THE RELATIVE AVERSIVENESS OF SIGNALLED VERSUS UNSIGNALLED SHOCK-PUNISHMENT¹

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Six rats were trained on a two-component multiple schedule with each component consisting of a two-link chain schedule. Differential response suppression in the two initial links, as well as in the two terminal links of the chain schedules, was used as a measure of the relative aversiveness of stimulus events in the two terminal links. When signalled and unsignalled shock-punishment (in addition to equal numbers of food reinforcers) were scheduled in the separate terminal links, subjects responded at lower rates in the initial link preceding unsignalled shock-punishment than in the initial link preceding signalled shock-punishment. Similarly, subjects responded at lower rates in the terminal link containing unsignalled shock-punishment than in the terminal link containing signalled shock-punishment. Reversing the terminal-link positions of signalled and unsignalled shock-punishment led to a reversal of the differential response suppression in the two initial and the two terminal links of the chain schedules. These results indicate that signalled punishment is relatively less aversive than unsignalled punishment and support an "information hypothesis", which assumes that a condition in which information is provided about the onset of environmental events, even negative events such as shock punishment, is more reinforcing than a condition in which such information is absent.

There is ample evidence that a punishing stimulus more effectively suppresses behavior when applied immediately following that behavior than after some temporal delay (Banks and Vogel-Sprott, 1965; Baron, 1965; Kamin, 1959; Myer and Ricci, 1968). For those students of punishment who would argue that punishment acts in a manner analogous to but opposite reward (Azrin, 1956; Church, 1969; Kamin, 1959), this finding of a "delay of punishment gradient" is reassuring, since there are numerous references in the positive reinforcement literature to a comparable "delay of reinforcement gradient" when positive reinforcement is delayed following a response (*cf.*, Kimble, 1961, pp. 151-153). In some of these studies, the effectiveness of reinforcement has been shown to depend not only on the delay inter-

val but also on the presence or absence of an external stimulus intervening between the response and the delayed reinforcer (Grice, 1948; Perkins, 1947). Presumably, as outlined by Spence (1947), these external stimuli, acting as conditioned reinforcers, provide the animal with a means of "bridging" the temporal gap between the response and the primary reinforcer, thus increasing the effectiveness of that reinforcer.

A reasonable extension of the above conclusion to the area of punishment leads to the prediction that the presence of an external stimulus between a response and a delayed punisher would increase the effectiveness of the punishing event. To be consistent with the analogue of positive reinforcement, the stimulus preceding shock punishment would be expected to acquire conditioned-punishing properties that "bridge the gap" between the response and the primary punishing stimulus. In support of this assumption, several studies have shown that stimuli associated with shock suppress ongoing behavior when presented in the form of conditioned punishment (Evans, 1962; Hake and Azrin, 1965; Vogel-Sprott, 1966).

While several studies have investigated the question of the relative aversiveness of sig-

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nalled *vs* unsignalled punishment, procedural limitations in two of the studies (Knapp, Kause, and Perkins, 1959, Experiment II; Badia, Suter, and Lewis, 1967) and a source of confounding in the remaining study (Church, 1969, pp. 138-140) prevent an unambiguous interpretation of the findings. Thus, Knapp *et al.* (1959, Experiment II) and Badia *et al.* (1967) showed that rats and humans, respectively, would choose signalled over unsignalled shock-punishment; however, in both cases the shock was long delayed following the response and the signal was relatively brief, thus minimizing the role of the signal in bridging the temporal gap between the response and the delayed punisher. It is not clear whether these same effects would have been obtained if the signal of punishment had followed the response immediately and remained on until the shock-punisher occurred; this would have provided a greater degree of association between the response and punishment. In Church's (1969) study, which was conducted as a direct test of the hypothesis that a signal preceding delayed punishment should improve the association between the response and the punishing stimulus and thus increase the suppressive effects of punishment, the exact opposite was found: subjects receiving signalled punishment suppressed less overall than subjects receiving unsignalled punishment. Unfortunately, in this study subjects were allowed to respond in the interval immediately preceding the delayed shock punisher. An analysis of the data showed that, as a result of this arrangement, subjects that received the unsignalled shock-punishment responded at a higher rate in the interval immediately preceding shock than did subjects that received the signalled shock-punishment. Thus, the greater suppression found in the unsignalled-punishment group might well be attributed to the shorter response-punisher intervals for this group. This confounding of the presence or absence of signal and the delay between the response and the punisher in this study suggests that the question of the relative suppressive effects of signalled *vs* unsignalled punishment has not been adequately answered.

