In a reaction time (RT) task 40 subjects were told to react to the onset of a 6-second shock. Following 10 trials, half of the subjects were told that by decreasing their RT they would reduce shock duration. Remaining subjects were simply told that shock duration would be reduced. All subjects, regardless of group assignment or RT, received 3-second shocks in the second half of the study. During the second half of the study, subjects who believed they had control showed fewer spontaneous skin conductance (SC) responses and smaller SC responses to shock onset than subjects who did not feel they had control. Results indicated that perception of control was related to stress responses.

Discussion of related research and implications of the results are included.

Recent years have seen increasing attention paid by experimental psychologists to a problem area not well integrated into learning theory, namely, the stressfulness of aversive stimuli as a function of the degree to which the subject can control their onset and/or offset. The classic study by Mowrer and Viek (1948) remained for about 20 years the first and only experiment on the issue. It will be recalled from this study that rats who were trained to escape shock% by performing an instrumental response reacted in the same situation less fearfully than yoked controls, whose shocks were not influenced by their own behavior.

In a recent article, Seligman, Maier, and Solomon (in press) reviewed this and other studies which, taken as a whole, indicate the important role that subject control of aversive events plays in determining how stressful the stimuli will be.

Perhaps because the bulk of the experimental work has been restricted to subhuman species, the focus has been entirely on the experimental arrangement of events, namely, "These concepts are defined by experimenter's arrangement of experimental events, not in terms of subject's perception of them. [Seligman et. at., in press]. " There is at least one alternative explanation, however, which is logically possible and perhaps more interesting, namely, that the experimental arrangements achieve their stress-reducing effects through the induction of the belief in the subject that he can affect favorably the amount of stress to which he is to be subjected. While this suggestion raises considerable epistemological problems in the case of rats, such issues seem more manageable when dealing with humans (others have been more intrepid philosophically, vide Festinger's, 1961, discussion of cognitive dissonance in rats).

If one shifts the focus from the experimenter's operations to the subject's perceptions, it seems possible that the latter need not be isomorphic to the former. That is, perhaps the already demonstrated stress-reducing effects of subject-control can be demonstrated when subject's believe incorrectly that they can effectively reduce the duration and/or intensity of aversive stimulation. A strong test of the hypothesis that it is the perception by the subject rather than the arrangement by the experimenter which is the crucial factor would be to create the perception of effective control in human subjects where there really is none.

This was done in the following experiment. Forty male volunteer college-student subjects underwent pretreatment and posttreatment threshold tests with electric shock. Part I of the study was identical for all subjects; during 10 trials they pressed a reaction switch as soon as they first felt shock. This shock lasted 6 seconds...
and was always preceded by a 10-second ready signal. In Part II, half of the subjects (perceived control) were told that shock duration would be halved if their reaction times (RTs) attained a certain speed. Nonperceived control subjects were simply told that the shocks would be shorter. In actuality, all subjects were programmed to receive shocks of 3 seconds' duration. The experimental design is summarized in Table 1.

The following hypotheses were formulated:

1. Perceived control subjects would rate their shocks as less painful once they had been led to believe that they were shortening them; nonperceived control subjects would not show this increase in pain threshold.

2. Perceived control subjects would show less autonomic arousal to those shocks over which they believed themselves to be exerting effective control; nonperceived control subjects would not show this reduction in autonomic response to the second series of shocks.

3. Perceived control subjects would find it generally less stressful to be in the situation in which they believed themselves to be shortening the duration of the shocks, that is, their general level of arousal would decrease, while nonperceived control subjects would not become less aroused overall.

METHOD

Subjects and Procedure

Subjects were 40 male undergraduates at the State University of New York at Stony Brook. Each subject was met by a female experimenter (Experimenter 1), who conducted him to the experimental room. The subject was seated in a comfortable arm chair in a sound- and electrically shielded chamber. The experimenter explained that the study was concerned with RT. and physiological reactions to shock. Further, it was explained that a series of measurements would be taken to determine the individual’s sensitivity to electric shock. Following these preliminary instructions, the experimenter attached skin (SC), heart rate (HR), and shock electrodes. SC was recorded from the subject’s palm and wrist of the non-preferred hand. HR electrodes were placed in Lead I1 position, and the shock electrode was placed on the ankle on the same side as the SC electrodes. The experimenter who performed the above tasks and subsequently obtained the threshold measurements sat not aware of the subject’s group assignment.

Sensation threshold and pain threshold were not, obtained from each subject in the following: The experimenter increased shock voltage from well below detection level until the subject first reported sensation. That voltage level was recorded, and the voltage level was increased until the subject reported pain. The voltage level associated with pain was noted, and the shock was turned off. This procedure was repeated four more times.

