Predictable and unpredictable aversive events: Evidence for the safety-signal hypothesis*

KENNETH P. PRICE and JAMES H. GEER†
State University of New York at Stony Brook, Stony Brook, N.Y. 11790

GSR was compared in two groups exposed to either predictable or unpredictable aversive stimuli. Spontaneous fluctuation (SF) of skin resistance was the primary variable measured because it is unconfounded by attentional responses elicited by experimental stimuli. The unpredictable group showed nearly twice as many SFs as the predictable group. Amplitude of GSR occurring within 0-4 sec after onset of the aversive stimulus differentiated between groups, but amplitude of GSR occurring within 4-8 sec after onset did not. The results, discussed in terms of Seligman's safety-signal hypothesis, indicated that arousal is greatest for the unpredictable group during intertrial intervals rather than during the presentation of the UCS.

Furedy (1970; Furedy & Klajner, in press) has criticized the notion that predictable shock is less aversive than unpredictable shock on a number of grounds. His criticism that animal studies are inconclusive because grid shock, and hence avoidable shock, was used is believed to be erroneous because Weiss (1968, 1970) and Price (in press), using tail electrodes to deliver unavoidable shock, found a greater incidence of ulcers and weight loss in rats subjected to unpredictable shock rather than predictable shock. Furedy criticized most human experiments on the grounds that reduced GSR responding to predictable shock could be due merely to a response suppression brought about by any prior stimulus (Grings & Schell, 1969). Furedy & Klajner (in press) attempted to devise an "unconfounded and validated autonomic" index of shock aversiveness by using a CS that predicted a whole *series* of predictable or unpredictable shocks. They found no differences in the psychophysiological and verbal responses of the Ss to predictable and unpredictable shock.

The study reported here also attempted to devise an unconfounded index of shock aversiveness using a different and simpler procedure. A two-group design was used comparing a group receiving a signaled unconditioned stimulus (UCS) to one receiving an unsignaled UCS. Instead of using electric shock as the UCS, pictures of dead bodies were used as the UCS. Such stimuli are less disruptive to the recording of GSR than electric shock applied to a S and are more similar to real-life aversive stimuli than electric shock is. Slide photos of dead bodies have already been shown to be appropriate stimuli for studying autonomic responsivity to aversive events (Geer, 1968; Geer & Klein, 1969).

Five measures of UCS-produced arousal were used. The first was the number of spontaneous fluctuations (SFs) exhibited by a S during intertrial intervals (ITIs). SFs have been used before (Geer, 1968) as an index of emotional arousal. An advantage to this measure is that it is not open to criticisms (such as those made by Furedy) of confounding by other stimuli or responses. The second measure was the specific GSR to the UCS occurring within 0-4 sec after onset of the UCS ("R1"). The third measure was a change in skin conductance (SC) occurring 4-8 sec after onset of the UCS ("R2"). The fourth and fifth measures were the latencies in seconds to the appearance of a GSR within 0-4 sec (R1) and 4-8 sec (R2) after the onset of the UCS. The UCS was divided into two response intervals after Lockhart (1966), who has commented on multiple skin-conductance responses to stimuli of long duration. A response occurring within the first 4 sec of the onset of the UCS was thought to contain both orienting and emotional components. This is illustrated by an experiment by Geer & Klein (1969). Additionally, Grings & Schell (1969) have shown that if any two stimuli are presented successively, the GSR to the second stimulus is reduced. Therefore, a response occurring 4-8 sec after the onset of the UCS was considered a purer measure of arousal, since it was unconfounded by an orienting response (OR) to the onset of the UCS. In the context of this experiment, increased arousal was interpreted as increased emotionality or negative affect.

SUBJECTS AND PROCEDURE

Twenty male undergraduates enrolled in Introductory Psychology served as Ss. They were seated in a reclining chair inside a slightly darkened sound-attenuating chamber and told only that their physiological reactions to pictures of dead bodies were to be measured. While each S was informed that he could terminate the experiment if it proved too aversive, the E emphasized that it was highly unlikely that anyone would feel unable to remain throughout the entire experiment. Both groups of Ss put on earphones with the simple instructions: "I'd like you to wear these please." The earphones were functional only for the predictable group (PG). In order to ensure that Ss looked at the slides, all Ss were instructed to keep their eyes open during the experimental session. They were further told that occasionally a light or a letter or word might be flashed on the screen superimposed on the slide and that it was important that they remember what it was in order to answer questions at the end of the session. (Of course, nothing was ever superimposed on the slides, although several Ss reported noticing flashes of light on some slides.) Ss were also requested to sit as still as possible during the experiment, but that if they moved, they were to tell the E immediately.

