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THE VARIED EFFECTS OF PUNISHMENT ON BEHAVIOR

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The punishment procedure is one in which an aversive stimulus is contingent upon the occurrence of a response. Various theories of the mechanism through which punishment exerts its influence on behavior emphasize the unconditioned fear response, the unconditioned skeletal response, the escape response, the similarity between the conditions of punishment and the conditions of training, the correlation of response and punishment, and the possible sources of reinforcement for nonresponse. The major problem of this paper was to determine whether any of the proposed mechanisms, or a combination of them, are sufficient to account for the varied effects of punishment on behavior. A systematic examination of the data led to the conclusions that if an aversive stimulus is contingent upon a response there will be greater suppression (or less facilitation) of the response than if the aversive stimulus is not contingent upon the response, but that the aversive stimulus, itself, may result in response facilitation under some conditions and response suppression in others.

In 1913, Thorndike presented the view that both reward and punishment had simple and clearly predictable effects. He wrote, "When a modifiable connection between a situation and a response is made and is accompanied or followed by a satisfying state of affairs, that connection's strength is increased: When made and accompanied or followed by an annoying state of affairs, its strength is decreased [Thorndike, 1913, p. 4]." With respect to reward, his position remained essentially unchanged in his later writings and it is the dominant position today. With respect to punishment, however, Thorndike (1932) was confronted with numerous instances in which punishment did not weaken the strength of a response. Thus he reported, "Rewarding a connection always strengthened it substantially; punishing it weakened it little or not at all [p. 58]." Considerable uncertainty remains today regarding the effect of punishment and there does not appear to be any single reliable effect. Much experimental evidence indicates that punishment decreases the probability of occurrence of a response or increases its latency, but there is also much conflicting evidence. In some experiments punishment has only a temporary suppressing effect on a response, or none at all, and in other experiments punishment actually has the paradoxical effect of increasing the strength of the response it follows. The purpose of this paper is to describe the conditions under which the various effects of punishment are observed with the hope that a systematic organization of the data may lead to increased theoretical understanding of the phenomenon.

DEFINITION OF A PUNISHMENT

It is far less difficult to define the punishment procedure than it is to define a punishment. The punishment procedure is one in which a noxious stimulus is contingent upon the occurrence of a response, but the definition of the key concept, "noxious stimulus," presents serious problems. (In this paper the terms "noxious stimulus" and "aversive stimulus" will be used interchangeably, and such a stimulus will be called a "punishment" if it is contingent upon a response.) In most experiments on the effects of punishment, the subject is administered an electric shock of some intensity and of brief duration immediately following or accompanying a specified response. At low intensities it is meaningful to ask whether or not the electric shock was aversive.

Mowrer (1947) defined a punishment as "a relatively sudden and painful increase of stimulation following the performance of some act [p. 136]," but neither the specification of the aversive stimulus in physical nor in subjective terms has led to precision. Most definitions of a noxious stimulus involve some reference to behavior, unconditioned or conditioned. The aversive quality of a stimulus can be defined and scaled in terms of the effect of its presentation on certain unconditioned autonomic or skeletal responses. The former would be particularly relevant if "fear" were critical to the punishment procedure; the latter would be particularly relevant if "competing responses" were critical to the punishment procedure.

In the case of definitions of a noxious stimulus in terms of response-contingent procedures, logically, there are four alternatives. The effect of a response can be to remove a stimulus or prolong its absence, or it can be to produce a stimulus or prolong its presence. In the case of noxious stimuli, the first three procedures are called escape, avoidance, and punishment, respectively. The fourth procedure has no commonly accepted name, so it will be called the "preservation procedure." (*a*) The escape procedure is one in which the noxious stimulus is present and the response terminates it, (*b*) the avoidance procedure is one in which the noxious stimulus is absent and the response prolongs its absence, (*c*) the punishment procedure is one in which the noxious stimulus is absent and the response produces it, and (*d*) the preservation procedure is one in which the noxious stimulus is present and the response prolongs its presence. The noxious stimulus can be defined in terms of any of these procedures.

Thorndike (1913) defined the noxious stimulus in terms of both the escape and the preservation operations. He described the punishment procedure as one in which a modifiable connection between a situation and a response is accompanied or followed by an annoying state of affairs, and an annoying state of affairs as "one which the animal does nothing to preserve, often doing things which put an end to it [p. 2]." Several recent theoretical treatments of punishment have employed the escape operation as the basis for the definition of a noxious stimulus (Dinsmoor, 1954; Skinner, 1953). Why have not psychologists chosen to say a stimulus is a punishment if it suppresses behavior? There are no logical grounds for defining a noxious stimulus in terms of the escape operation rather than in terms of the punishment operation, but it appears at the present time that the effects of the escape operation are far more reliable than those of the punishment operation. Because of the apparently varied effects of punishment, some indirect definition of the noxious stimulus used in the punishment situation is currently favored by most psychologists in their theoretical remarks.

In practice, however, very few experimenters have taken seriously the empirical definition of noxious stimulus in terms of the escape operation, and thus they have not actually determined whether or not their punishing stimulus would really lead to escape learning. In some cases the punishing stimulus is obviously sufficient to produce escape learning. For example, in one experiment a rat could terminate a punishment only by performing a specific escape response (Kamin, 1959, Experiment I). In many cases it is not clear whether or not the punishing stimulus would have produced escape learning, whereas in other cases the punishing stimulus was selected to be nonescapable, e.g., the punishment of less than 100-millisecond duration used on pigeons by Azrin (1960). It is doubtful that a pigeon could learn to escape from shocks of such brief duration although, by other definitions, the stimuli could be considered noxious.

The use of the single concept of noxious stimulus to embrace the procedures of aversive classical conditioning, escape training, avoidance training, punishment, and preservation may be a costly parsimony. In a particular situation there will be a measurable threshold of intensity of the punishment necessary to obtain some response suppression. Is this also the threshold of fear? Is it the weakest aversive stimulus that will elicit competing responses? Is it the threshold for escape or for avoidance? Further empirical work must be done to establish the relationship between the effect of variations in the physical dimensions of the aversive stimulus in the punishment procedure on some measure of punished behavior and the effect of similar variations of the aversive stimulus on behavior in other negative reinforcement procedures. This could lead to important statements regarding the conditions under which a stimulus will serve as an effective punishment. Of course, the effectiveness of of a punishment may depend on numerous factors other than the severity of the stimulus, e.g., the effortfulness of the response, the amount and kind of previous training, the drive level, the probability that the noxious stimulus and the positive reinforcement will follow the response. Similarly, there are many factors other than the severity of the stimulus that determine the effectiveness of the procedures of aversive classical conditioning, preservation, escape training, and avoidance training. For these reasons, no indirect definition of a noxious stimulus can be made with confidence. Therefore, in this paper, the punishment procedure will refer to response-contingent presentation of stimuli that vary tremendously in severity.

We have found it useful to distinguish between two types of training conditions and two types of extinction conditions as follows: (*a*) regular-training (or, training) refers to a procedure in which positive reinforcement is contingent upon a response; (*b*) punishment-training refers to a procedure in which both positive reinforcement and an aversive stimulus are contingent upon a response; (*c*) punishment-extinction refers to a procedure in which an aversive stimulus is contingent upon a response; and (*d*) regular-extinction (or, extinction) refers to a procedure in which neither positive reinforcement nor an aversive stimulus is contingent upon a response.

Finally, we have found it useful to differentiate between training based on positive reinforcement (positive instrumental responses) and that based on negative reinforcement (escape and avoidance responses).

THEORIES OF PUNISHMENT

Before making a detailed consideration of the effects of punishment on behavior, it may be useful to consider the possible mechanisms through which this procedure may be effective. Consider a rat that has learned to press a lever for food reinforcement when an auditory stimulus occurs. On the first trial of punishment-training, the auditory stimulus came on, the rat moved toward the lever and pressed it, and an electric shock began. The rat squeaked and jumped back, the shock and the auditory stimulus terminated, and the rat ate the food. Later in punishment-training, the auditory stimulus came on, the rat moved toward the lever but it did not press it. Why did the rat change its behavior after the introduction of the punishment?

On the first trial of punishment-training the following events occurred: There was a discriminative stimulus under the control of the experimenter and response-produced stimuli under the control of the subject. These were followed by a lever response that was followed by punishment. The onset of the punishment was followed by emotional and skeletal responses that were followed by the termination of the punishment. Which of these events were necessary to produce the observed change in behavior?

Theories Not Necessarily Involving the Correlation of the Response and Punishment

In the punishment procedure the response always intervenes between the discriminative stimulus and the punishment, but is this response of any consequence? Empirically, the problem is to compare the performance of an experimental group under the punishment procedure and that of a control group receiving the same sequence of discriminative stimuli and punishments, but uncorrelated with their responses. If the two groups are similar in their performance, then some theory not involving the correlation of response and punishment will be required to account for the effects of punishment. Four suggestions have been offered to explain the effects of punishment that do not require a correlation of the response and punishment. All four mechanisms can account for either response facilitation or response suppression under conditions of punishment. The *fear hypothesis* emphasizes the emotional responses elicited by the punishment; the *competing response hypothesis* emphasizes the skeletal responses elicited by the punishment; the *escape hypothesis* emphasizes the responses which occur shortly before termination of the punishment. Any of these responses (emotional, skeletal, or escape) may be postulated to be produced by discriminative stimuli under the control of the experimenter. If appeal is made to response-produced stimuli, e.g., the exteroceptive and interoceptive cues of anticipatory responding, then the effect of punishment will be a function of its correlation with the response. The final suggestion of a theoretical mechanism which does not require a correlation between response and punishment is the *discrimination hypothesis* which emphasizes the similarity between the conditions of punishment and the conditions of training.