The present study attempted to answer this question using the rat as subject and a two-component multiple schedule with each component consisting of a two-link chain schedule.

Under this schedule, responding in one of the initial links of the chain schedules (either the first or third) produced one of the two terminal links (either the second or fourth) during which food reinforcers and either signalled or unsignalled shock-punishers were presented. Differential response suppression in the two initial links, as well as in the two terminal links, was assumed to reflect the relative aversiveness of the stimulus events—either signalled or unsignalled shock-punishment—in the terminal links.

To ensure that the results would be interpretable in terms of these contingencies, several procedural matters required consideration. Special precautions were taken to ensure that additional responses did not occur in the interval between a response and the delayed punisher. Unless such responding was eliminated, as was the case in Church's (1969) study the response-punisher intervals might not be equal under the two conditions. This methodological problem was handled by having each response in the terminal links retract the lever for a fixed period of time, during which signalled or unsignalled punishment, as well as positive reinforcement, was presented. While it should be noted that lever retraction itself provided a source of stimuli to "bridge the gap" between the response and the delayed punisher, such stimuli were equally present in both terminal links and thus could not provide a differential amount of association between the response and the punisher. On the other hand, the presentation of an additional external stimulus between the response and the delayed punisher in one terminal link but not in the other provided a differential amount of association between the response and the punisher, thereby allowing an assessment of whether increases in association function to increase or decrease the aversiveness of the punishment.

The presentation of both positive reinforcers and shock as a function of lever pressing in the terminal links allowed for the possibility that the number of these events received by the subject would not be equal in the two separate terminal links. And, if this occurred, any differential response rates obtained in either the initial or the terminal links could not be interpreted as being due strictly to the signalled- *vs* unsignalled-punishment treatments. To provide for this equality of contin-

gencies, a certain number of reinforcers and punishers were scheduled to occur in each terminal link, and in the event that an animal's response rate was low, the link duration was extended to allow additional time for the subject to obtain all or most of the scheduled events.

Because signals of punishment were presented in one terminal link but not in the other, some consideration was given to the question of whether the absence of the signal in the signal-punishment link provided any information (other than the absence of punishment) to the animal. One obvious possibility to guard against was to ensure that the absence of signal did not itself provide a signal of food as, for example, would be the case if food was presented for all responses *except* those followed by signalled punishment. With such an arrangement, differentially higher rates in the link preceding and containing the signalled-punishment treatment could be interpreted as being due to either the lesser aversiveness of signalled punishment or the greater reinforcing value of signalled reinforcement. This possibility was eliminated by scheduling food reinforcement for every response, independently of the signal, in both terminal links.

Finally, precautions were taken to ensure that reinforcement was never presented during the signal or during a comparable interval of time in the nonsignalled-punishment link; if it were, there probably would have been a difference in the number of reinforcers consumed, since animals are not likely to drink during a signal of shock. Since, on the basis of previous discussion, the signal of punishment had to be presented immediately contiguous to the response and remain on until punishment occurred, this last consideration suggested that food reinforcement might best be presented *after* the point at which punishment occurred.

METHOD

Subjects

Six female albino rats, 90 days of age at the start of the experiment, were maintained at 80% body weight of a free-feeding control group. Maintenance feeding occurred in the home cage at least 30 min after daily experimental sessions and water was always available in the home cage.

Apparatus

Sessions were conducted in a commercially constructed chamber and chest (Lehigh Valley #1316 and #1316C). A refrigerator was modified to enclose these units and provide additional sound attenuation. Two exhaust blowers, one on the chest and one on the refrigerator, provided the necessary ventilation as well as a masking noise. Within the chamber a single, retractable response lever protruded through the wall approximately 1 in. (2.5 cm) above a grid floor and 2 in. (5 cm) to the left of a centrally located opening through which a 0.01-cc dipper could be raised. The grid floor of the chamber was connected to a Grason-Stadler shock generator and scrambler (E#1064) and all shock parameters were defined in terms of dial settings on this shock source. Two lamps were available for presenting visual stimuli associated with the various links of the chain schedules: One, a small, dim (1.1 W), white-jeweled lamp, was mounted in the wall 2 in. (5 cm) above the lever; the other, a larger and brighter (7.6 W) lamp, was located immediately outside the rear Plexiglas wall of the chamber. The light from both of these lamps was also associated with auditory stimuli, a 200-Hz, 74-dB tone and a 75-dB white noise, delivered through a speaker mounted on the rear wall of the chest. A 28-V dc relay, wired as a buzzer (80 dB), was mounted alongside the speaker and served as a signal preceding shock. Scheduling and recording equipment were located in an adjoining room.