Ten minutes after electrodes were in place, the recording of GSR began. After a 2-min baseline period, the first stimulus was presented. For the PG, the CS was an 8-sec 50-dB 1,000-Hz tone. The UCS was a 5-sec exposure of a color slide photo of a dead body, the onset of which was simultaneous with the offset of the CS. Slides were projected onto a screen in front of the S. The size of the projected image was 81 cm^2. The unpredictable group (UPG) received only the UCS. A random presentation of "CSs" was not employed because this has been shown to be more arousing than UCSs presented alone (Geer, 1968). For both groups, 15 UCSs were presented according to a VI 2 schedule (Fleshler & Hoffman, 1962), the order of ITIs determined randomly. For the PG, the ITI was calculated from the offset of the UCS to the onset of the next CS. For the UPG, the ITI was calculated from the offset of the UCS to the onset of the next UCS. Each ITI was of exactly the same duration for each group.

Spontaneous fluctuation of skin resistance was defined as a decrease of at least 400 ohms that occurred during an ITI and was not associated with movements. Skin resistance had not only to decrease, but had to begin increasing after reaching asymptote. Square root of conductance change was used as the measure of GSR amplitude.

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†Requests for reprints should be sent to either author, Department of Psychology, State University of New York, Stony Brook, N.Y. 11790.

APPARATUS

Slides were presented by a Kodak Carousel projector located outside the sound-attenuation chamber. An intercom permitted continuous sound monitoring of the S. Photo duration was controlled by interrupting the projector's light circuit with an electronic timer, which also controlled the CS's duration. The ITIs were controlled via a Gerbrands tape timer. Two channels of GSR were recorded on a Beckman Type RB polygraph. The first channel, recorded using the Beckman GSR coupler, was recorded at low sensitivity and was used to measure basal skin resistance. The second channel was an amplification of the first with the addition of an 8-sec time constant in the circuit, and it provided information concerning changes in resistance. Beckman biopotential silver/silver chloride electrodes placed on the palm of the nonpreferred hand were used for the GSR measurement.

RESULTS

Two Ss in the UPG requested that they be allowed to discontinue the experiment and were allowed to do so. One terminated after 6 stimuli, the other after 11 stimuli had been presented. Their data were used in the analysis so far as possible. The predictable and unpredictable groups did not differ from each other in the number of SFs counted during the baseline measurement period. When the two groups were compared on the number of SFs during the ITIs, the UPG exhibited significantly more SFs (mean = 16) than the PG (mean = 8.5), $U = 18.5$, $p < .01$. Specific GSRs to the UCS were compared between groups: the UPG responded with significantly greater amplitude than the PG during the first response interval, R1 (mean square-root conductance change for UPG = 1.14, for PG = .44), $U = 24$, $p < .05$. There were no differences between groups during the second response interval, R2. There were also no differences between groups in latency to GSR. During R1, the average latency in both groups was 2.1 sec; during R2, the average latency was 4.9 sec in the PG and 4.8 sec in the UPG.

DISCUSSION

Nearly twice as many SFs occurred in the unpredictable group than in the predictable group, indicating clearly that the former exhibited greater emotional arousal than the latter. The UPG also exhibited greater responsivity—or arousal—to the onset of the UCS than the PG. However, as has already been pointed out, this may be due merely to the suppression of a response by a previous response. If, then, R1 is considered primarily an OR, the fact that there were no differences between the two groups in R2—supposedly a pure measure of emotionality—gives rise to an interesting interpretation of the data—that is, that there are no differences between a mildly and a severely "stressed" group in their immediate response to an aversive stimulus but that the difference shows up during rest periods. This is an appealing explanation because it fits in with a host of animal data. For example, Brady (1958) and his coworkers found that monkeys developed ulcers only under the proper stress-rest cycle. Rice (1963) found a similar phenomenon with rats. Mason et al (1961) found a depression of plasma pepsinogen levels in monkeys during a Sidman avoidance session of 72 h and then a dramatic increase in pepsinogen levels at the conclusion of the session, during a rest period.

Seligman (1968) has proposed a safety-signal hypothesis to account for his animal data. This holds that the total amount of time spent in fear is the crucial variable in studies of stress of this nature. A S receiving a predictable aversive event is afraid only during the CS and during the UCS. A S receiving an unpredictable aversive event is always in fear. Thus, we find a similar reaction to the UCS itself, but quite different reactions during the ITIs when the UPG is still afraid but the PG is not.

We cannot quarrel with Furedy's claim that a CS does not reduce the pain or aversiveness of a UCS, because a means of psychophysiologically measuring the aversiveness of the UCS itself eludes us at the moment. But it seems clear that signaling an aversive UCS reduces the emotional arousal or aversiveness of the *total situation* in which the aversive event occurs.

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