The fear hypothesis. Some psychologists would emphasize the importance of the unconditioned fear response elicited by the punishment that, by the principles of classical conditioning, may occur to the discriminative stimuli or to the response-produced stimuli. For example, Estes (1944) wrote,

> It is clear, then, that a disturbing or traumatic stimulus arouses a changed state of the organism of the sort commonly termed "emotional" and that any stimulus present simultaneously with the disturbing stimulus becomes a conditioned stimulus capable of itself arousing the state on subsequent occasions [p. 36].

If an aversive stimulus is administered to the subject in a particular stimulus situation it may depress its rate of response for positive reinforcement in the presence of that situation (Estes & Skinner, 1941). But there are many instances in which fear increases response strength. For example, the rate of avoidance responding may be increased by the presentation of a stimulus associated with an aversive stimulus (Sidman, Herrnstein, & Conrad, 1957).

The competing response hypothesis. Some psychologists would emphasize the importance of the unconditioned skeletal responses elicited by the punishment that, by the principles of classical conditioning, may occur to the discriminative stimuli or to the response-produced stimuli. For example, Guthrie (1935) wrote, "Punishment achieves its effects . . . by forcing the animal or the child to do something different [p. 158]" and "To train a dog to jump through a hoop, the effectiveness of punishment depends on where it is applied, front or rear [p. 160]." Thus if the responses elicited by the aversive stimulus are incompatible with the punished act, punishment will suppress the act; but if the responses elicited by the aversive stimulus are similar to the punished act, punishment may facilitate the act.

The escape hypothesis. Some psychologists would emphasize the importance of the response that resulted in escape from punishment that, by the principle of generalization, may occur to the discriminative stimuli or to the response-produced stimuli. As Gwinn (1949) has written, "if the response to the punishing stimulus is compatible with the punished act, punishment will facilitate rather than inhibit an act motivated by fear [p. 260]." Although, in the example given, the unconditioned skeletal response elicited by the onset of the punishment was also the escape response, this need not generally be true. If the punishment is of fixed duration of several seconds, the subject may be adventitiously reinforced for a particular response; in other cases a particular escape response may be required to terminate the punishment.

The discrimination hypothesis. Some psychologists would emphasize the similarity between the conditions of punishment and the conditions of training. With the discrimination hypothesis, the aversive stimulus of the punishment procedure is considered as a response-produced cue with the same functions as nonaversive stimuli following a response. If punishment reinstates a condition of training it may facilitate the response; if punishment results in a change from the conditions of training a generalization decrement should be observed. Holz and Azrin (1962) have written, "Whenever punishment is differentially associated with reinforcement, a discriminative property will probably influence the effectiveness of the punishment." If punishment is correlated with positive reinforcement, response rate may be increased; if it is correlated with nonreinforcement, response rate may decrease.

Theories Necessarily Involving the Correlation of Response and Punishment

The theories described above all assume that the correlation between response and punishment may be irrelevant for the effect of punishment on behavior. Whenever the effect of a response-contingent noxious stimulus and a response-independent noxious stimulus are empirically shown to be identical, recourse must be made to one of these theories. In most cases, however, the performance under conditions of response-contingent punishment is radically different from that under response-independent aversive stimulation. For these cases, two theoretical mechanisms have been proposed, both of which account for response suppression (but not facilitation) under conditions of punishment.

The suppression hypothesis. Some psychologists would emphasize the correlation between the instrumental response and punishment, and postulate some form of inhibition for responding in the punishment situation. Thorndike's (1913) original statement of the law of effect involved suppression by punishment. He wrote, "When a modifiable connection between a situation and a response is made . . . and accompanied or followed by an annoying state of affairs, its strength is decreased [p. 4]."

The avoidance hypothesis. Some psychologists, also emphasizing the correlation between the instrumental response and punishment, reject the notion that punishment decreases response strength. Instead of postulating some form of inhibition for responding in the punishment situation, they postulate some form of reinforcement for not responding in the punishment situation. Mowrer (1947), for example, wrote:

> The performance of any given act normally produces kinesthetic (and often visual, auditory, and tactual) stimuli which are perceptible to the performer of the act. If these stimuli are followed a few times by a noxious ('unconditioned') stimulus, they will soon acquire the capacity to produce the emotion of fear. When, therefore, on subsequent occasions the subject starts to perform the previously punished act, the resulting self-stimulation will arouse fear; and the most effective way of eliminating this fear is for the subject to stop the activity which is producing the fear-producing stimuli [p. 136].

The application of the avoidance hypothesis usually involves (*a*) a classical conditioning process involving experimenter-controlled stimuli or subject-produced stimuli in association with punishment and (*b*) an instrumental learning process involving some kind of reinforcement for a nonresponse. This may be reduction or termination of experimenter-controlled stimuli, of subject-produced stimuli, of fear, or of expectation of punishment. The latter three sources of reinforcement are currently indistinguishable.

No major theorist has relied exclusively upon a single explanation of the effects of punishment. The treatment of punishment by Estes (1944) is usually associated with the fear hypothesis, that of Guthrie (1935) with the competing response hypothesis, that of Mowrer (1960) with the avoidance hypothesis, etc., but all of them have used more than one mechanism to account for the observed phenomena of punishment. Even Dinsmoor (1955), in an attempt to interpret as many of the effects of punishment as possible in terms of the avoidance hypothesis, found it necessary to rely upon (*a*) the competing response hypothesis to account for Estes' (1944, Experiment I) finding of an equal effect of response-contingent and response-independent aversive stimuli, (*b*) the escape hypothesis to account for Gwinn's (1949) and Whiteis' (1955) finding that punishment increased the resistance to extinction of acts motivated by fear, and (*c*) the discrimination hypothesis and the fear hypothesis to account for Muenzinger's (1934) finding of faster learning in a visual discrimination task if subjects were punished for correct responses than if they were not punished. Although it has not been possible to deal with all of the phenomena of the punishment procedure with the use of only one of the theories listed above, it may be possible to account for the data with fewer than all of them. Hopefully, an examination of the data will lead to a new synthesis.

CONTIGUITY BETWEEN RESPONSE AND PUNISHMENT

Many psychologists believe that, to be effective, a punishment must be presented almost immediately after the act. For example, Watson (1924) wrote, "The idea that a child's future bad behavior will be prevented by giving him a licking in the evening for something he did in the morning is ridiculous [p. 183]," but he defended the efficacy of mild punishment, "provided the child is caught in the act and the parent can administer the rap at once in a thoroughly objective way." In his influential monograph on punishment, Estes (1944) challenged this position. He suggested that, in many instances, the effect of punishment can be explained in terms of the general emotionalizing effect of the aversive stimulus, rather than in terms of the correlation between the aversive stimulus and any particular response. Our understanding of the manner in which punishment affects behavior is considerably enhanced by evidence regarding the relevance of the correlation between the response and punishment.

Contingent versus Noncontingent Procedures

One approach to the problem of the relevance of the correlation between the aversive stimulus and the response involves a comparison of the performance of experimental subjects punished for a particular response and the performance of control subjects that receive the same aversive stimuli uncorrelated with the response. If the performance of the experimental and control subjects is similar, then some theory not involving the correlation of response and punishment will be required to account for the effects of punishment.

In one experiment (Estes, 1944, Experiment B) rats were trained to press a lever on a 1-minute variable interval schedule of reinforcement. The subjects with a 10-minute session of punishment-extinction, in which each lever-press response was followed by a brief "severe" shock, showed suppression of the response relative to those with a 10-minute session of regular extinction. In another experiment (Estes, 1944, Experiment I), after training on the 1-minute variable interval schedule of reinforcement, rats either received a 10-minute session of regular extinction or a 10-minute session with shocks administered at intervals of about 30 seconds, but not during or immediately following a lever-press response. Again, the group receiving shock showed significantly more suppression of the leverpress response than the group receiving the regular-extinction procedure, but the important observation was that the performance of the two groups receiving shocks was similar. The data are not sufficient to say that the performance under response contingent punishment was exactly the same as under response-independent aversive stimulation, but the degree of suppression of response rate was certainly of the same order of magnitude. These results led a number of investigators to design experiments to determine whether the correlation between response and noxious stimulus is relevant to the suppression often found in punishment situations.

Hunt and Brady (1955) performed an important experiment that demonstrated some of the differences between the contingent and noncontingent procedures. They trained rats to press a lever on a 1-minute variable interval schedule of reinforcement during a number of 12-minute sessions, and then assigned the subjects to two kinds of groups. In the case of the subjects in the Punishment group, all responses during a 3-minute CS were punished with a 1.5 milliampere shock; in the case of the subjects in the CER group, no responses during the CS were punished but there were two momentary 1.5 milliampere shocks at the time of CS termination. These conditioning sessions were interspersed with adaptation sessions in which no CS or shock was used, and they were followed by 10 days of regular extinction. The results showed almost complete suppression in response rate during the CS for the Punishment group, in which the shocks were contingent on the response, and for the CER group, in which the shocks were contingent upon the stimulus. There were, however, a number of reliable differences between the treatments: (*a*) the amount of suppression during the adaptation days (in the absence of the CS) was greater for the CER group than for the Punishment group, (*b*) the resistance to extinction was considerably greater for the CER group than for the Punishment group, and (*c*) the behavior of rats in the two groups was radically different. In the CER group the dominant response pattern was crouching, freezing, and defecating; in the Punishment group the dominant response pattern was abortive leverpressing. These results are similar to those of the earlier study by these investigators (Hunt & Brady, 1951).

