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Classical EDR conditioning using a truly random control and subjects differing in electrodermal lability level

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Electrodermal lability has been shown to be correlated with a measure of perceptual sensitivity. The relationship between lability and those processes subserving attention and vigilance was investigated within a conditioning paradigm as contrasted with a "truly random" control procedure. Male undergraduate subjects received either tones paired with shocks (conditioning group) or a truly random control procedure in which tones and shocks were programmed completely independently and randomly. An analysis of variance of adjusted results revealed main effects of lability and experimental group and no significant interactions. An erratic response curve provided no support for a phenomenon of increasing habit strength. The failure to demonstrate conditioning was considered in light of recent literature.

Frequency of spontaneous electrodermal responses (EDRs) has been shown to be a useful index of central nervous system arousal (Burch & Greiner, 1960; Katkin, 1965, 1966; Silverman, Cohen, & Shmavonian, 1959). Furthermore, a high rate of resting spontaneous electrodermal activity differentiated clinically anxious subjects from normals and object-specific phobics (Lader, 1975; Lader & Wing, 1964).

Recent research (Hastrup, 1977; Sostek, Katkin, & Sostek, Note 1) suggests that differences between normal subjects with a high frequency of spontaneous EDRs ("labiles") and those with a low frequency ("stabiles") might be accounted for by differences in "attentional set" or vigilance. These results prompted Katkin (1975) to suggest that lability reflects a variable that is a "selective enhancer of effective central processess, rather than merely a generalized arousal mechanism."

If individual differences in electrodermal lability reflect differences in cognitive efficiency, then labiles would be expected to be more conditionable than stabiles. Several studies have compared the conditionability of labile and stabile subjects (Crider & Tursky, 1967; Ohman & Bohlin, 1973; Stern, Stewart, & Winokur, 1961; Stern, Winokur, Stewart, & Leonard, 1963). None to date, however, has incorporated all of the following three important methodological precautions.

(1) Differentiation between orienting responses and true conditioned responses—The current study employed the method of Prokasy and Kumpfer (1973), in which responses occurring between 1.2 and 3.5 sec after CS onset are designated first anticipatory responses (FARs). Only those responses occurring more than 3.5 sec after CS onset, and thereby outside the range of latency for the unconditioned orienting response, are considered possible conditioned responses.

(2) Use of a random control group, advocated by Rescorla (1967), in which CS and UCS are programmed independently and randomly such that no contingency whatever exists between them.

(3) Assessment of spontaneous EDR rate during a preexperimental rest period rather than during the experimental manipulation itself—This procedure, of course, potentially confounds the assessment of lability with response to experimental treatment.

The present authors were careful to include each of these methodological safeguards in the study reported here.

METHOD

Subjects

Subjects were 63 male students in introductory psychology who were fulfilling a course requirement that they participate in four psychology experiments.

Apparatus

The experimental set-up has been described in detail elsewhere (Hastrup & Katkin, 1976). The conditioned stimulus, a tone of 64 dB, was generated by a Heathkit audio generator, Model 1G-72, amplified by an Olson AM-400 audio amplifier, and delivered to the subjects through a headset. Electric shock, the UCS, was produced by a 6-V power supply with a maximum output of 50 mA. The dial was set so the subjects received approximately 60 V; this level of shock had been determined in pilot work to be generally unpleasant but not painful.

Procedure

Forty-three of the subjects were run by a female experimenter and 20 subjects by a male experimenter. Upon arriving in the laboratory, subjects were given a statement to read that informed them that during the ensuing experiment, they would receive a harmless electric shock of 2 sec duration to one finger. Participation in the experiment was described as entirely optional, and subjects were asked to indicate their decision by either signing or not signing a small card and returning it to the experimenter in the next room. Subjects who agreed to participate (less than 4% declined) were asked to wash their hands and were then seated comfortably in the chamber.

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The experimenter gave the following explanation and instructions while attaching the electrodes and respirometer to the subject: "In this experiment were are interested in measuring the effects of different kinds of environmental stimuli on responses of the nervous system. In order to measure these responses we're going to attach two electrodes to your palm and another one to your finger. This [points] goes around your waist to record your breathing; I'm going to attach this [respirometer] now. . . . This should be snug but not tight– How does that feel?