Following the threshold data collection a male experimenter (Experimenter 2) entered the experiment chamber and told the subject that the shock level used (throughout the experiment would be at a level lower than what had just indicated as painful. Then following instructions were given to all subjects:

Let me briefly describe what your task will be.

I of the experiment. On the screen in front of you, a picture will appear requesting to place your finger near the reaction switch. After this picture goes off, shock will begin. Your task be simply to flick the reaction switch, as quick as possible, once shock begins. This shock will last for 6 seconds. I urge you to react as quickly as possi...
since we are interested in the speed of your reaction time under shock conditions. Your speed of reaction, however, will in no way determine the duration of shock. It will always be 6 seconds. There will be a total of 10 such trials. Are there any questions? The experiment will begin in 10 minutes.

When the instructions were finished, the subject was given a 1 second sample of the shock level that was to be used. The actual shock level was the second highest voltage that the subject had rated as painful. A 10-minute rest period began, during which time any final adjustments were made on the recording apparatus, and the subject was given time to adapt to the experimental conditions.

Part I began with the visual presentation of the words, "Please place your finger on the reaction switch." This visual stimulus was on for 10 seconds, and its termination was contiguous with the onset of the 6 seconds of shock. The warning signal was projected in front of the subject at eye level. Ten such trials were given with a 30-second intertrial interval. After completion of Part I, the male experimenter reentered the experimental chamber and gave the subject, according to random group assignment, one of the two following instructions. For the nonperceived control group, he read:

Part II of the experiment will be exactly the same as Part I. The only difference will be that shock duration will be decreased in length from 6 seconds to 3 seconds. Thus, follow the same procedure as you have been following, and again, please react as quickly as possible. Again, there will be 10 trials.

The perceived control group were read the following instructions:

Part II of the experiment will be essentially the same as Part I. The only difference will be that now, if your speed of reaction time is as fast or faster than the average of your reaction times in Part I, shock duration will be decreased in length from 6 seconds to 3 seconds. Thus, if you can react quickly enough, you can significantly cut down the duration of shock you receive on each trial. The timer which is recording your reaction times is capable of recording times as low as a thousandth of a second, so that even a slight decrease in reaction time will cut down the duration of shock you will receive. Again, there will be 10 trials.

It should be clearly noted that in Part II both groups received 3 seconds of shock regardless of the speed of the subject's RT. Throughout both Part I and Part II, SC and HR were recorded, and RTs were recorded for each of the 20 trials. The experimenter who recorded RT was unaware of the subject's group assignment. At the completion of the second 10 trials, threshold and pain threshold were again determined for each subject; and each subject was given a 6-point rating scale on which he was to rate the subjective level of shock intensity as he perceived it throughout the two RT tests.

**TABLE 2**

<table>
<thead>
<tr>
<th>Group</th>
<th>Pt. I</th>
<th>Pt. II</th>
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</thead>
<tbody>
<tr>
<td>Perceived control</td>
<td>.430</td>
<td>.340</td>
</tr>
<tr>
<td>Nonperceived control</td>
<td>.490</td>
<td>.610</td>
</tr>
</tbody>
</table>

**Apparatus**

Electric shock was administered through an annular disk electrode (Tursky, Watson, & O'Connell, 1964) by a Grass Model S4 stimulator with a stimulus unit. Shock frequency was 10 cycles per second, and pulse duration was 50 milliseconds. The ready signal was delivered by a Kodak Ektographic projector that was located outside the sound chamber. Electronic timers were used to determine stimulus durations, and intertrial intervals were controlled by a tape timer. A Hunter Klockcounter was used for determination of RT.

Physiological data were recorded on a Beckman Type B dynograph, using that instrument the response of the subject. SC was recorded on two channels, one recording galvanic skin responses (GSRs) and the other, basal skin resistance. Beckman biopotential electrodes and electrode paste were used for all physiological data collection. Physiological data were recorded simultaneously on tape, as data analysis was actually performed on the digital output from that tape.