Azrin (1956) also demonstrated differences between a situation in which the aversive stimulus was contingent upon a response and a situation in which the aversive stimulus was not contingent upon the response. He trained pigeons on a 3-minute variable interval schedule of reinforcement and then alternated an orange and a blue light on the response key every 2 minutes. In the presence of a blue light on the key there was a continuation of the reinforcement procedure; in the presence of an orange light on the key there was the addition of a punishment procedure. The punishment was 600 volt ac for .5 second through 120,000 ohms in series with a grid. The noxious stimulus was either contingent upon a response (scheduled to follow the first response after a fixed or variable length of time after the onset of the orange light) or it was not contingent upon the response (scheduled to occur a fixed or variable length of time after the onset of the orange light). The results indicated that, both in the case of the fixed and variable interval, the response rate was dramatically lower in the case of the contingent than in the noncontingent situation.

Both the studies of Azrin (1956) and Hunt and Brady (1955) demonstrate that the contingency between response and punishment is a relevant dimension of the punishment situation. The results of these studies suggest that the contingent punishment procedure, relative to the noncontingent procedure, produces (*a*) greater suppression of the punished response, (*b*) less suppression of other responses, and (*c*) less resistance to extinction. Further comparisons of the contingent and noncontingent procedures should be made. Based on the data from Hunt and Brady (1955) and Azrin (1956), the amount of suppression should be greater for the contingent group, especially at low levels of punishment intensity. If the level of shock intensity were sufficiently high, both the contingent and noncontingent groups may hardly respond at all, but at lower levels of shock intensity, the groups may be more easily differentiated. In a parametric investigation of shock intensity in CER, Annau and Kamin (1961) noted that a level of shock insufficient to produce CER (.28 milliampere) was sufficient to produce a punishment effect. Presumably at such low levels of punishment intensity, the most striking differences between the contingent and noncontingent procedures are to be found.

None of the previous studies comparing the effect of contingent and noncontingent shocks on response rate have equalized the number and temporal distribution of shocks received by the two groups, although the investigators have believed that it is improbable that the differences observed were a result of this confounding variable. Unfortunately, the use of a matched (yoked) control procedure to equalize the number and temporal distribution of the shocks received by subjects under the contingent and noncontingent procedures could lead to serious errors. Consider an experiment in which subjects that have been trained to press a lever are paired on some basis and one of the two members of each pair is randomly selected as the experimental subject with the other member of the pair as its matched control subject. An aversive stimulus then can be delivered to both experimental and control subjects immediately following each response by the experimental subject. As a result a control subject receives the same aversive stimuli as its matched experimental subject but the aversive stimuli are presented to it in a way not necessarily correlated with the response. The problem is that a reliable difference between the experimental and control groups could emerge even if the temporal relationship between response and punishment were irrelevant, assuming only that there are individual differences in the effectiveness of the shock in suppressing behavior. Typically, reliable individual differences may be demonstrated between a pair of subjects, so that either the experimental subject or its matched control subject will be more affected by the aversive stimulus. At levels of shock intensity that result in total suppression after a few applications, if the control subject is more affected than the experimental subject, the control subject will stop responding first and the experimental subject will continue to respond a few more times until it has produced enough additional aversive stimuli to suppress its own response. If the experimental subject is more affected than the control subject, however, the experimental subject will stop responding first, and the control subject will continue to respond *indefinitely* since the experimental subject is delivering no additional shocks to it. A statistical test that did not take into consideration the magnitude of the difference, e.g., the sign test, would meet this objection but it would require the unreasonable assumption that the effectiveness of the punishment is constant in time for a given subject.

Lichtenstein (1950) has demonstrated that long-lasting feeding inhibitions may be developed in dogs by punishing the act of eating. Ten dogs were first trained to eat pellets in a stock, and then they were punished for eating. Under this treatment food was presented to the dog and, if it began to eat, an 85-volt ac electric shock of 2-second duration was administered to its foreleg. These subjects inhibited the act of eating after a mean of 1.7 shocks, and they did not eat again in the stock on three subsequent days of 20 trials per day. Three other dogs that received the aversive stimulation when the food was presented (i.e., before they began to eat) did not form a feeding inhibition. Apparently, the feeding inhibition was considerably more pronounced if the shock was administered simultaneously with the response than if it was administered immediately after the presentation of the food. In the latter case, the animal may be afraid of the food, but it is not afraid to eat it. Masserman (1943) has described similar feeding inhibitions in cats that received a brief air blast or electric shock at the moment of eating. Most of the cats refused to eat in the apparatus for months without further punishment, despite the fact that they were severely deprived of food. Using the Lashley jumping apparatus, Klee (1944) has found that a rat may starve to death rather than respond in an insoluable problem which results in food reward on half the trials and punishment on the other half.

Delay of Punishment Gradient

In a direct comparison between the contingent and noncontingent procedures, the aversive stimulus either occurs immediately after the response or it is unrelated to the response. If the contiguity between response and punishment is a parameter of consequence, then there should be a delay of punishment gradient. Such a gradient has been found in a Y maze by Warden and Diamond (1931), but not by Bevan and Dukes (1955). It has also been found in a lever box by Sidman (1953), and in a shuttlebox by Kamin (1959) and by Coons and Miller (1960).

In Kamin's experiment, rats were given standard avoidance training in which the subject could avoid a shock of 1.1 milliamperes by moving to the other half of a shuttlebox within a 10-second CS–US interval, or it could escape from the shock by moving to the other half of the shuttlebox after the shock had gone on. After the subject met the acquisition criterion of 11 consecutive avoidance responses, a punishment-extinction procedure was begun in which shock was administered *only* if the subject moved to the other side of the shuttlebox in the 10-second CS–US interval. During the punishment-extinction period, there was a delay of punishment of 0, 10, 20, 30, or 40 seconds, and a control group that received no punishment for responses during extinction. The results showed a delay of punishment gradient, with the number of responses to extinction positively related to the temporal interval between response and punishment. Kamin notes, however, that the number of responses to extinction was considerably greater in the unpunished control group than in the group with 40-second delay and considers this supportive of the generalized emotional effect of shock that was only remotely contingent. Although it must be recognized that shock, per se, whether or not it is associated with a particular response will have clearly measurable effects, Kamin's results (1959) demonstrate that the temporal relationship of the punishment to the response is a relevant parameter.

The CS–US Interval in Punishment Training

Normally, in the punishment situation the aversive stimulus is applied immediately after the response. There are some studies of punishment, however, that more closely resemble the avoidance procedure by using a fixed CS–US interval. In these studies punishment is applied a given number of seconds after the stimulus, if a particular response occurs (Bixenstein, 1956; Mowrer & Ullman, 1945). In the Mowrer and Ullman study, for example, rats were trained to go to a food cup and eat during a 3-second buzzer. During punishment-training, a 2-second shock was administered to a subject if it made the response of eating the food during the 3-second buzzer. (They were free to eat the food after this time.) The punishment for the response occurred 3 seconds, 6 seconds, or 12 seconds after the onset of the buzzer for the three groups. The results of this experiment showed that the percentage of trials in which the subjects waited throughout the 3-second period was inversely related to the CS–US interval. This experiment, presumably, can be interpreted in a manner similar to delay of punishment studies, e.g., the greater the interval between response and punishment, the less effective the punishment for the suppression of the response.

Selective Punishment of a Quantitative Dimension of a Response

In all of the studies considered so far, there has been a single measured response that would, under certain conditions, be followed by punishment. Now, we must consider cases of punishment of selective learning in which there are two or more measured responses. Logan (1960) has reported a number of experiments in which punishment was correlated with the speed characteristic of a response. Rats were trained to run down a 4-foot alley and then the final 1 foot was electrified for 150 milliseconds when the rat crossed it. Although there was no increase in speed when punishment was differentially applied to slow responding, there was a decrease in speed when punishment was differentially applied to fast responding.

Selective Punishment of a Qualitative Characteristic of a Response

In a two-choice situation, if one response results in food reward for a hungry rat (the "right" response) and the other response does not (the "wrong" response), the evidence is overwhelming that punishment for the wrong response results in facilitation of the response differentiation. The early work with the discrimination box by Hoge and Stocking (1912) and Warden and Aylesworth (1927) clearly indicated that the rate of learning is greater if nonreward and a brief punishment follow the wrong response than if merely nonreward follows the wrong response. Muenzinger's (1934) experiment may be taken as a model for this kind of finding. He trained rats in a T-shaped discrimination box to run to a black or white card that was first visible from the choice point. Fifteen subjects were trained under a correction procedure with 75-millisecond pulses of a constant current of 0.15-milliampere dc for the wrong choice; 15 other subjects were trained under the same conditions, but no punishment. In 100 trials of training, the group that was punished for wrong responses had a mean of 10.8 errors; the group that was not punished had a mean of 30.0 errors ($p < .01$). Further evidence that punishment of incorrect responses under a correction procedure increases the speed of learning of a visual discrimination habit is given by Muenzinger, Bernstone, and Richards (1938) and by Muenzinger and Powloski (1951). Punishment for incorrect responses in a visual discrimination habit under the noncorrection procedure also produces faster learning than no punishment (Muenzinger, Brown, Crow,

& Powloski, 1952; Muenzinger & Powloski, 1951; Wischner, 1947; Wischner, Fowler, & Kushnick, 1963). Although Fairlie (1937) found that shock at the "moment of choice" for wrong responses did not facilitate learning, and Drew (1938) found that subjects with no punishment made fewer errors than subjects receiving punishment for wrong responses, there are few exceptions to the general statement that punishment for the incorrect response results in faster learning. There is also some evidence that punishment may lead to faster reversal learning in a two-choice situation (Whiting & Mowrer, 1943).

In conclusion, it appears that both psychologists who emphasize the correlation between response and punishment and those who emphasize the general emotionalizing effect of punishment are correct. If an aversive stimulus is contingent upon the occurrence of a response it will be more effective than if it is not contingent upon the response. Nonetheless, the mere presentation of stimuli associated with an aversive stimulus may serve to suppress responding. No adequate theory of punishment can fail to take account of both observations, although it would seem to be of particular importance to understand why the contingent procedure is more effective than the noncontingent procedure.