[While attaching electrodes] "These measure activity of the sympathetic nervous system by measuring sweat gland activity; however, they are also very sensitive to movement, which is why we ask that while you participate in the experiment you try to move as little as possible.

"You'll be spending the first 10 min in here just relaxing while we record your resting responses. Following that you'll receive a series of tones and then a series of tones and harmless electrical stimuli. During the experiment we ask that you relax but please don't fall asleep, and don't meditate.

"This intercom will be on the whole time you are in here. If you wish to contact me, all you have to do is speak in a normal voice and I will hear you.

"If you have any questions, please ask me now."

Following an initial 10-min rest period during which the number of spontaneous EDRs were recorded, all subjects were presented with a habituation series consisting of 20 tones, each 8 sec in duration. Intervals between tones were variable, ranging from 11 to 19 sec, with a mean of 15 sec.

Following the habituation series, subjects in the conditioning group were presented with a series of 21 8-sec tones, each of which was followed immediately by a shock of 2 sec duration. Intervals between successive tones were distributed randomly between 37 and 56 sec, with a mean of 47.59 sec.

Following the habituation series, subjects in the random control group received a total of 21 8-sec tones and 21 2-sec shocks, programmed completely independently and randomly. The average interstimulus interval was 21.2 sec, and the range was 3-78 sec. The overall duration of this phase of the experiment was the same as that for the conditioning group.

RESULTS

According to the scheme outlined by Prokasy and Kumpfer (1973, p. 165), SARs were defined as those responses occurring 3.5 sec or more after CS onset but before UCS onset. Responses occurring within 1.2 and 3.5 sec of a respiratory irregularity were disregarded as artifactual.

A change in log conductance was calculated for each response according to the formula, $\log 1/R_2 - \log 1/R_1$, where R_1 and R_2 represent pre- and poststimulus resistance levels, respectively. The first score, corresponding to the first trial, was eliminated, since this response occurred before the first presentation of the UCS and therefore cannot be said to reflect conditioning. The scores corresponding to the remaining 20 acquisition trials were reduced to 10 trial blocks of 2 averaged trial scores each. Each trial block score was multipled by a constant (500) in order to avoid having to work with very small numbers.

Classification as labile or stabile was determined in each of three ways: on the basis of frequency of spontaneous EDRs, rate of habituation, and a more stringent criterion incorporating both of these measures. Three separate, corresponding analyses were performed on the data.

The number of spontaneous EDRs occurring during the last 2 min of the rest period was scored for each subject. A spontaneous EDR was defined as a decrease in resistance of at least 100 ohm. Scores ranged from 0 to 32 with a median of 10. Those subjects scoring above the median were designated as labile, those scoring below the median as stabile, and three subjects scoring at the median were eliminated.

The index of habituation was designated as the number corresponding to the earliest trial in the habituation series to be followed by three consecutive trials during which the subject made no response. A "response" in this case was defined as a change in resistance at least 1,000 ohm in magnitude and could occur at any time during tone presentation. Habituation scores ranged from 0 (no response to first three trials) to 20, with a median of 13. One subject scoring at the median was eliminated from this analysis.

The correlation between a subject's spontaneous EDR score and his habituation score was .57. It is suspected that this correlation would have been higher had we not imposed a ceiling (20) on possible habituation scores. Crider and Lunn (1971), for example, continued presenting tones to each subject until he habituated; the correlation they reported between spontaneous EDR scores and habituation was .75.

For purposes of the third analysis, subjects were designated as labile only if they scored above the median on both the distribution of spontaneous EDR scores and the distribution of habituation scores. Similarly, only those subjects below the median on both distributions were classified as stabile. Twenty-two subjects not meeting either of these criteria were eliminated from the analysis. The four cells thereby constituted were as follows: conditioning-labile ($n = 8$), conditioning-stabile, ($n = 8$), random-labile ($n = 12$), random-stabile ($n = 13$).

The patterns of results for each of the three analyses were identical and, for that reason, only the results based on the analysis utilizing the more stringent dual criterion of frequency of spontaneous EDR fluctuations and habituation score will be presented and discussed here.

Examination of subjects' responses to the last tone presented during the habituation series showed that there were no pretreatment differences between conditioning and random experimental groups. For FARs, the means for conditioning and random groups were 2.92 and 6.07, respectively [$t(39) = .7$, $p > .05$]; means for SARs were 5.875 and 5.97, respectively [$t(39) = .021$, $p > .05$].

