at least 10 sessions and until no systematic variation in licking and pressing was observed. The order of testing for Rats 1 and 5 was 0% change (80% of body weight), 15% increase, 25% increase, 15% increase, and 0% change (Table 2). For Rat 3, the order of testing was 25% increase, 15% increase, 0% increase, 15% increase, 25% increase, 15% increase, and 0% increase. The change in body weight was accomplished through manipulation of home-cage feeding. Seven to ten days were needed to accomplish the weight changes, during which time the animals were studied in the chambers, but data for transitions are not presented.

RESULTS AND DISCUSSION

Figures 5 and 6 show the mean rate of pressing and licking for each animal in the components associated with signaled and unsignaled shock for each weight condition of Experiment 2. For the signaled-shock condition, white noise was the preshock CS.

As in Experiment 1, there were differences between animals, but the overall pattern of results was consistent. Prior to the introduction of shock, Rat 1 pressed the lever on the average of 15 times per minute and emitted 100 licks per minute in both components (Figure 5). The yoked-control animal, Rat 2, emitted approximately 120 licks per minute (Figure 6, dashed lines).

Introduction of .3 mA shock had relatively little effect on Rat 1's pressing and licking. As body weight was increased by 15% and then by 25%, licking during unsignaled shock for Rat 1 decreased markedly, whereas licking during signaled shock either remained the same or increased slightly. As in the previous experiment, the decrease in licking rates was due to omission of some, and shortening of other, postpellet licking bouts. This differential suppression of licking during signaled and unsignaled shock hardly can be attributed to the increase in body weight, per se, since the yoked-control rat, who similarly was exposed to variations in weight, revealed stable high

Table 2
Order of Percent Body Weight Change in Experiment 2

Rat 1 % of Free-Feeding Weight ¹			Rat 3 % of Free-Feeding Weight			Rat 5 % of Free-Feeding Weight		
% Change	Sessions/Condition		% Change	Sessions/Condition		% Change	Sessions/Condition	
0	80	10	25	100	10	0	80	10
15	92	10	15	92	13	15	92	10
25	100	12	0	80	13	25	100	10
15	92	10	15	92	10	15	92	10
0	80	10	25	100	10	0	80	12
			15	92	10			
			0	80	10			

The free-feeding weight was determined at the start of the study. It is expected that the percentage of free-feeding weight would differ if it were determined from a growth curve.

rates of licking in both components (Figure 6, dashed lines).

The overall rate of lever pressing for Rat 1 declined somewhat in both components when weight was increased by 25%. Reduction in the rate of pressing was greater during unsignaled than during signaled shock (differential suppression). When weight was once more reduced to the 80% level, similar rates of licking and of lever pressing were maintained during signaled and unsignaled shock.

The suppression of pressing for Rat 1 during the CS was less sensitive to changes in weight (Figure 5). For each weight condition, a low rate of responding was maintained during the CS. At 80% weight, for example, the rate of pressing during the CS was much lower than the overall rate of pressing (calculated without CS responses) in the absence of the CS in the signaled shock component, and was also much lower than during preshock periods of the unsignaled-shock component.

Licking for Rat 1 also was suppressed more

during the CS than in its absence (compare licking for each body weight in the upper and lower panels of Figure 6). Licking during the CS was very much affected by body weight. As weight increased by 15 and 25%, licking during the CS decreased.

Data for Rats 3 and 5 are similar, with some differences. Rat 3 revealed differential suppression of overall licking rates at each body weight. Lever-pressing rates, however, were fairly similar for this animal under the 0% change condition. With increases in weight of 15 and 25%, pressing rates in both components were reduced, although pressing was most severely impaired during unsignaled shock. The marked conditioned suppression of licking and pressing for Rat 3 was apparent throughout Experiment 2.

The performance of Rat 5 closely resembled the pattern of responding displayed by Rat 1 (Figures 5 and 6). Differential suppression and conditioned suppression were influenced in the same manner by changes in body weight, but

Fig. 5. Mean rates of lever pressing for each animal during the components associated with signaled and unsignaled shock in Experiment 2. The data points are the means for the final three sessions of each condition.

Fig. 6. Mean rates of licking for each animal during the components associated with signaled and unsignaled shock in Experiment 2. The data points are the means for the final three sessions of each condition.

conditioned suppression of licking and pressing occurred under conditions (80% of body weight, .30 mA shock) that did not yield differential suppression of pressing and licking.