Procedure

Lever-press training. Following dipper training, subjects were trained to lever press and allowed to earn 300 reinforcers per day for five days on a continuous reinforcement schedule. Throughout the experiment, each reinforcer consisted of a 2-sec presentation of the dipper containing full-strength evaporated milk.

Baseline training. Subjects were then exposed to a two-component multiple schedule with each component consisting of a two-link chain schedule. Only one of the four links of this schedule was in effect at any time. When either of the two initial links was in effect, a lever press after an average interval of 90 sec (VI 90-sec) produced one of the two terminal

links. During the terminal links, each response retracted the lever for 10 sec and delivered a delayed food reinforcer, which occurred 8 sec after the response (Figure 1). As shown in Figure 1, lever retraction and re-insertion each took 2 sec to complete; thus, the 2-sec dipper presentation occurred simultaneously with the re-insertion of the lever. Shocks or signals were not presented at any time during baseline training. Throughout the experiment, the terminal links continued in effect until the subject received 20 reinforcers or until 20 min had elapsed, whichever occurred first. In either case, when a terminal link ended, one of the initial links (either the first or the third) was presented on a random basis. With this arrangement, each session continued until 10 terminal links had been presented or until 2 hr had elapsed since the start of a session.

In summary, two chain schedules, each containing two links, were alternated on a random basis. Responding on a VI 90-sec schedule in either of the initial links (first or third) produced one of the terminal links (second or fourth, respectively) during which responding was reinforced continuously on a discrete-trial basis. Each of these four links was associated with a different stimulus as follows: (S1) tone and chamberlight, (S2) intermittent tone and chamberlight (0.5 sec on, 0.05 sec off), (S3) white noise and leverlight, and (S4) intermittent white noise and leverlight. With this schedule in effect, baseline training was continued for 15 sessions in order to establish a baseline.

Punishment vs no-punishment training. To determine whether the chain-schedule methodology would be sensitive to the effects of shock punishment, a 0.2-mA shock was presented after every tenth response on the average (VR 10) in S2 with no shock occurring in S4. The shock was of 2-sec duration and its onset was delayed 6 sec after a response (Figure 1). After the tenth session of punishment vs no-punishment training, shock intensity was increased to 0.3 mA for an additional 10 sessions, after which shock was discontinued to allow response rates to recover.

Buzzer vs no-buzzer training. After 10 recovery sessions, a 6-sec buzzer was presented immediately following every tenth response on the average (VR 10) in S2 (Figure 1); no buzzer occurred in S4. This treatment remained in effect for 10 sessions and was designed to ascer-

tain the effects of a response-dependent buzzer on response rates.

Punishment vs signalled-punishment training. In this phase, the offset of the buzzer in S2 was followed immediately by a 0.2-mA shock of a 2-sec duration while a similar delayed shock occurred without a buzzer in S4. Thus, delayed shock punishment occurred on a VR 10 schedule in both S2 and S4 but was preceded by a signal in S2 only, during this phase. After 10 sessions, the shock intensity was increased to 0.3 mA, where it remained for an additional 10 sessions. Following this treatment, the punishment and signalled punishment (including the signal) were removed for 10 sessions and then reinserted into the opposite terminal links for 20 sessions. As before, shock was introduced at 0.2-mA intensity and increased after 10 sessions to 0.3 mA. Then, the signalled and unsignalled punishment were removed for 10 recovery sessions.

Fig. 1. The temporal relationship of stimulus events following a lever press in the terminal links of the chain schedules. Indicated in parentheses are the schedules of presentation of these events when programmed. Upward and downward deflections indicate onset and offset, respectively.

Additional buzzer vs no-buzzer training. Because the previous introduction of a response-dependent buzzer in one terminal link seemed to increase rate of responding in both initial links, it was decided to repeat this treatment phase and allow the buzzer to remain in effect for 20 sessions. After this treatment, the experiment was terminated.