There were no differences in the pattern of results produced by subjects run by the female experimenter and those run by the male experimenter.

The results of the analysis of variance of SAR scores are presented in Table 1. Cell means were as follows: conditioning-labile, 13.19; conditioning-stabile, 4.54;

Table 1
Results of Analysis of Variance of SARs During Acquisition

Source of Variance	df	Mean Square	F Ratio
Lability (La)	1	5073.48	14.38*
Experimental Group (Ex)	1	1072.44	3.04
Trial Blocks (Tt)	9	643.86	6.66*
La by Ex	1	202.40	.57
La by Tt	9	120.92	1.25
Ex by Tt	9	434.30	4.49
La by Ex by Tt	9	40.56	.42*

Note—Analysis utilized dual criterion of lability (see text).
$p < .001$.

random-labile, 9.37; random-stabile, 4.50. Mean scores are depicted graphically across trial blocks by experimental treatment in Figure 1 and by the lability factor in Figure 2.

Note that there were significant main effects for lability and trial blocks and a significant interaction between experimental treatment and trial blocks. There was, however, no significant main effect of treatment; nor was there a significant triple interaction among trials, lability, and treatment.

It was suspected that the significant Trial Blocks by Treatment interaction was almost entirely due to the strong responses to the first and second trial blocks shown by subjects in the random group. These atypically strong responses may be accounted for by the fact that, as random programming would have it, the first stimulus presented to these subjects was a shock.

The analysis was therefore repeated on Trial Blocks 3-10 only. The results showed that, as expected, the main effect of trial blocks and the interaction between trial blocks and treatment were no longer significant. There was, however, a significant main effect of experimental treatment [$F(1,31) = 8.90, p < .01$].

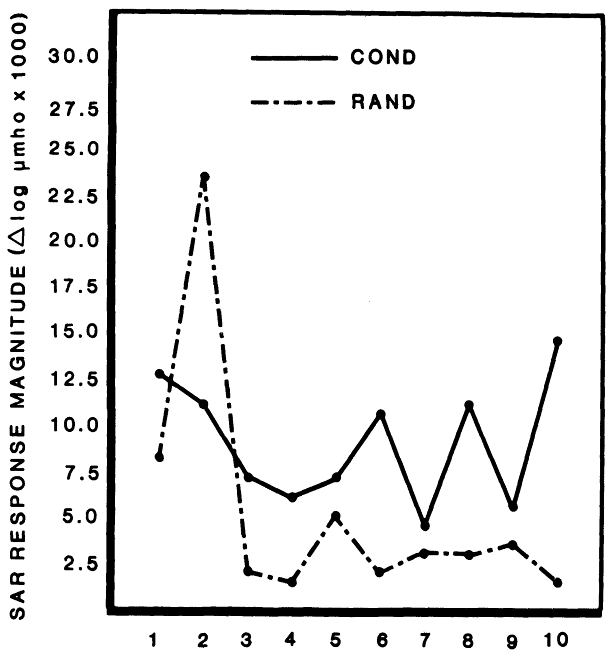

Figure 1. Mean SARs during acquisition as a function of experimental group.

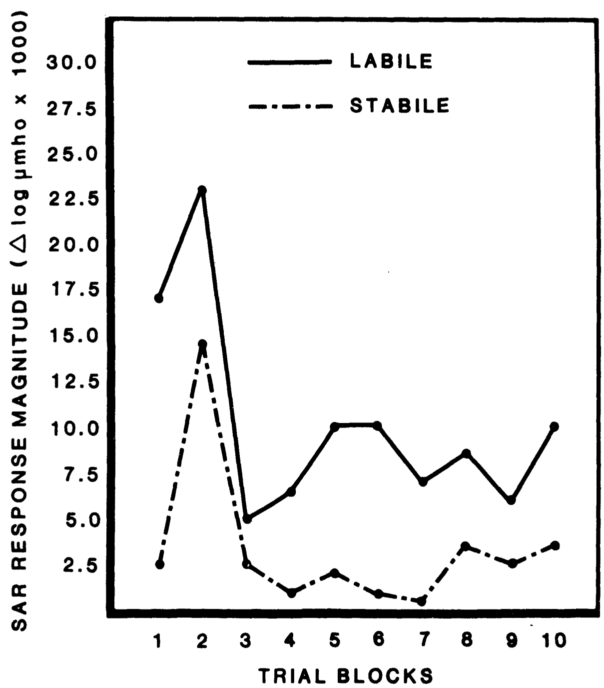

Figure 2. Mean SARs during acquisition for labile and stabile subjects.