Punishment of Positive Instrumental Responses

Although punishment contiguous with a response is more effective than equivalent aversive stimulation administered independently of the response, punishment may not be an effective technique for reducing the strength of a response. Most psychotherapists do not use punishment techniques to eliminate the undesirable behavior of their patients and, in fact, they typically act in a notably permissive manner. Boardman (1962), however, describes the case of a 5-year-old boy with a severe behavior disorder who was effectively treated by a short period of punishment. The boy's symptoms included running away from school, lying, stealing, walking on the roof of his house, riding his bicycle on a busy street, setting fires, and destroying property. On instructions from the therapist, the boy's parents severely punished him for such misbehavior. When such behavior appeared they would immediately punish him by spanking him, refusing him meals, calling off his birthday party and presents, locking him in his room, and even locking him out of the house. Within a week of this treatment the major symptoms of this patient were eliminated, and they did not recur during the next 11 months. In comments on this paper, Bandura (1962) expressed concern that the punishment technique would have undesirable side-effects, e.g., that the parents would serve as models for aggression, that the child would avoid his parents, that some of the child's methods of avoiding the punishment might be undesirable, or that the punishment might increase his aggressive responses. Miller (1962) described various bases for the apparent success of the treatment, e.g., punishment helped the boy atone for his guilt, and the treatment resulted in his getting more attention from his parents. He predicted that the punishment treatment would have only temporary effect.

Because of the difficulty of evaluating the success of the punishment technique in the clinical situation, we will examine the effect of experimental studies of punishment, most of which used rats as the subjects and electric shock as punishment. There are many studies in which the subject is trained to perform some positive instrumental response, to run to the end of an alley or to press a lever for food reward, and then after training has progressed to some point, responses are punished as well as reinforced. This procedure establishes an approach-avoidance conflict, extensively analyzed by Miller (1959). There is some evidence that an animal will learn to make a response to terminate such a conflict situation (Hearst & Sidman, 1961). The most reliable effect in experiments comparing the punishment-training procedure with the regular-training procedure is a suppression of response under conditions of punishment.

A number of different aversive stimuli have been used in studies of punishment to suppress behavior, such as a slap from a lever (Skinner, 1938), a bump on the nose and a fall into a net (Maier, 1949), a loud noise (Carlsmith, 1961), a toy snake (Masserman & Pechtel, 1953), and a swat with a rolled-up piece of newspaper (Stanley & Elliot, 1962). Nonetheless, electric shock has been employed as the aversive stimulus in most studies of punishment, and the characteristics of this punishing stimulus are particularly easy to measure and control. Electrodes firmly attached to the subject, either on the surface of the skin or in some internal tissue allow even more exact control of the parameters of the punishing stimulus than the typical grid electrodes.

Of course, the intensity of the noxious stimulus employed in the punishment experiment is a critical factor in its effect on behavior. As the intensity of the punishment is increased, the following phenomena often emerge: (*a*) *detection*: the punishment has no influence on the response, although it is sufficiently intense to be used as a cue; (*b*) *temporary suppression*: the punishment results in a temporary suppression of the response, followed by complete recovery; (*c*) *partial suppression*: the punishment results in a suppression of the response, without complete recovery; (*d*) *total suppression*: the punishment results in complete suppression of the response, without recovery. Other dimensions of the noxious stimulus have been less thoroughly studied than intensity, but they may be equally as important. Campbell and Teghtsoonian (1958) have described some of the consequences of variations of frequency and source impedance when external electrodes are used. Finally, duration may be particularly critical. If the punishment is of brief duration, the coulomb may be a more accurate reflection than the ampere of its efficacy as a suppressor of behavior. If the punishment is of longer duration, responses that happen to occur at the time of shock termination may become adventitiously reinforced.

Response Suppression as a Function of Punishment Intensity

A recent study by Karsh (1962) may be taken as representative of studies indicating the degree of suppression is a monotonically increasing function of the level of intensity of the punishment. In Experiment I rats were trained to run to the goal section of an 8-foot alley for food reinforcement during the first 75 trials. Then each subject received one trial per day for 40 days with both food and shock at the goal. The levels of shock intensity for the various groups were 0, 75, 150, 300, and 600 volts ac for 100 milliseconds administered through 250,000 ohms resistance in series with the rat. The subjects receiving 75-volt punishment were similar to control subjects, and they showed no clear change in speed of running down the alley. The subjects with 300- and 600-volt punishments showed complete cessation of running within a few trials. Perhaps the most interesting group in this experiment was the 150-volt punishment group which, unlike the lower shock groups, slowed down, but unlike the groups with the higher shocks, did not cease to respond.

Several experiments by Azrin (1959, 1960, 1961), Holz, Azrin, and Ulrich (1963), and Azrin, Holz, and Hake (1963) using pigeons in a Skinner box have also demonstrated that the intensity of the punishment is an important variable determining the amount of suppression of a response. The procedure used was to train pigeons in a positive instrumental response of pecking a key under some schedule of reinforcement, and then to punish every response at some level of shock intensity. The shock was a variable ac voltage administered for durations usually less than 100 milliseconds through a fixed resistor into electrodes implanted in the subject's back. A large number of sessions were run under various levels of shock intensity, including 0, either in ascending order of intensities or in a mixed order. When a subject received extremely mild punishment, e.g., 10 volts, there was no apparent change in its behavior relative to its performance with no punishment; when a subject received extremely intense punishment, e.g., 130 volts for durations somewhat longer than 100 milliseconds, complete suppression of response was obtained. At intermediate levels of shock intensity, e.g., 80 volts, the subject reduced its rate of response, but it did not cease to respond.

Despite radical differences between their procedures, both Karsh and Azrin found intensities of punishment that were ineffective, partially suppressive, and totally suppressive. Other experimenters have also obtained greater suppression as a function of increased intensity of the punishment (Dinsmoor, 1952; Estes, 1944).

Fowler (1959), in an extensive parametric investigation, found that a mild punishment of short duration administered to a rat at the moment it touches the food can increase individual differences in running speed in an alley without affecting the average speed of a group. He presented evidence that whether a particular subject increased or decreased its speed as a function of punishment depended upon whether the skeletal response elicited by the aversive stimulus was compatible or incompatible with the instrumental response. Despite the difficulty in distinguishing between compatible and incompatible elicited responses, Fowler's observations provide some of the best evidence in support of the competing response hypothesis, at least for situations involving punishments of brief duration.

Response Suppression as a Function of Proximity to the Punishment

A response suppression gradient has been frequently reported in both the case of punishment of positively reinforced responses in the alley and in the Skinner box. For example, the speed of running is slower as the subject approaches the goal box (Karsh, 1962) and its strength of pull away from a punished goal is greater the nearer the subject is to the goal (Brown, 1948). In the case of responding on a fixed interval schedule of punishment, the rate of responding decreased to almost 0 close to the temporal point when punishment was to be received and, as a result, the subjects received few punishments (Azrin, 1956). The degree of response suppression is a direct function of the proportion of the responses that result in punishment, so that intensities of punishment that are effective if they typically follow a response may be ineffective if they only occasionally follow a response (Azrin, Holz, & Hake, 1963).

Response Suppression as a Function of the Strength of the Punished Response

In general, it may be supposed that the amount of suppression of a response is inversely related to its strength. Postman (1947) described the evidence available at the time that responses of weak strength are more liable to disruption by punishment. Estes (1944, Experiment F) is consistent with this interpretation. Miller (1959) proposed that the factors that increased the excitatory strength of the positive response would serve to decrease the effectiveness of punishment. Thus the amount of suppression would be decreased by increase in drive level, decrease in delay of reward, increase in amount of reward, and increase in number of trials of training. The data of Bower and Miller (1960) support the notion that increasing the amount of reward increases the subjects' resistance to punishment, but the data on the effect of number of trials of training were not at all in the expected direction. Miller (1960) and Karsh (1962) found that overtraining increased, rather than decreased, the effect of punishment.

Response Suppression as a Function of Prior Exposure to Punishment

The effect of the intensity of the punishment, specified in physical terms, may be influenced by the amount and type of prior exposure to punishment that the subject has previously experienced. Therefore, the independent groups design utilized by Karsh (1962) in the study of the effect of intensity of punishment is useful in eliminating the variable to prior exposure. In the absence of data, one might speculate either that prior exposure to shock would serve to increase the resistance of a rat to later disruption by shock (adaptation) or one might expect that such exposure would make the rat emotional and serve to decrease its resistance to later disruption by shock (sensitization). The data consistently support the adaptation hypothesis.

Miller (1960) investigated this problem by training rats to run down an alley for food reinforcement for 150 trials and then subjecting them to a punishing shock of 335 volts through 250,000 ohms for .1 second when the subject picked up the food reinforcement. These subjects were compared with a group that had a gradually increasing level of punishing shock during the last 75 trials of the 150 trials of training. The group with the gradually increasing shock was much less affected by the 335-volt punishment than the group that did not have prior exposure to the shock. This result suggests that experiments using an ascending order to punishment err in the conservative direction with respect to obtaining treatment differences, although such differences can be obtained using the ascending order (Logan, 1960). With respect to the effectiveness of the gradually increasing exposure to shock on later reduction in the effect of punishment, it is important to note that there was no adaptation if the shock was administered in an apparatus different from the one used in training. A similar result has been reported in the case of adaptation of the CER (Kamin, 1961). Baron and Antonitis (1961), however, found that 18 trials of shock in one apparatus reduced the suppressive effect of punishing shock in another apparatus on the untrained lever-press response of mice.

