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FAILURE TO CONDITION EVALUATIVE AND
ELECTRODERMAL RESPONSES TO NEUTRAL STIMULI
BY MEANS OF PREPARED CUES

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Failure to condition evaluative and electrodermal responses to neutral stimuli by means of prepared cues
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Some authors (e.g. Rachman, 1970; Bennet-Levy & Marteau, 1984) have treated
Seligman's preparedness hypothesis (1971) and Gray's suggestion (1979, 1982) that
phobias might be based on innate fears as quite similar formulations. There is,
however, a crucial difference between the theoretical positions of Seligman and
Gray. According to Seligman (1971), the survival chances of our ancestors profited
from a tendency or "preparedness" to readily associate certain stimuli (e.g. snakes,
spiders, enclosed spaces, etc.) with fear reaction. He holds that this tendency is
easily activated by mildly aversive events and, in addition, that it forms the basis
of a substantial number of clinical phobias exhibited by modern man (de Silva,
Rachman & Seligman, 1977). The research of Öhman and co-workers has provided
psychophysiological evidence that seems to support Seligman's hypothesis. Using
electric shocks as aversive, unconditioned stimuli (US), they demonstrated in more
than a dozen conditioning studies that the skin conductance response (SCR) of
neutral stimuli, once conditioned either to prepared stimuli (slides of snakes or
normal subjects, spiders) or to neutral stimuli (slides of mushrooms or flowers), extinguishes more

1 Parts of this research were presented at the symposium on "Affect and Emotions", of the World Psychiatric Association, October 1987, Vienna, Austria.

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slowly with the former than with the latter category of stimuli (see for review Ohman, 1986). It should be noted, however, that attempts by researchers from other laboratories to obtain a straightforward replication of the Ohman results have met with considerable difficulties (e.g. Merckelbach & van den Hout, 1987).

Whereas prepared learning, in the sense of Seligman and Ohman, requires aversive conditioning and, hence, the presence of an aversive US, Gray (1979, 1982) has suggested that stimuli like snakes and spiders induce innate fear reactions, even in the absence of aversive events. According to Gray, preparedness is a superfluous concept when one chooses the simpler move “to treat spiders and snakes, and the like as innate stimuli for fear, requiring no conditioning at all” (1982, p. 434). The study of Bennett-Levy and Marteau (1984) and of Merckelbach, van den Hout and van der Molen (1987) can be taken as support for Gray’s position: in both studies, it was found that healthy subjects attribute negative characteristics (e.g. strange appearance, unpredictability, etc.) to such animals as snakes and spiders. Gray (1982) showed that it is, in principle, possible to re-examine the delayed extinction of the conditioned SCR to prepared stimuli, reported by Ohman et al., in such a way that conditioning accounts are not necessary. Basically, this reinterpretation says that in the typical Ohman et al. experiments, SCRs to prepared stimuli reflect innate fears which are further potentiated by electric shocks and, consequently, become resistant to extinction. In terms of Pavlovian theory, one could summarize the difference between Ohman and Seligman, on the one hand, and Gray, on the other hand, as follows: while Seligman and Ohman regard such objects as snakes and spiders as a special subclass of conditioned stimuli (CS), Gray’s remarks seem to imply that these objects function as USs for anxiety.

The present experiment sought to answer the question of whether it is possible to condition evaluative and electrodermal responses of healthy subjects to neutral stimuli (slides of mushrooms or flowers) by means of prepared cues (slides of snakes or spider). If it could be shown that prepared cues do, indeed, function as USs in a conditioning paradigm, then this would support Gray’s position and his critical reinterpretation of the Ohman et al. experiments.

Some remarks concerning the choice of the dependent variables are in order. Evaluative responses were included in the present study because the research by Martin and Levey (1976) has demonstrated that evaluative responses of subjects are sensitive to various aspects of conditioning process. For example, Levey and Martin (1975) asked subjects to indicate how much they liked or disliked various postcards. When neutral postcards were repeatedly followed by negatively or positively evaluated postcards, the negative or positive affective value of the latter postcards was transferred to the formerly neutral postcards.

Both Fowles (1980) and Gray (1982) have suggested that electrodermal rather than cardiovascular responses reflect the reaction of the anxiety system, in their words, the behavioral inhibition system (BIS), to threatening stimuli. Meyers and Smith (1977) reported an asymmetry in bilaterally recorded SCRs, with SCRs recorded from the right hand being relatively greater under “affective conditions”. In order to test whether SCRs differ as a function of recording side, SCRs were derived from the left hand in one group of subjects and from the right hand in a second group.

**METHOD**

**Subjects**

The subject sample consisted of 23 healthy students (19 females and 4 males). Their mean age was 22.4 years (range: 19–31 years). The subjects participated in the experiment in exchange for a small financial reward.
Apparatus and Stimulus Materials

SCRs and skin conductance level (SCL) were recorded with a Beckman Skin Conductance Coupler (type 9844). The coupler allowed for a maximum sensitivity of 0.05 microhmo. Respiration was recorded with a Beckman Pressure/Pulse/Voltage Coupler (type 9855 A). After the skin had been cleaned with distilled water, Ag–AgCl electrodes (8 mm diameter), filled with Hewlett Packard Redux paste, were attached with adhesive collars to the electrodermal recording sites. They were placed on the medial phalanges of the second and third finger. In 12 subjects SCRs were recorded from the left hand and in 11 subjects recordings were made from the right hand. Respiration was derived from a Beckman Respiration Belt (type 218880), fastened around the subject's chest. SCR and respiration were monitored using a Beckman R 711 polygraph.