DISCUSSION

Experiments 1 and 2 show that schedule-controlled lever pressing and schedule-induced licking are suppressed more by unsignaled than by signaled shock. This differential suppression of licking and pressing is determined by the intensity of shock (Experiment 1) and by body weight (Experiment 2). Differential suppression occurs when a sufficiently intense shock is introduced or, in the case of relatively mild shock, when the weight is allowed to increase sufficiently.

The findings on shock intensity are consistent with previous studies by Hymowitz (1977a) and others (Seligman & Meyer, 1970). When two classes of behavior, such as lever pressing and licking, are studied simultaneously, a richness in the data emerges that is not apparent when only one response is studied at a time. Differential suppression of one behavior, such as licking, often occurred at parameter values that did not reveal differential suppression of the other behavior, lever pressing. Although this has been reported previously (Hymowitz, 1977b), the present data are more compelling since the use of the yoked-control animals overcomes ambiguities of interpretation in the previous report (Hymowitz, 1977b), and the present studies varied body weight as well as shock intensity.

The fact that one type of behavior is sup-

pressed more during unsignaled than during signaled shock whereas another occurs at comparable rates during both shock conditions emphasizes the need for caution in interpreting the data. Concepts such as "preparation" and "safety" are, perhaps, too "molar" to account fully for these findings. If it is "safe" to press, why is it not "safe" to lick? If the animal is sufficiently "prepared" for the shock, why should pressing rates continue unabated while licking rates are suppressed? What is preferable is a functional analysis of the relation between specific types of behavior and their environmental determinants. In this case, schedule-induced licking and schedule-controlled lever pressing seem to be affected in the same manner by such variables as the signaling of shock, the intensity of shock, and variations in body weight. However, the two classes of behavior differ in the parameter values required to produce comparable changes in rates. Analysis of performance in terms of concepts such as "preparedness," "danger," and "safety," although sufficient at one level of analysis, are incomplete and, perhaps, misleading at another.

Is the behavior that occurs in the presence of the CS (response suppression or "preparation") a major determinant of behavior in the absence of the CS (viz., high rates of pressing and licking)? It seems not. Conditioned suppression (during which animals may "prepare for" or "attend to" the pending shock) occurs at lower shock intensities (Experiment 1) and higher body weights (Experiment 2) than does differential suppression. The occurrence of conditioned suppression is less sensitive to changes in shock intensity or food deprivation

than is differential suppression, although the degree of conditioned suppression was very much influenced by these variables in Experiments 1 and 2. Similarly, conditioned suppression seemed to be relatively independent of the context in which the CS was presented, whereas differential suppression depended very much upon context. Conditioned suppression occurred during the Reversal conditions of Experiment 1 as soon as the CS was presented, even though it was presented in a different component. Differential suppression, on the other hand, did not emerge until the animals had considerable exposure to the stimuli that identified signaled and unsignaled shock components.

These findings favor Seligman's safety-signal hypothesis, although more fine-grained analyses are necessary to explain fully the behavior of the animals during signaled and unsignaled shock. What occurs immediately prior to the delivery of shock does not seem to be a major determinant of what occurs following shock. The occurrence of conditioned suppression is not a reliable predictor of differential suppression, and the two forms of suppression need not be affected in the same manner by the same experimental manipulation. Animals may very well "prepare" for impending shock, and, under other conditions, select the experimental conditions which provide information about impending shock (Marlin, Sullivan, Berk, & Miller, 1979). However, such preparation need not bear critically upon the occurrence of high rates of responding in the absence of the CS. Rather, the latter depends upon discriminability of shock-free time, intensity of the shock, body weight, and the class of behavior under study. The data may be more properly understood in terms of control over rate of responding by stimuli (preshock stimulus, correlated stimulus) associated with presence and absence of shock and their interaction with the parameters of food and shock delivery, body weight, and the nature of the response. Terms such as "preparation" and "safety" may be unnecessary, if not misleading, and the suppression of responding may be adequately explained by basic principles of conditioning and learning already available (see Fanselow, 1980, for an analysis of the literature on preference for signaled over unsignaled shock in terms of basic principles of aversive conditioning). Although additional research may reveal some

influence of preshock variables such as "preparation" on response rates in the absence of the preshock stimulus, the role of those variables probably will be relatively minor when compared with the powerful influence of stimuli associated with shock and shock-free time.

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