A second line of evidence in favor of adaptation to punishment is provided by Azrin (1959, 1960, 1961) who found that continued presentation of brief punishments of moderate intensity results in an immediate partial suppression of response, followed by complete recovery after a number of sessions.

Effect of Punishment-Extinction on Resistance to Extinction

Most of the studies of punishment of positive instrumental responses have involved a comparison of the punishment-training and the regular-training procedures. Only a few studies have compared punishment-extinction with regular-extinction, but they demonstrate that subjects respond more slowly during punishment extinction (Matsumiya, 1960; Mowrer & Aiken, 1954; Mowrer & Solomon, 1954). All of these studies have employed a stimulus associated with a primary noxious stimulus as the punishment. The procedure was (*a*) to allow a rat to press a lever for food reinforcement, (*b*) to present a neutral stimulus in temporal contiguity with an unconditioned shock stimulus, and (*c*) to count the number of responses per minute of the subjects under conditions when each response produced a brief presentation of the formerly neutral stimulus. These studies have demonstrated that the amount of response suppression is a function of intensity of the punishment (Matsumiya, 1960), CS–US pattern (Matsumiya, 1960; Mowrer & Aiken, 1954) but not of the conditions of US termination (Mowrer & Solomon, 1954). It has been observed that if a parent threatens to punish and does punish his child long after the response has occurred, the act may not be suppressed but the parent's threats may become an object of fear. Following the paradigm of the experiments above, the threats of punishment by such a parent, administered in association with a response, should serve to suppress the response.

Although the subjects reach a criterion of extinction more rapidly under conditions of punishment-extinction than under conditions of regular-extinction, several studies suggested that punishment did not affect resistance to extinction. Skinner (1938) described a situation in which a short period of mild punishment did not serve to reduce the number of responses during regular extinction. Estes (1944, Experiment A) found that a 10-minute period of mild punishment did not influence the number of responses to extinction or the time to extinction. However, a 10-minute period of severe punishment did reduce the number of responses to a criterion of extinction, although it did not affect the time to reach that criterion, and a 1-hour period of severe punishment reduced both the time to reach a criterion of extinction and the number of responses to reach that criterion (Estes, 1944, Experiments B and C). Dinsmoor (1952) also found conditions under which punishment-extinction was more effective than an equal period of regular-extinction in reducing resistance to extinction.

Response Facilitation under Conditions of Punishment

Although the dominant effect of punishment of a response is the suppression of that response, there has been a continuing search for paradoxical effects of punishment. There are a number of situations in which punishment of a positive instrumental response results in facilitation of the response.

Discriminative properties of punishment. The clearest cases of response facilitation under conditions of punishment have been provided by the experiments of Holz and Azrin (1961, 1962). In these studies, if punishment is associated with nonreinforcement it results in a decrease in response rate, but if punishment has been correlated with positive reinforcement it may result in an increase in response rate. In their first study of this phenomenon, Holz and Azrin (1961) demonstrated that pigeons responded far more rapidly under conditions of punishment-extinction than under conditions of regular-extinction if they had previously been given both sessions of regular-extinction and punishment-training. This result was obtained both with a punishment that reduced the rate of response to one-half its previous level and with an intensity that did not influence the response rate.

In their recent study of the discriminative function of punishment, Holz and Azrin (1962) trained pigeons on a fixed interval schedule of reinforcement and punished all responses during various portions of the interval with shocks of various intensities. The effect of the punishment at fairly low intensities was similar to that of a response-produced neutral cue, a green light. At higher intensities there was increased suppression. Apparently, the punishment may serve as a response-produced cue correlated with the reinforcement schedule, and an event leading to suppression of response rate.

Punishment of an incompletely learned response. If punishment-training is introduced before the asymptotic performance under regular training procedure has been reached, there may be further improvement under the punishment training procedure. Such an observation was made by Karsh (1962), and in such cases there is no reason to believe that the introduction of the punishment served to increase response speed more than would have been obtained with increased trials under regular training conditions.

Contrast effects. One of the more interesting facilitation effects in the case of punishment of a positive instrumental response is that sometimes observed when the punishment is omitted. Azrin (1960, 1962) found that if a mild punishment is applied to every response there is a temporary suppression and then a complete recovery. When punishment is terminated, however, there may be a temporary increase in response rate over that which would have occurred without punishment. Similarly, the rate of response in the presence of a stimulus correlated with positive reinforcement may be increased by the punishment of responses in the presence of another stimulus (Brethower & Reynolds, 1962).

These observations may be taken as evidence for "contrast" but its opposite, "generalization," can often be found. Generalization may be said to occur when punishment of one response affects related responses in a similar manner, but perhaps to a lesser extent. Thus termination of punishment may be followed by a residual suppression of response (Hunt & Brady, 1955) and punishment of responses in the presence of one stimulus may decrease the response rate in the presence of other stimuli (Dinsmoor, 1952). Further work is necessary to determine the conditions under which punishment of one response weakens, strengthens, or leaves unchanged related responses.

Punishment of the "Right" Response

Muenzinger (1934) described one of the most baffling of the paradoxical effects of punishment, when, in his highly original study, he found that punishment of the "right" response in a selective learning situation (i.e., the response that leads to food) served to *increase* the rate of development of response differentiation. Muenzinger noted that the earlier work of Hoge and Stocking (1912) and Warden and Aylesworth (1927) demonstrated that shock after the wrong response increased the rate of selective learning. Was the increase due to the correlation of the punishment with the wrong response or was it due to some other characteristic of the shock? Muenzinger's first attempt to answer this question was to determine the rate of learning of groups of rats punished for correct responses, and to compare their performance with that of rats that were not punished or punished for incorrect responses. The results of the first experiment were dramatic. The subjects shocked for correct responses were similar to those that were shocked for incorrect responses, both of which learned the discrimination habit more quickly than the subjects without punishment. Apparently punishment did not act on a specific response but had some more general function.

One possible explanation for these findings, and the one emphasized by Muenzinger, was that the punishing shock after the choice point served to slow down the subject at the choice point so that it was more fully exposed to the relevant cues. To explore this possibility, Muenzinger and Wood (1935) compared the performance of subjects that were shocked after each choice with those shocked before each choice. The former group learned more quickly than the latter. The subjects that were punished on each response, whether right or wrong, learned about as quickly as those that were punished on all correct responses or on all incorrect responses. The subjects that were punished before each choice learned no more quickly than the subjects that were not punished. The evidence was mounting that punishment facilitated selective learning because it slowed down the subject at the choice point. Other methods of slowing down the subject at the choice point also served to increase the speed of discrimination learning, such as a gap after the choice point, but not a gap before the choice point (Muenzinger & Newcomb, 1936) and an enforced delay at the choice point (Muenzinger & Fletcher, 1937).

The conclusions from Muenzinger's 1934 experiment had to be modified in a critical way after a replication of the research demonstrated that subjects shocked for all correct responses made more errors than subjects shocked for all wrong responses (Muenzinger, Bernstone, & Richards, 1938). Thus, as we have previously observed, punishment of a qualitative characteristic of a response selectively suppresses that characteristic. Nevertheless, the investigators again found that the average number of errors in 100 trials of training was significantly greater for subjects that were not punished than for subjects that were shocked on all correct responses, although the magnitude of the difference was not as great as in the original experiment.

Wischner (1947) performed an important experiment demonstrating that the statement that punishment for correct responses increases the speed of learning is too broad a generalization. Using a noncorrection method in a discrimination box, Wischner (1947) found that the group that was punished for wrong responses learned more quickly than those not punished, but that the group that was punished for right responses was similar with respect to the total number of errors to the group that was not punished. Wischner suggested that the superiority of the group punished for correct responses over the group not punished may be a finding restricted to the correction method. In a comparison of the results of this experiment with his own, Muenzinger (1948) emphasized the relevance of the definition of learning efficiency. In the correction method it is traditional to define a trial as a sequence of one or more responses ending in a reinforcement, and to define an error as a sequence in which the subject enters the incorrect alley one or more times. In the noncorrection method, on the other hand, it is traditional to define a trial as a single entry into one of the two alleys, and an error as an entry into the incorrect alley. In Wischner's (1947) experiment subjects in the shock-right group began with significantly greater than chance number of errors but when they did begin to learn to enter the alley with the shock they learned quickly. Thus different measures of learning efficiency may give different conclusions. What is the proper measure of efficient learning? If time is short, the number of trials to criterion is critical; if mistakes are costly, the number of errors to criterion is critical, but if the cost of the reward is greater, then the number of reinforcements to criterion is critical.

Wischner's (1948) reply emphasized the differences between the methods employed rather than the definition of the efficiency of learning. Although Wischner emphasized the significance of the use of the correction technique to obtain the facilitation effect, Muenzinger found that the superiority of a shock-right group over a nonshocked group may be obtained under conditions of the noncorrection procedure. Muenzinger and Powloski (1951) found that the shock-right group learned more quickly than a nonshock group under a noncorrection procedure, although the differences between the treatments were more pronounced with a correction procedure. Muenzinger, Brown, Crow, and Powloski (1952) found that the shock-right group produced faster learning than a nonshock group after pretraining trials with shock. With shock adaptation the shock-right group was similar to the shock-wrong group; without shock adaptation the shock-right group was similar to the nonshocked groups. Prince (1956, Experiment II) found that after 25 trials of regular training subjects under conditions of punishment for correct responses showed faster learning than nonshocked controls. (The differences between punished and unpunished groups was less apparent with 0 or 15 trials of regular training.)