**RESULTS**

**Check on Manipulation**

There is reason to believe that we successfully induced in perceived control subjects the mistaken belief that they were responsible for consistently reducing by one-half the duration of the unpleasant shocks administered to them in the second part of the "reaction-time experiment." Table 2 contains mean RTs calculated for Parts I and II. A 2 X 2 repeated-measures analysis of variance revealed a significant Trials X Conditions interaction ($F = 4.97$, df = 1/33, $p < .03$): subjects in the perceived control condition reduced their RTs in Part II, as compared to the increase shown by nonperceived control subjects. Perceived control subjects reacted more quickly in Part II because, we would suggest, they believed that faster RTs would pay off in shorter shocks. Also, as seen in Table 3, perceived control subjects yielded lower mean sensation thresholds following the entire experiment, as compared to the
TABLE 3
MEAN SENSATION THRESHOLD (IN VOLTS)

<table>
<thead>
<tr>
<th>Group</th>
<th>Time of data collection</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Before</td>
</tr>
<tr>
<td>Perceived control</td>
<td></td>
<td>3.3</td>
</tr>
<tr>
<td>Nonperceived</td>
<td></td>
<td>3.2</td>
</tr>
</tbody>
</table>

Preexperimental measures; the Trials X Conditions interaction was significant ($F = 4.48$, $df = 1/38$, $p < .05$). Assuming that early detection of shock would be rewarded by shorter shocks, perceived control subjects "sensed" shock sooner than nonperceived control subjects. Both these points will be more fully discussed below.

Hypothesis 1

It was expected that following the RT trials (Part II), during which effective control was (deceptively) demonstrated, perceived control subjects would find the shocks less painful. Information regarding this hypothesis is available from two sources. It will be recalled that prior to and immediately following Parts I and II, all subjects underwent four replications of an ascending-limits shock-threshold test, indicating at which point in the continuously increasing voltages they experienced the shock as painful. Prechanges to postchanges in this pain threshold were not different in the two groups, though the trend was in the predicted direction; that is, perceived control subjects increased their postpain thresholds slightly more than did nonperceived control subjects. The other data come from the overall rating of how irritating subjects found the experiment as a whole. Expected differences did not emerge from this 6-point rating scale, possibly because the variance was so small (all subjects tending to use the top three values of the rating scale). Thus, Hypothesis 1 failed to be confirmed.

Hypothesis 2

It was predicted that autonomic responding to the individual shocks during Part II of the experiment (during which perceived control subjects believed they were effectively shortening duration of shocks) would be reduced for those subjects, but not for nonperceived control subjects. Figure 1 shows the mean log change in conductance for subjects during both parts of the experiment. Since all subjects were treated the same in Part I, we found, as expected, no significant differences between groups in this first block of RT shocks on a repeated-measures ANOVA. (As would be expected, both groups did similarly show a trials effect, $p < .025$, that is, SC decreased similarly in both groups over these first 10 shock trials.) Of direct interest is the predicted divergence in curves for Part II: SC to the discrete shocks diminished more rapidly for perceived control subjects than for nonperceived control subjects, as shown by a significant Trials X Condition interaction ($F = 4.21$, $df = 4/152$, $p < .005$).

Hypothesis 3

It was expected that perceived control subjects would, in general, be less upset during Part II than would nonperceived control subjects.

The equipment recorded skin resistance; however, the actual dependent variable was the log (base 10) of the change in conductance that began between .51 and 3 seconds after shock onset. The formula employed was: $[(1/R_2 - 1/R_1) x 10] + 1.0$, where $R_1$ is skin resistance, in ohms, at the start of response inflection, and $R_2$ is the skin resistance, in ohms, at the point of maximum inflection.
subjected to aversive stimulation. To test this, we employed an index of general level of autonomic arousal which has been successfully used earlier (Geer, 1963; Katkin, 1966), namely, spontaneous SC fluctuations. Such a fluctuation was defined as a measurable decrease in skin resistance of over 200 ohms that occurred at a time other than when stimuli were presented and that was not associated with movements or other signs of subject activity. In order to be considered a "spontaneous SC fluctuation," skin resistance had to begin increasing after reaching asymptote. Table 4 contains the total number of fluctuations for subjects in the two conditions during Parts I and II of the RT experiment. It may be seen that fluctuations during Part II were less for perceived control subjects than for nonperceived control subjects, and this reduction was confirmed by a repeated-measures ANOVA that detected a Trials X Conditions interaction ($F = 4.20, df = 1/38, p < .05$). These results were taken to indicate that perceived control subjects were generally less aroused during Part II than were nonperceived control subjects.

Analyses of HR data will not be presented, since none of the statistical analyses approached significance; however, it can be mentioned that the direction of differences between groups was the same as the SC data reported above.