Table 1 presents a summary of the experimental conditions. As shown in this table, treatment conditions, with the exception of the first buzzer treatment, remained in effect for 20 sessions; recovery conditions remained in effect for 10 sessions.

RESULTS

Figure 2 presents mean response rates in each of the four links, grouped in blocks of

Table 1
Summary of Conditions

Condition	No. of Sessions	Links of Chain Schedules			
		S1	S2	S3	S4
Baseline	15	VI 90-sec	CRF	VI 90-sec	CRF
Pun <i>vs</i> no pun	20	VI 90	CRF and Pun	VI 90	CRF
Recovery 1	10	VI 90	CRF	VI 90	CRF
Buzzer <i>vs</i> no Buzzer	10	VI 90	CRF and Buzzer	VI 90	CRF
Signal-pun <i>vs</i> pun	20	VI 90	CRF and Signal- pun	VI 90	CRF and pun
Recovery 2	10	VI 90	CRF	VI 90	CRF
Pun <i>vs</i> Signal-pun	20	VI 90	CRF and pun	VI 90	CRF and Signal- pun
Recovery 3	10	VI 90	CRF	VI 90	CRF
Buzzer <i>vs</i> no Buzzer	20	VI 90	CRF and Buzzer	VI 90	CRF

two sessions. Figure 3 shows the individual response rates of each of the six subjects. Because of the large amount of data collected, only the last 10 sessions of each treatment condition are shown on these graphs with connected points indicating consecutive sessions.

Baseline. The first panel of Figure 2 shows that there was no consistent difference in mean response rates in either the two initial links (S1 and S3) or the two terminal links (S2 and S4) by the end of baseline training. Rates in these links averaged, respectively, about 15 and five responses per minute. Although terminal-link rates seem low by comparison, this was due to the response restriction imposed by the 10-sec lever retraction following each lever press. Considering that the highest possible rate could have been only six responses per minute in either terminal link (one response every 10 sec), the obtained mean rates of about five responses per minute were close to the maximum during this baseline phase.

Punishment *vs* no punishment. As shown in the second panel of Figure 2, the effect of presenting delayed-shock punishment in one terminal link but not in the other was to reduce response rates both in the punished link (S2) as well as in the preceding initial link (S1), while leaving generally unaffected the rates in the other two links (S3 and S4). This finding was consistent across subjects, as may be seen in Figure 3, indicating that the shock-punishment parameters were suitable for reducing response rates in the terminal as well as in the initial links of the chain schedules.

Recovery 1. When punishment was removed from S2, mean response rates in that link as well as in the preceding link (S1) recovered within a few sessions to their original baseline level (Figure 2, panel 3). In an earlier experiment (MacDonald and Baron, 1973), when response-independent shock was removed from one of the terminal links of a chain schedule, say S2, initial-link (S1) response rates recovered

Fig. 2. Mean response rates, grouped in two-session blocks, of the six subjects in S1 and S3 (the "initial" links of the chain schedules) and S2 and S4 (the terminal links of the chain schedules) under each experimental condition. Only the last 10 sessions of each treatment condition are presented, with connected points indicating consecutive sessions.

to a level above the rates observed in the initial link (S3) not associated with shock. Although such "compensatory" behavior did not occur in the present study, this may have been due to the relatively shorter period of recovery allowed in the present study as opposed to the earlier study (10 *vs* 20 recovery sessions). That such a "compensation" effect may have occurred if the recovery phase had been extended in the present experiment is suggested by the fact that on the last two-session block of the first recovery phase, five of the six subjects (all except B2) were responding at a relatively higher rate in the initial link (S1), which had previously been associated with shock punishment (Figure 3, panel 3). Also, as indicated below, the introduction of the response-dependent buzzer into the same terminal link (S2) that had previously been associated with shock punishment may have had an adverse effect on the occurrence of compensatory responding in the initial link (S1).

Buzzer *vs* no buzzer. As seen in Figure 2 (panel 4), the presentation of a response-dependent buzzer in S2 resulted in a slight and transient reduction in mean response rate in

that link only, an effect largely due to the behavior of Subjects B3 and B6 (Figure 3, panel 4). This reduction in rate in the link containing the buzzer may have been due to either the direct suppressive effect of the buzzer-sound (see Baron, 1959) or to the procedure of presenting the buzzer in the same link that had previously been associated with shock punishment. In either case, the observed reduction in responding was only of a temporary nature and thus did not prevent the use of the buzzer subsequently as a signal of punishment. Since the buzzer in S2 did reduce responding in that terminal link, it seems likely that a similar reduction should also have occurred in the preceding initial link (S1). The fact that such a reduction did not occur in S1 during the buzzer *vs* no-buzzer condition suggests the possibility that the suppressive effect of the buzzer may have been counteracting the compensation effect referred to above, one cancelling out the other.