DISCUSSION

The significant main effect of lability in this experiment confirms the finding of previous studies that lability is significantly correlated with magnitude of response to tone (Purohit, 1966; Silverman et al., 1959).

The data, however, provide no support for the major hypothesis of an interaction between lability and response to CS within a conditioning paradigm. The results, in fact, provide no evidence that conditioning occurred. Although the analysis of 10 trial blocks produced a significant Treatment by Trial Blocks interaction, analysis of Trial Blocks 3-10 only revealed that this interaction was the spurious result of unusually large responses on Trials 1 and 2. While the second analysis produced a significant main effect of experimental treatment, the erratic response pattern over time depicted in Figure 1 provides no evidence for a phenomenon of increasing habit strength.

The current failure to demonstrate GSR conditioning prompts one to reconsider the tenability of the phenomenon generally. Other observers have noted that the SAR "acquisition" curves reported for GSR conditioning are varied and generally not typical of learning curves for other types of responses. Decreasing (Martin, 1963; Ohman & Bohlin, 1973), inverted-U (Stern et al., 1961; Stewart, Stern, Winokur, & Fredman, 1961), erratic (Burstein & Smith, 1972; Prokasy & Ebel, 1967), and increasing (McDonald & Johnson, 1965) response curves have all been reported. There are, in fact, "virtually no reports of GSR conditioning involving the 75%-100% level of asymptotic performance which has been reported with other responses, e.g., eyelid conditioning, and which one would expect with a successful conditioning procedure" (Burstein, Note 2, p. 11).

These findings become more meaningful within the context of a perspective that stresses the overriding importance of subjects' cognitive, as opposed to merely autonomic, processes in shaping the pattern of responding over time. Brewer (1974) has reviewed the results of numerous studies that have attempted to dissociate cognitive from autonomic determinants of conditioning. The studies fairly consistently report a failure to demonstrate conditioning in the absence of the subject's ability to verbalize the contingencies being employed. Conversely, "conditioning" has been produced in at least seven studies when subjects were led to expect, but did not actually receive, CS-UCS pairings.

One may also question the veritability of GSR conditioning as an autonomic phenomenon. Burstein (Note 2), for example, has directed some thoughtful attention to the function of the GSR in the natural environment. The point of view he adopts is that the GSR response, whether FAR or SAR, is essentially reflexive in nature: It is "wired in" to alert the organism to potentially lethal stimuli. Should the stimulus prove to be nonlethal, the GSR is programmed to adapt out. Contact with a lethal stimulus will, adaptively, prompt the organism to escape; repeated unavoidable contact with such a stimulus will maintain the reflexive GSR. Within such a scheme, it is clear that the gradual acquisition of an electrodermal response that functions as an alerting system will have little survival value for the organism.

As Burstein (Note 2) points out, this explanation suggests that experiments reporting an initial rise in SAR responding followed by a decline may be depicting an initial reinstatement of the OR due to novel pairing of tone with shock, followed by habituation. Other experiments, such as the one reported here, that have produced erratic curves may demonstrate OR maintenance. The differentiating feature may be the perceived aversiveness of the shock for the subject; this is corroborated by the observation in the current study that nearly all subjects continued to produce responses to the UCS until the end of the trials.

Finally, we note that the conditioning group showed greater sensitivity to the tone in Trial Blocks 3-10 than did the control group. We would, therefore, not rule out the possibility that these curves have some theoretical significance. At the present time, however, as Burstein (Note 2) observes, "the precise nature of this significance is not entirely clear" (p. 11).

In summary, the data we have reported provide no support for the hypothesis of a correlation between lability and conditionability. In addition, we could adduce no evidence that subjects in either experimental group conditioned and considered different theoretical explanations of this result. It appears, therefore, that the relationship between lability and those central processes subserving alertness and vigilance may be more advisably examined within experimental paradigms other than conditioning.

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