Two of the three hypotheses of this study were confirmed: perceived control subjects, who (incorrectly) believed that they could shorten the duration of aversive stimulation administered to them, manifested less reactivity to this stimulation than nonperceived control subjects, who were not led to believe that they could do anything that would alleviate the stress to which they would be subjected. This can be seen in some, though not all, of our measures. As indicated above in Table 4, perceived control subjects showed a smaller number of spontaneous GSR fluctuations once they began to believe that they had some beneficial influence over the shock than did the nonperceived control subjects, suggesting that they were less aroused throughout the second part of the study (Hypothesis 3). Furthermore, as seen in Figure 1, perceived control subjects exhibited significantly lower levels of GSR activity in response to the individual shocks by the end of Part II, suggesting that the shocks were becoming less stressful for them as they (mistakenly) perceived themselves reducing the duration of each of the 10 shocks (Hypothesis 2).

Turning to the more psychological measures, we found that perceived control subjects exhibited significantly lower sensation thresholds than did nonperceived control subjects following the second block of RT trials (Part II) (see Table 3); and they also became significantly faster in their RTs to the onset of shock during Part II (Table 2). These two results taken together provide, in our view, an adequate check on the manipulation for perceived control: perceived control subjects believed they would be "reinforced" if they (a) perceived when shock was beginning so that they could quickly react to this perception with the button press, which supposedly could reduce the duration of painful stimulation. The lower sensation threshold of the perceived control subjects, then, can be fruitfully seen as resulting from a payoff matrix which rewards for false positives without punishing for them: these subjects had nothing to lose except pain if they "noticed" when the shock was beginning at its low intensity. As Dember (1960) has stated:

If for some reason the subject is strongly involved in showing how sensitive he is, then the simple yes-no response may yield spuriously low thresholds. All the subject has to do is say yes even when he does not detect the stimulus, and his threshold will appear lower than it "really" is [p. 33].

It might be argued that the lower sensation thresholds for the perceived control subjects go against our hypothesis, for these data do indicate that the perceived control subjects be-

<table>
<thead>
<tr>
<th>Section of experiment</th>
<th>Group</th>
<th>Pt. I</th>
<th>Pt. II</th>
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<tbody>
<tr>
<td>Total number of spontaneous skin conductance responses</td>
<td>Perceived control</td>
<td>197</td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>Nonperceived control</td>
<td>198</td>
<td>210</td>
</tr>
</tbody>
</table>
came more sensitive to minimal shock during Part II. Does this mean, indeed, that they were beginning to find the shocks more stressful? A less problematical psychological measure is available in the pain thresholds reported by subjects prior to and subsequent to Parts I and II, for if our perceived control subjects were, indeed, coming to react with more self-reported stress to the shocks, we would expect them to report pain sooner than the nonperceived control subjects. This was not the case: though the differences did not achieve significance (thus failing to confirm Hypothesis 1), perceived control subjects did take somewhat higher intensities of shocks following Part II than did nonperceived control subjects before announcing pain. It will be recalled also that subjects were asked, following both series of shocks, to rate their overall reaction to the shocks on a 6-point scale that ranged from "intensely irritating" to "nonirritating." While, again, differences did not reach significance (Hypothesis 1), the trend was in the same direction, that is, perceived control subjects found the shocks slightly less irritating than nonperceived control subjects.

Some recent research by Glass, Singer, and Friedman (1969) is likewise concerned with subjects' perceptions of control over their environment. In a first experiment, they demonstrated that unpredictable noise produced greater postadaptive stress than predictable noise, though subjects adapted to both kinds of noise in similar fashion. The second study was designed to investigate why adaptation to unpredictable noise takes such a toll on human subjects. The working hypothesis was that exposure to such noise produces feelings of helplessness which, in turn, produce interference in later functioning. To test this, they provided experimental subjects with a button which could be pressed to terminate aversive noise, while controls had no such option. Subjects provided with the button were, however, discouraged from using it. In fact, no one used the button, but knowing that a negative reinforcement was available produced the predicted differences in postadaptive stress, that is, the subjects who felt that they control the noise (even though they did not actually do any controlling) were affected less on the postnoise test tasks.

The similarities between this study and the present one, while worth noting, should not mask two crucial differences: (a) Glass et al. were concerned with differential effects as a function of perceived control following exposure to the stress; they did not predict nor did they find differences during the noise trials, rather only on those poststress problem-solving tasks which were designed to measure the psychic costs of adaptation to the stressor. Our findings, in contrast, are concerned with differential reduction of stress during the aversive trials themselves. It would, indeed, be of considerable interest to investigate postadaptation five consequences within our paradigm. (b) Another difference lies with the fact that our study examined control which was (mistakenly) perceived by subjects to be perceived control subjects saw all their shocks reduced by 50% "as a result of the improved reaction time"—while Glass et al. dealt with the perception of potential, not actual, control.