One interesting effect that did occur under the buzzer *vs* no-buzzer condition was a gradual increase in response rates in both initial links over the 10 sessions in which this condi-

Fig. 3. Individual response rates, grouped in two-session blocks, of the six subjects in S1 and S3 (the initial links of the chain schedules) and S2 and S4 (the terminal links of the chain schedules) under each experimental condition. Only the last 10 sessions of each treatment condition are presented, with connected points indicating consecutive sessions.

tion was in effect (Figure 2, panel 4). Although this increase in responding was not obtained from every animal (*e.g.*, see Subject B5, Figure 3, panel 4), it did occur with sufficient frequency to warrant a repetition of this phase of the experiment. Thus, the last procedural phase was to present the buzzer in one terminal component for 20 sessions and to observe the effects of this treatment on initial-link response rates. While the mean data, as presented in Figure 2 (panel 9), indicate a slight increase in rate over the last 10 sessions of this treatment phase, the individual-subject differences (Figure 3, panel 9) do not allow the conclusion that a rate increase reliably occurs as a result of introducing a response-dependent buzzer. The rate increase that occurred during the first buzzer *vs* no-buzzer condition might easily be attributed to the possibility that initial-component response rates had not reached a stable high level by the end of the first baseline or first recovery phase, and thus tended to approach that level during the buzzer *vs* no-buzzer condition. The higher response rates obtained during subsequent recovery phases (Figure 2, panels 6 and 8) support this interpretation.

Signalled punishment vs punishment. To determine the relative suppressive effects of signalled and unsignalled punishment, a comparison was made of initial-link response rates when punishment and signalled punishment were scheduled in the separate terminal links. As shown in Figure 2 (panel 5), when signalled punishment occurred in S2 and punishment occurred in S4, mean response rates were relatively higher in the link (S1) preceding signalled punishment. In all cases, individual subjects showed this differential responding on at least four of the last five two-session blocks in which these treatments were in effect (Figure 3, panel 5). Furthermore, mean and individual response rates were consistently higher in the link (S2) containing signalled punishment than in the link (S4) containing punishment (Figures 2 and 3, panel 5).

When punishment and signalled punishment were scheduled in the opposite terminal links from which they occurred previously, these findings were replicated. As may be seen in Figure 2 (panel 7), mean response rate in the initial component (S3) preceding the signalled-punishment condition was relatively higher than in the component (S1) preceding

the punishment condition. Although two of the subjects, B1 and B5 (Figure 3, panel 7), responded non-differentially in the initial links during this phase, the remaining four subjects responded in a manner consistent with their behavior during the first presentation of these treatments. Figures 2 and 3 (panel 7) also show that the mean and individual response rates were relatively higher in the link containing signalled punishment (S4) than in the link containing unsignalled punishment (S2).

One additional and somewhat unexpected finding occurred during the punishment *vs* signalled-punishment conditions. As may be seen in Figure 2 (particularly in panel 7), mean response rate in the initial link preceding signalled punishment (S3) was as high or higher than the mean response rate obtained in this link during the preceding recovery phase. That this effect was obtained from at least three subjects (B2, B4, and B6, Figure 3, panel 7) suggests that signalled punishment may, under certain conditions, suppress responding as little as or even less than no punishment. Very little can be offered here as an explanation of this finding; however, it does indicate that the behavior of an individual at a given moment in time must always be considered in terms of the *relative* aversiveness or reinforcing value of the contingencies operating at that moment. Thus, in the present study, the relative aversiveness of signalled punishment was minimal (or even negated) in comparison to unsignalled punishment. Presumably, if a condition of signalled punishment *vs* no punishment had been presented, then the relative aversiveness of signalled punishment would have increased (in comparison to an earlier baseline involving signalled *vs* unsignalled punishment). Clearly, the present study was not designed to provide data relevant to such speculation.