Wischner, Fowler, and Kushnick (1963) observed that the Muenzinger noncorrection experiments have some similarities to the typical correction experiments, e.g., trials are massed and the location of the stimuli is not changed after an error. They found more rapid learning of a visual discrimination habit with nonshock than with shock for the correct response at all shock intensities used. As punishment intensity increased, the magnitude of the differences increased. Thus, at the present time there is a clear conflict in the data regarding the relative efficiency of the shock-right and nonshock procedures.

The effect of punishment for every response in selective learning is not yet clear. As noted above, Muenzinger and Wood (1935) found in a correction procedure that punishment of every response resulted in faster learning than no punishment. Freeburne and Taylor (1952), using a noncorrection procedure, also found that subjects shocked for both right and wrong responses took fewer trials to criterion than subjects that received no shock. Prince (1956, Experiment I), however, using a noncorrection procedure, found subjects shocked for both right and wrong responses took an equivalent number of trials and errors as a group that received no shock.

To summarize, in the two-choice discrimination learning situation the experimenters may punish incorrect responses, correct responses, both incorrect and correct responses, or neither incorrect nor correct responses. The rate of discrimination learning is typically fastest when incorrect responses are punished, a result that requires a theory involving the correlation of response and punishment. In some situations punishment for correct responses reliably results in faster learning of a discrimination and in other situations it reliably results in slower learning of a discrimination. An important contribution would be made by the identification of a parameter that would result in facilitation by punishment at some values and inhibition by punishment at other values. When punishment of correct responses results in facilitation of a discrimination, it is probable that the facilitation is not because the punishment is selectively paired with the correct response but in spite of it. In no case has it been demonstrated that punishment for all correct responses leads to faster learning than punishment for correct and incorrect responses.

PUNISHMENT OF NEGATIVE INSTRUMENTAL RESPONSES

Punishment of a negative instrumental response reinstates one of the training conditions, and thus may serve to increase the strength of a response. Bandura (1962) in his discussion of the treatment of a boy with a severe behavior disorder described by Boardman (1962), observed that punishment might augment the undesirable behavior by generating hostile feelings similar to those that may have caused the original behavior disorder. Mowrer (1944, 1947) observed that if the subjects learn to make a particular instrumental avoidance act when in a state of anxiety, punishing that act may strengthen it by increasing the anxiety. In support of this hypothesis, Mowrer cited some observations of Judson Brown that a rat, that had learned to avoid shock by running during a 10-second CS–US interval, continued to respond indefinitely even after it was punished only for making the avoidance response. This is one of the most important and fascinating of the paradoxical effects of punishment, and it suggests that punishment of negative instrumental responses may produce considerably different results than punishment of positive instrumental responses.

Punishment of Escape Responses

The first major test of Mowrer's hypothesis of the paradoxical effect of punishment on acts motivated by fear was an experiment by Gwinn (1949). Gwinn trained rats to run around a circular alley for 18 escape trials and then compared several punishment-extinction procedures with a regular-extinction procedure. The results indicated that resistance to extinction was greater under conditions of punishment-extinction than under conditions of regular-extinction, and that it was higher with a more intense punishing shock than with a lower shock. Although subjects punished for escape responses did not continue to run indefinitely, they did take more trials to reach a criterion of extinction than subjects not punished for their escape responses. Brown, Martin, and Morrow (1962) have presented further evidence in support of the hypothesis that resistance to extinction of an escape response is greater under conditions of punishment-extinction than under conditions of regular-extinction.

Several studies have not found punishment of escape responses to increase resistance to extinction (Moyer, 1957; Seward & Raskin, 1960, Experiment IV). Moyer (1957) trained 18 rats to escape from shock by running to a goal box in an alley on 10 escape trials. The mean number of trials to a 2-minute extinction criterion was similar under conditions of punishment-extinction, and regular extinction, although the variance of the number of extinction responses was greater in the punished group than in the regular extinction group. Furthermore, Moyer (1957) presented evidence that "the shock group extinguished quite suddenly, whereas the nonshock group gradually approached the 2-min. criterion."

Seward and Raskin (1960, Experiment IV) trained 45 rats to escape from shock by running to a goal box in an alley for 20 trials. A group receiving a punishing shock on every extinction trial met a 10-second criterion of extinction in fewer trials than a group under regular extinction. Seward and Raskin (1960, Experiment IV) note that "The shocked rats appeared to meet the criterion suddenly, i.e., they ran fast or not at all. Control Ss, on the other hand, slowed down progressively."

To review the results of the above four studies: two gave evidence that punishment of escape responses increases resistance to extinction (Brown, Martin, & Morrow, 1962; Gwinn, 1949); one presented evidence that punishment of escape responses does not affect resistance to extinction (Moyer, 1957); and one gave evidence that punishment of escape responses decreases resistance to extinction (Seward & Raskin, 1960). Our understanding of this phenomenon would be greatly increased if it were possible to obtain all three results in a single experiment by varying some parameter. Although the punishment-extinction procedure does not reliably increase or decrease the number of trials to extinction, it does reliably change the course of extinction. Under the regular-extinction procedure, the process is gradual; under the punishment-extinction procedure it is abrupt.

Punishment of Avoidance Responses

There have been a number of studies on the effect of punishment of avoidance acts on resistance to extinction. As previously noted, Mowrer (1947) cited the observations of Brown in which "flight from this area continues to occur indefinitely." In 1946–47, Whiteis (1955) obtained evidence supportive of the hypothesis that punishment of avoidance acts serves to increase resistance to extinction. Although the details of the experiment have not been published, the experiment is cited by Mowrer (1947) and Whiteis (1956). The apparatus was an alley and subjects, 12 rats, were given 50 trials of avoidance training with a CS–US interval of 10 seconds. Six subjects were then subjected to a punishment-extinction procedure in which they would receive shock only if they made the response; the other six rats were given a regular-extinction procedure. Ten trials a day were run, and the criterion of extinction was a single trial in which the subject spent more than 120 seconds before entering the goal box, or 250 trials, whichever came first. The subjects under the punishment-extinction procedure showed an immediate *decrease* in mean response latency upon the introduction of the procedure. Four of these subjects continued to run at a speed of about 4 feet per second for 250 trials. The two subjects that met the extinction criterion did so abruptly, i.e., a rapid run on one trial was followed by a 2-minute wait on the next trial. Four of the six subjects under the regular extinction procedure met the criterion of extinction, and all of them showed a gradual increase in response latency. On Trial 80, for example, the regular-extinction subjects had a mean response time of 28.2 seconds; the punishment-extinction subjects had a mean response time of 1.0 second ($p = .01$).

Seward and Raskin (1960, Experiment V) investigated the effect of punishment on an avoidance response, repeating all other details of their experiment on the effect of punishment on an escape response. The subjects in groups punished for evey response, punished on half the responses, and not punished during extinction were indistinguishable with respect to number of trials to extinction.

In the course of their work on traumatic avoidance learning in dogs in a shuttle box, Solomon and his associates frequently employed a shock extinction procedure (Brush, 1957; Brush, Brush, & Solomon, 1955; Church & Solomon, 1956; Solomon, Kamin, & Wynne, 1953; Wynne & Solomon, 1955). In these experiments a dog would be trained to perform an instrumental avoidance act of jumping over a barrier to a criterion of avoidance, given a fixed number of regular extinction trials, and then given a punishment-extinction procedure in which the dog would receive shock of 3-second duration only if it made the instrumental response to the signal. The results indicated a remarkably high resistance to extinction under conditions of punishment. In the first experiment (Solomon, Kamin, & Wynne, 1953) only one of seven dogs previously given 200 regular-extinction trials and only two of six dogs given 10 regular-extinction trials extinguished with 100 trials of punishment-extinction. In the later experiments the punishment procedure was slightly more effective. The most extensive study of the punishment-extinction procedure in the shuttle box with dogs was performed by Brush (1957). He found that 73% of the 25 dogs given 10 trials of regular-extinction met the criterion in 100 trials but only 36% of the 25 dogs given 200 trials of regular-extinction met the criterion in 100 trials of punishment-extinction. The punishment-extinction procedure was not regarded by Solomon and his associates as an efficient method of eliminating an instrumental avoidance response, although it was certainly more efficient than the regular-extinction procedure. The behavior of subjects that continued to respond during punishment-extinction was interesting. "These dogs jumped *faster* and *more vigorously* into the shock than they had jumped previously under the ordinary extinction procedure [Solomon, Kamin, & Wynne, 1953, p. 295]." Their anticipatory responses, especially vocalization, clearly indicated that they expected the punishment. Nonetheless, many dogs continued to make the response during 100 trials of punishment-extinction.

Appel (1960) trained monkeys to postpone the occurrence of a shock for 20 seconds by making a lever response, and then alternated periods of such avoidance training in the presence of one stimulus with periods of punishment-extinction in the presence of another stimulus. During punishment-extinction only the first response after a mean interval of 6 minutes was followed by a 500-millisecond shock. Punishment of the avoidance response resulted in an initial period of increased response rate before eventual suppression of the response. Also using a free-responding procedure, Black and Morse (1961) trained dogs to postpone the occurrence of a shock by making a response of jumping over a barrier in a shuttle box. Again, a punishment-extinction procedure typically resulted in an initial period of increased response rate, followed by eventual suppression. Three other studies, however, present evidence that the punishment-extinction procedure may produce more rapid extinction than the regular extinction procedure. Moyer (1955) found this result with rats in a straight alley, and Kamin (1959) and Imada (1959) found this result with rats in a shuttle-box. Thus, as in the case of punishment of escape responses, there is evidence that punishment-extinction is more effective, equally effective, and less effective than regular-extinction. No study has yet found all three effects as a result of variation of a single parameter, but a considerable contribution would be made by such a study.