Our data do not directly shed light on the mechanisms whereby nonveridical perceived control reduces stress, but they are in accord with a body of research relating pain perception to anxiety- (e.g., Beecher, 1959; Melzack, 1961). Higher levels of anxiety about pain tend to increase the painfulness of given aversive stimuli. In a recent experiment done independently of ours, Bowers (1968) has shown that human subjects will designate higher levels of shock as painful and maximally tolerable if they are told that the former will be used to punish them for incorrect responses in a subsequent learning experiment, the shocks being therefore, avoidable. Bowers also furnished some data confirming the positive relationship between level of anxiety and perceived pain.

The data provided in the present experiment may then be seen as suggestive of lower anxiety in perceived control subjects. As already seen, these subjects were less aroused, as measured by spontaneous GSR fluctuations during Part II, and they likewise reacted with lower levels of GSR activity to the second series of shocks, which they believed they could shorten by their RTs. In view of the confusion in the literature regarding various psychophysiological measures of anxiety, however (e.g., Martin, 1961), I would exercise caution in seeing our perceive
control subjects as necessarily less "anxious." They were, indeed, significantly less "aroused."

The search for psychological/physiological mechanisms for the above phenomena, including the results of the present study, should be a fascinating one. At this point, we find ourselves inclined to explain our own results along relatively simple learning lines: that is, human beings tend to find less stressful those aversive situations over which they at least believe they have some degree of control. Indeed, such situations in real life are probably, as a rule, less stressful. The instructions to our perceived control subjects then enable these individuals to label the situation as one in which they are not helpless. Their subsequent behavior is then affected in the same way as it has been in the past, when control was available.

There is at least one alternative explanation worth mentioning, though we find it implausible. From the point of view of our perceived control subjects, they were involved in a task for which they were led to believe there was payoff. In our experiment this payoff was reduction in aversive stimulation. It might be argued that this perceived control over unpleasant events is better construed more generally in motivational terms: similar results might have been achieved by telling subjects that improved RT could earn them money. According to this notion, involvement in such a task (which would be unrelated to the topography of the RT experiment) might likewise have reduced the aversiveness of the second series of shocks. While readily testable, such an interpretation is at variance with the typical finding of increase in arousal under conditions regarded as "motivational" (e.g., Elliott, 1969; Malmo, 1965).

The present experiment may be fruitfully viewed in another context. Recent social psychological research, growing out of the cognitive theory of emotional behavior put forth by Schachter (1964), has demonstrated impressive plasticity in human behavior coming out of beliefs that are not necessarily veridical. For example, Nisbett and Schachter (1966) increased the tolerance for moderate levels of electric shocks in human subjects who had been mistakenly led to believe that a capsule they had ingested (actually a placebo) could produce side effects such as palpitations and dry mouth. The comparison group contained subjects whose expected side effects were irrelevant to anticipating and receiving painful levels of shock. The authors suggested that the errorneous belief led to lowered sensitivity via attribution of some of the shock-produced symptoms to the capsule. Valins (1966) and Valins and Ray (1967) have shown that certain emotionally based behavior can be influenced markedly by deceiving subjects into believing that they are reacting autonomically in a particular way to certain external stimuli. In the second study, for example, snake-phobic subjects approached a snake significantly more closely after hearing what they believed to be their hearts not increasing to snake stimuli, as they did to administration of uncomfortable shock. In actuality, the HR feedback was bogus. These studies, and others (e.g., Davison & Valins, 1969; Ross, Rodin, & Zimbardo, 1969), underline the importance that can be played by a person's belief system even when it is not in line with reality (as defined by the experimenter).

But one says little that is new to people like philosophers and psychotherapists when he suggests that human behavior is importantly a function of cognitions or beliefs that do not mesh with external reality." Clinicians every day see people who suffer from beliefs which sometimes even they regard as erroneous, for example, the claustrophobic who knows it is silly to be afraid to sit in a phone booth. And on the more therapeutic side, experienced clinicians of many ideological persuasions can doubtlessly recall instances in which calm reassurance furnished at least some short-term relief. Indeed, the literature on placebo effect (e.g., Honigfeld, 1964) demonstrates conclusively that merely the belief that something is so often can lead to that very state of affairs. And these effects are not necessarily illusory or short-lived; namely, Paul (1967) has reported maintenance of gains over 2 years for all groups in his comparative desensitization study, including the attention-placebo group.

Man creates his own gods to till in gaps in his knowledge about a sometimes terrifying environment (Malinowski, 1949), creating at
least an illusion of control which is presumably comforting. Perhaps the next best thing to being master of one's fate is being deluded into thinking he is.

REFERENCES


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