DISCUSSION

The major findings of the present study do not support the prediction that an external stimulus intervening between a response and a delayed punisher increases the effectiveness of that punisher. Presumably, such a stimulus should have functioned to "bridge the gap" or, in other words, to increase the association between the response and the punishing stim-

ulus. Since actual increases in association due to shorter response-punishment intervals are known to produce greater response suppression (*e.g.*, Banks and Vogel-Sprott, 1965; Baron, 1965; Meyer and Ricci, 1968), one might expect a manipulation that effectively increases the association between the response and punishment also to produce greater suppression. However, the fact that in the present study the insertion of an external stimulus between a response and a delayed punisher produced a lesser amount of suppression than a delayed punisher without such a stimulus obviously does not follow from this expectation.

One interpretation of these findings that must be considered is the possibility that the lower response rates in the unsignalled-punishment condition may have been due to the lower rate of reinforcement obtained in this condition, since rate of reinforcement varied directly with rate of responding. Although this possibility exists, there is some evidence to suggest that the shock punishment and not the decreased reinforcement rates maintained the lower response rates in the unsignalled-punishment condition. In a study using a similar chain-schedule design (MacDonald and Baron, 1973), subjects showed greater initial-link response suppression to unsignalled in comparison to signalled shock when the shock and the reinforcers were both presented independently of behavior in the terminal links of the chain schedules. Thus, in that study, unsignalled shock suppressed behavior to a greater degree than signalled shock, even when the rate of response-independent reinforcement was equated under the two conditions. This finding suggests that had rate of reinforcement been equated in the terminal links of the present study, unsignalled punishment would still have produced a relatively greater amount of suppression than signalled punishment. One approach to this problem would have been to provide reinforcement on a variable-interval schedule such that even though response rates differed considerably, the rates of reinforcement would have been equal under the two conditions. Unfortunately, the use of an intermittent schedule of both punishment and reinforcement allows for the possibility that the two contingencies would be differentially associated in the two terminal links.

Assuming that "rate of reinforcement" is

not a viable explanation of the results, another approach might be to consider the data in terms of the two possible roles that signals of environmental contingencies may play. Firstly, it is a common observation that signals play an associative role. When associated with positive events, such as food, they acquire positive properties and may serve as conditioned reinforcers (Bugelski, 1938); when associated with negative events, such as shock, they acquire negative properties and may serve as conditioned punishers (Hake and Azrin, 1965). Thus, in its associative role the signal acquires the sign, either positive or negative, of the stimulus event with which it is associated. Obviously, if this were the only mechanism operating in the present study, then signalled punishment should have suppressed responding more than unsignalled punishment because the negativity of the signal and shock combined, in the former treatment, would have been greater than that of the shock alone. Perhaps the reason for the lesser aversiveness of signalled in comparison to unsignalled punishment is related to the second role that signals may play, namely their informational role. There is a growing body of literature to indicate that signals, even those signalling negative events such as extinction (*e.g.*, Wyckoff, 1969) or shock (*e.g.*, Lockard, 1963), acquire positive reinforcing properties to the extent that animals behave in predictable ways to obtain them. Whether signals of shock acquire these properties because they allow the animal to prepare for the shock (Perkins, 1955), because they reduce uncertainty (Berlyne, 1960), or because their absence provides a kind of "safety signal" (Seligman, 1968), is still unclear and is not the point of issue here. The point being made here is that signals of any event, either positive or negative, acquire a positive sign.

In the present experiment, the terminal link of the chain schedule containing signalled punishment was pitting the associational role of the signal against its informational role. Considering this dual role played by the signal, it could be argued that signalled punishment suppressed responding to a lesser degree because the positive properties of the signal derived from the information it provided outweighed the negative properties accrued to the signal as a result of its association with shock, making signalled punishment somewhat more

positive than unsignalled punishment. However, the reader may recognize that such a theoretical argument is not completely satisfying because of its ability to explain any outcome that might have been obtained.

Perhaps instead of trying to explain the outcome of the present experiment within a theoretical framework, a better approach would be to conclude that signalled punishment suppresses responding less than unsignalled punishment and then begin to examine the generality of this effect. Further research might include a systematic analysis of those variables that may influence this effect, including such factors as signal duration, signal-shock contiguity, and response-shock frequency. Hopefully, with a better understanding of these controlling variables, *post hoc* explanations pitting informational against associational mechanisms would not be necessary.

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