Some theoretical considerations. In most experiments in which punishment of negative instrumental responses has resulted in facilitation of the response, the punishment reinstated a condition present earlier in training, it elicited fear, the punishment elicited skeletal responses that were similar to the punished response, and the termination of the punishment may have coincided with responses similar to the punished response. Any of the theoretical mechanisms we have examined previously, except the suppression hypothesis and the avoidance hypothesis, may be adapted to account for these paradoxical findings of apparently "masochistic" behavior. Carlsmith (1961), however, has described a procedure, involving qualitatively different aversive stimuli, which may serve to distinguish among the alternative hypotheses. Half the rats learned an avoidance response in a straight alley with an electric shock as the aversive stimulus; the remaining subjects learned the avoidance response with a loud horn as the aversive stimulus. Half the subjects in each of these groups was extinguished with the same punishing stimulus that was used in the original avoidance training; the remaining subjects were extinguished using the punishing stimulus that was not used in the original training. Carlsmith (1961) found that the mean number of trials to a criterion of extinction was uninfluenced by the conditions of original training or by the conditions of punishment, but that there was a large and significant interaction effect. If the same aversive stimulus was used as a punishment that was used as the unconditioned stimulus for avoidance training, resistance to extinction was much greater than if a different aversive stimulus was used as a punishment. Although control groups with a regular-extinction procedure were not used to determine whether the punishing stimulus resulted in actual absolute facilitation, the results strongly suggested the discrimination hypothesis, i.e., that facilitation may occur in the case of punishment of negative instrumental acts because of the reinstatement of specific stimuli present earlier in the training. There is no evidence that the fact that the aversive stimulus is contingent upon the response increases the response facilitation. On the contrary, the response-dependence of the aversive stimulus is probably the factor responsible for the eventual suppression of the response typically observed in these experiments.

Factors affecting punishment-extinction. There are a number of factors which may be important in determining the relative resistance to extinction under conditions of regular extinction and punishment-extinction.

1. Resistance to punishment-extinction may rise more rapidly than the resistance to regular extinction as a function of an increase in the strength of the original response. Brush (1957) found greater resistance to punishment-extinction after 200 trials of regular extinction than after 10 trials of regular extinction; Moyer (1955, Experiment I) found greater resistance to extinction after 50 or 110 trials of avoidance training than after 10 trials of avoidance training. Black and Morse (1961) also found that the greater the length of previous avoidance training, the longer it took for the punishment-extinction procedure to produce eventual suppression of avoidance responding.

2. The presence of an external cue at the site of punishment will decrease the resistance to punishment-extinction. Moyer (1955, Experiment III) found that the placement of an additional cue at the locus of the punishment decreased the number of trials to extinction. Whiteis (1956, Experiment II) also emphasized the importance of the cue at the point of punishment.

3. The intertrial and intersession intervals may be important, and they have varied widely in various experiments. Although the intersession interval has been shown to be important in avoidance learning (Kamin, 1957), the only punishment study in which the interval between acquisition and punishment-extinction was varied has been performed by Moyer (1955, Experiment II). He found that responding was faster after a 1-day interval than after 7, 15, 30, or 60 days.

4. The intensity of the punishment, undoubtedly, plays an important role in the effect of the punishment-extinction procedure on resistance to extinction, but the relationship is uncertain. Seward and Raskin (1960) suggested that the shock intensity they used for punishment, 190 volts through 150,000 ohms resistance, may be too great to obtain a facilitation effect whereas the milder shocks of Gwinn, 60 volts and 120 volts through 250,000 ohms, might produce facilitation. Available data on variations of punishment intensity on negative instrumental responses, however, suggest greater facilitation as a function of increase in shock intensity (Gwinn, 1949; Imada, 1959). Using five levels of punishment intensity and a regular-extinction control group, Imada (1959) found that weaker shocks appeared to suppress responding more than stronger shocks, although response speed and number of responses to extinction were less under conditions of punishment-extinction than under conditions of regular-extinction.

5. Finally, arbitrary and trivial as it may seem, the criterion of extinction is not to be ignored with respect to the resistance to extinction of escape and avoidance acts that have been punished. In some experiments the subject is said to have become extinguished if it fails to make the response in 120 seconds on 10 consecutive opportunities (Solomon, Kamin, & Wynne, 1953). In other experiments the subject is said to have extinguished if it fails to make the response in 10 seconds on one trial (Gwinn, 1949). This is a difference that can make a difference since it is commonly reported that punishment produces an abrupt transition from rapid responding to nonresponding whereas regular extinction typically produces a gradual decrease in speed of response (Brush, 1957;

Moyer, 1957; Seward & Raskin, 1960).

Comparison of Punishment-Training with Regular Training

Most studies involving the punishment of escape and avoidance acts have compared the punishment-extinction procedure with the regular-extinction procedure. In contrast, most studies involving the punishment of positive instrumental acts have compared the punishment-training procedure to the regular-training procedure. A few studies have made this comparison in the case of negative instrumental responses. Church and Solomon (1956) found that punishment-training of escape responses of dogs in a shuttle box produced response suppression; Whiteis (1955, Experiment II) found that punishment-training of avoidance responses of rats produced facilitation of response speed and a decrease in resistance to regular extinction; Shepard (1963), on the other hand, found that punishment-training of avoidance responses of rats produced a suppression of response speed, but it did not affect resistance to regular extinction. Although it is feasible to employ the punishment-training procedure in the case of negative instrumental acts, the parameters are unexplored.

Punishment of Responses during Selective Learning

Maier and his associates have obtained considerable evidence consistent with the hypothesis that punishment of responses of a rat working on an insoluable problem results in an abnormal fixation of the response (Maier, 1949). Most of the experiments were performed with rats working on two-choice discrimination problems in the Lashley jumping apparatus. If the subject makes the correct choice it jumps from the stand, hits a card with its nose, and gains entry to a platform on which it may eat; if the subject makes an incorrect choice it jumps from the stand, bumps its nose when it strikes a card that is securely latched, and falls into a net. A rat may be trained to respond reliably either to a position (left or right) or to a symbol on the card (e.g., white circle on black background or black circle on white background). If the subject is confronted with an insoluble problem (i.e., the two cards are latched at random, without respect to position or symbol) most subjects refuse to jump. If they are forced to jump after 30 seconds by the administration of a blast of air, an electric shock, or a prod with a stick, they typically form strong position stereotypes. A number of studies have compared the performances of experimental subjects that are trained on an insoluble problem and control subjects that are trained to a given position (Klee, 1944; Maier, Glaser, & Klee, 1940; Maier & Klee, 1943; Maier & Klee, 1945). Although subjects in both of these groups have the same level of performance toward the end of training, i.e., they are both responding reliably to a given position, the experimental group is much less likely to learn a later response on the basis of reward. This difference becomes larger as the number of days of training are increased (Maier & Feldman, 1948).

There are several possible bases for the higher resistance to change of the experimental subjects with the insoluble problem and the control subjects with the learned position response. First, the experimental group is punished on a random half of its trials whereas the control group is not punished after it has learned the position response. Second, unlike the control group, the experimental group is avoiding or escaping from a noxious stimulus on the platform. Third, the experimental group is rewarded on a random half of the trials; the control group is rewarded on all trials and, finally, the experimental subjects make more abortive jumps to the cards than the control subjects. Why is the resistance to change greater among the experimental subjects than among the control subjects? Avoidance responses may be more resistant to extinction than positive instrumental responses (Lichtenstein, 1957). The abortive responses of the experimental subjects may retard later learning (Wilcoxon, 1952) and, finally, partially reinforced responses may be more resistant to extinction than 100% reinforced responses (Wilcoxon, 1952). Maier and Ellen (1951) and Maier (1956) have argued effectively that the alternative explanations have not been demonstrated as necessary for the observed effects and that they are insufficient to account for some of the observations that have been made. Nonetheless, the evidence at the present time is insufficient to demonstrate that the punishment involved in the treatment of subjects in an insoluble problem is involved in their high resistance to change. Clearly, further work is required with partial reinforcement controlled and levels of punishment sufficiently low that no noxious stimulation need be applied in the starting platform. Under such conditions the effects of punishment of a response on resistance to extinction could be assessed.

Farber (1948) also obtained results which led him to conclude, "There can be little doubt that shock, as compared with the absence of shock, was effective in fixating the original response." He trained four groups of rats to go to their preferred side of a T maze for 40 trials. The subjects in the experimental group were then shocked immediately after their choice responses; subjects in the control group were not shocked. Following this punishment-training or regular-training procedure, all subjects were given test trials involving reward for a response opposite their original preference. The subjects in the control group that had previously received regular-training learned the new response more readily than subjects in the experimental group that had previously received punishment-training. As in the case of the experiments by Maier and his associates, the interpretation of this result is complicated by the fact that it was necessary to administer an occasional shock to experimental subjects in the stem of the T maze to force them to run through the punishing shock. This procedure resulted in experimental and control subjects that were both moving to their preferred side of the T maze for positive reward at about the same speed, but the experimental subjects were also escaping or avoiding a shock in the stem and being punished with a shock after the choice point. When reversed, the experimental subjects were slower to change their response than the control subjects. This may have been because the experimental subjects had previously been punished for a response, but it also may have been because their escape or avoidance responses were more resistant to extinction than the control subjects' approach responses. Further work on this problem should certainly be done with equivalent treatment of experimental and control subjects in the stem of the maze.

An Evaluation of the Effectiveness of Punishment

Should punishment be used to reduce the strength of a response? Some psychologists have opposed the use of punishment on the grounds that (*a*) it is less effective than some of the alternatives, (*b*) it produces undesirable effects other than the reduction of the strength of the response, and (*c*) it is unkind to the individual. We will quickly pass over the moral objections after noting that, usually, the choice is not simply between reward and punishment. Whenever the alternative to punishment involves deprivation or extinction, the relative moral values are difficult to assess.

Despite the objections to punishment, parents do punish their children, and most parents use physical punishment at least on some occasions. Sears, Maccoby, and Levin (1957) carried out a major interview study of the child rearing practices of mothers of 379 kindergarten children in two Massachusetts communities. They found that, although there were enormous differences among the respondents in the frequency and severity of physical punishment that they used on their children, 99% of the parents reported that they had spanked their children at least once. Curiously enough, in answer to the question, "How much good does it do to spank?," only about half of the mothers were basically affirmative. Why should a parent spank his child if he believes it will do no good? It may be that his beliefs are more affected than his behavior by the cultural norms against punishment, or it may be that his punishment really is ineffective because it is not properly applied or because punishment per se is ineffective. Some parents admit that they punished their children partly because they were angry.

Two major alternatives to punishment for the reduction of the strength of a response are extinction of the response, and counterconditioning (extinction of the response and reinforcement of an incompatible response). Both of these procedures require the identification of the source of reinforcement for the original response and the ability to eliminate that reinforcement, requirements often difficult to meet outside of the laboratory. In the cases where the source of reinforcement can be identified and eliminated, evidence from animal investigations suggests that the addition of punishment will increase the speed of elimination of the response. Special precautions must be taken with the counterconditioning procedures so that the subject will not repeat the act scheduled for elimination in order to get a counterconditioning trial with positive reinforcement.

Sears, Maccoby, and Levin (1957) state that punishment may be effective if it is combined with positive reward for some alternative response, but that by itself punishment has only a temporary effect. In some cases punishment serves to suppress behavior only as long as the punishment is applied; as soon as the punishment is stopped, behavior returns to its former state (Azrin, 1960). Ideally, parents seek a technique to eliminate undesired behavior that will last for a long period of time, even in the absence of the punishing agents. Whiting and Child (1953) have proposed that techniques of punishment involving a loss of love may be more effective than techniques invloving physical punishment for the production of guilt. Nonetheless, strictly physical punishment, particularly if it is severe, can produce highly persistent response suppression. We have described cases of punishment in which the subject completely suppressed a previously learned instrumental response until it died of starvation (Klee, 1944).

Some unfortunate side effects of punishment are described by Sears, Maccoby, and Levin (1957). When a parent punishes a child he gives him a model for aggressive behavior, and the child may come to hate or fear the parent. They found that children of parents that used a considerable amount of physical punishment generally had more behavioral problems, particularly in the area of aggression, than did children of parents that used less physical punishment. Similar results have been reported by others (Bandura & Walters, 1959; Glueck & Glueck, 1950). There are various interpretations of this type of correlation. It may be that punishment produces behavioral problems, that children with behavioral problems are more often punished than normal children, or that, for some reason, the technique of punishment is currently practiced by the wrong sorts of parents, those characterized by problem children. Faced with such a multiplicity of explanations, and with no hope of disentangling them by means of the usual random assignment of subjects to treatments, we have not described these data in detail but, instead, have relied heavily upon the evidence from animal experimentation. Hopefully, there is sufficient phylogenetic continuity that the understanding of the effects of punishment of animals will contribute to our understanding of the effects of punishment on children.

A SYNTHESIS

Experiments on the effect of punishment on behavior have found conditions under which punishment reliably produces total suppression, partial suppression, temporary suppression, and even facilitation of the punished response. With such a variety of effects, any attempt at synthesis may be doomed to fail. Nevertheless, an examination of the data suggests the following generalization: *The amount of response suppression is greater, or the amount of response facilitation is less, when the noxious stimulus is contingent upon the occurrence of the response (the punishment procedure) than when the noxious stimulus is contingent upon the discriminative stimuli.*

Most of the data from experiments directly relevant to this generalization are consistent with the statement: (*a*) When the noxious stimulus is contingent upon the response the amount of response suppression is greater than when the noxious stimulus is administered independently of the response, (*b*) the amount of response suppression is inversely related to the time between response and punishment and it is inversely related to the interval between stimulus and punishment, (*c*) selective punishment of a quantitative or a qualitative characteristic of a response results in selective suppression of that characteristic, and (*d*) when punishment of an avoidance response results in response facilitation, the magnitude and duration of the effect is typically less than that obtained under conditions of noncontingent aversive stimulation. Thus an experimental subject that is punished may be compared with a control subject that receives the same aversive stimuli dependent upon the discriminative stimuli, not upon its responses, or a control subject that receives no aversive stimulation. When compared with this latter treatment, the effects of punishment are varied, but when compared with the former treatment, the invariable result of punishment is response suppression.

Two of the theoretical mechanisms that we have described are specifically designed to account for the empirical generalization that has been proposed, the suppression hypothesis and the avoidance hypothesis. In the case of the suppression hypothesis, some form of inhibition of the response is postulated on trials in which the response does occur; in the case of the avoidance hypothesis, some form of reinforcement for nonresponse is postulated on trials in which the response does not occur. Are there any differential consequences of these two statements? Response stereotypy on those trials in which the punished response does not occur would suggest that there was reinforcement for some specific nonresponse (avoidance hypothesis). An immediate change in performance as a result of a change of intensity of the noxious stimulus would suggest that there was inhibition from punishment (suppression hypothesis). Finally, an investigation of the sequence of punished and unpunished trials for a number of presumably homogeneous subjects during learning, or for a single subject at asymptotic performance, would give evidence regarding the relative importance of punishment and nonpunishment in determination of the behavior (Bush & Mosteller, 1955, pp. 237–258). Of course, it is definitely possible that both factors are involved. To date there has been no empirical attempt to test the differential implications of the suppression hypothesis and the avoidance hypothesis, so that the choice between them is a matter of taste. Dinsmoor (1954) has argued effectively for the avoidance hypothesis on the grounds that it does not make any new assumptions, i.e., it does not make any assumptions that are not typically made in the explanation of avoidance learning. Nonetheless, for the explanation of punishment effects alone, the suppression hypothesis is the simplest, and no data are available to favor the avoidance hypothesis over the suppression hypothesis.

Our empirical generalization may be satisfactory for those situations in which punishment produces a suppression of the response, but how is it possible to use such a generalization to account for those situations in which punishment produces response facilitation? The answer may be that response facilitation occurs in those instances not *because* the response was punished, but *in spite of the fact* that it was punished. Our generalization merely asserts that there will be more suppression (or less facilitation) if the noxious stimulus is contingent upon the response than if it is contingent upon the discriminative stimuli. For example, subjects that are punished for each avoidance response may take more trials than subjects under conditions of regular-extinction to reach a criterion of extinction. Our empirical generalization, however, leads us to expect that subjects that receive a shock of equal intensity and duration at the onset of the discriminative stimulus should have an even higher resistance to extinction. Unfortunately, this application is hightly speculative since most situations in which punishment has produced response facilitation have involved only a comparison of subjects that are punished with those that are not.

The remaining problem is to understand the difference in behavior between an experimental subject that receives punishment after a response and a control subject that receives no aversive stimulation. Under what conditions does such aversive stimulation produce response facilitation, and under what conditions does it produce response suppression? (Because it avoids the suppressive effect of response-contingent punishment, it might be more fruitful to consider the difference in behavior between a control subject that receives aversive stimulation contingent upon the discriminative stimulus and a control subject that receives no aversive stimulation, but this would be outside the scope of a treatment on punishment.)

In those cases in which punishment of a response results in facilitation of the response, various explanations are usually available. It may be (*a*) that the punishment reinstated one of the conditions of training (discrimination hypothesis), (*b*) that the aversive stimulus elicited fear which facilitated the response (fear hypothesis), (*c*) that the aversive stimulus elicited skeletal acts compatible with the punished act (competing response hypothesis), or (*d*) that the response associated with the termination of the aversive stimulus was compatible with the punished act (escape hypothesis).

Unfortunately, there are few experiments explicitly designed to demonstrate the necessity of any one of these hypotheses. Typically, an investigator has used one of these theoretical mechanisms to account for observed facilitation, but the alternatives were certainly not excluded. The relevance of the competing response hypothesis is particularly difficult to demonstrate since the response itself is difficult to manipulate, and the specification of "incompatibility" is uncertain. However, punishment of responses elicited by an aversive stimulus, such as crying, heart-rate increase, and urination, may result in substantial facilitation of the response before any suppression is obtained.

The escape hypothesis is directly testable since any response may be required by the experimenter to terminate the punishment. The assumption of the escape hypothesis is that there will be less suppression of the response if the escape response is similar to the punished response than if it is grossly different. There are many cases in which punishment of a negative instrumental response has resulted in facilitation of the punished response when the latter is similar to the response that terminated the aversive stimulation. Unless support for the escape hypothesis can also be found in the case of punishment of positive instrumental responses, however, the apparent support for the escape hypothesis may occur only because punishment reinstated a condition of original training.

Some variation of the fear hypothesis is certainly necessary to account for the response decrement usually observed when the subject has received noxious stimulation in the presence of discriminative stimuli. It is less certain whether or not such a fear hypothesis is required to account for the response facilitation sometimes observed when the subject is punished for a negative instrumental response. Apparently, more facilitation occurs if the specific aversive stimuli that aroused the fear in original learning are used to punish than if different aversive stimuli are used. Thus the fear hypothesis becomes a variation of the discrimination hypothesis, i.e., punishment may facilitate a response by reinstating a condition of training. The discrimination hypothesis, when specifically tested, has been shown to be a useful idea.

In comparison with a procedure involving no aversive stimulation, the effects of punishment are varied. If punishment reinstates a condition of original training, or if it elicits a response similar to the act that is being punished, then the procedure may produce response facilitation. Otherwise, punishment will produce response suppression. In comparison with aversive stimulation contingent upon the discriminative stimuli, however, the effect of punishment is simple. It always produces suppression.

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