A Kodak Carousel was used for presentation of the slides. The slides were projected onto a wall. The size of the projected image was approximately 80 x 120 cm, 2.5 m in front of the subject's chair. Subjects were exposed to slides of prepared (snakes or spiders) and neutral (mushrooms, flowers and apples) content.

Onset and offset of the slides, inter-trial intervals, and response registration were controlled by a microcomputer (PDP Minic-11).

Design and Procedure

The experiment was designed according to a within-subjects factorial model. The within-subjects factor (contingency) consisted of two levels and referred to the association of stimuli during the acquisition phase of the experiment. Each subject saw one neutral slide (CS+) that was repeatedly followed by a prepared stimulus (US) and one neutral slide (CS-) that was repeatedly followed by a neutral control stimulus (NCS). The CS- was followed by this second neutral stimulus to control for possible pseudo-conditioning effects (e.g. dishabituation) of the prepared US on responses to the CS+. In the statistical analyses, trial factors, in the form of repeated measures, were added to the within-subjects factor.

The subject was seated in a chair that was placed in a dimly lit, sound-attenuated chamber. Stimulus equipment and recording apparatus were in an adjacent room. Slides were projected through a hole in the wall. Subjects were told that the purpose of the experiment was to investigate physiological and subjective responses to various slides. They were not instructed about the contingencies between the slides.

To obtain baseline ratings of the subjective responses to the slides, subjects viewed three neutral (CS+, CS-, and NCS) and one prepared slide. Each slide was shown for 4 sec. Subjects rated each slide in terms of pleasantness on a 14 cm visual analog scale, ranging from 0 ("extremely unpleasant") to 14 ("extremely pleasant"). In the subsequent conditioning procedure the four slides were used as CS+, CS-, NCS and US.

The conditioning procedure consisted of three phases. The first was a habituation phase which involved 6 trials (3 CS+ alone and 3 CS- alone). Then, an acquisition phase followed in which the CS+ was associated with the US and the CS- was associated with the NCS. There were 6 CS+ and 6 CS- acquisition trials. Finally, an extinction phase, consisting of 12 trials (6 CS+ and 6 CS-), followed. No further presentation of the US or the NCS occurred during extinction. Throughout the conditioning procedure, the order of the CS+ and CS- slides was quasi-random. The duration of CS+ and CS- slide presentation was 6 sec. Inter-trial intervals varied between 12 and 16 sec, with a mean of 14 sec. During acquisition the US and control stimulus followed 1 sec after CS+ and CS-, respectively. Duration of the US and NCS presentation was 4 sec. The contingency factor was counterbalanced so that slides of flowers, mushrooms and apples served an equal number of times as CS+, CS-, and NCS. Half of the subjects saw a snake as the US and half saw a spider as the US.

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At the end of the experiment, subjects were again asked to rate the four slides on pleasantness.

**Response Definition**

SCL was measured on four occasions during the experiment: at the very beginning of the habituation, between habituation and acquisition, between acquisition and extinction, and, finally, at the end of the extinction phase. SCRs were defined as the largest phasic deflection occurring 1–4 sec after slide onset. SCL and SCR were measured in microhemo and square root transformed. Data were analyzed as response magnitudes. Respiration was used as a control variable; trials with respiratory irregularities, as defined by Stern, Ray and Davis (1980), were excluded from the data analyses. They occurred in less than 5% of the total number of trials. The SCR magnitudes on these trials were estimated by taking the mean of the two adjacent trials.

**RESULTS**

**Subjective Evaluation**

As can be seen in Table 1, subjects evaluated the prepared stimulus more negatively than the CS+ or, CS— or, NCS. When the pleasantness ratings were subjected to t-tests, it was found that the differences in subjective evaluations of the CS+, CS—, and control stimulus, on the one hand, and of the prepared stimulus, on the other hand, were highly significant, both before and after the conditioning procedure [for all comparisons: \( t (22) > 6.30, p < 0.01 \), one-tailed].

To examine whether the association of the neutral CS+ with a prepared stimulus (US) resulted in a more negative evaluation of the CS+, a 2 (pre- vs. post-conditioning) \( \times 2 \) (contingency: CS+ vs. CS—) analysis of variance (ANOVA), with both factors having repeated measures, was carried out. No significant main or interaction effects were obtained. Thus, no evidence for evaluative conditioning was found (Tab. 1).

**Skin Conductance**

SCL data were analyzed, using a 2 (left hand vs. right hand recording) \( \times 4 \) (period) ANOVA, with the last factor having repeated measures. Although SCLs from the right hand (mean \( \bar{SCL} = 3.54 \), std = 0.88) were higher than

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**Table 1. Mean subjective evaluations of prepared unconditioned stimuli (US), neutral conditioned stimuli (CS+, CS—) and neutral control stimuli (NCS), before (PRE) and after (POST) the conditioning procedure. Standard deviations are given between parentheses.**

<table>
<thead>
<tr>
<th></th>
<th>US*</th>
<th>CS+*</th>
<th>CS—*</th>
<th>NCS*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PRE</strong></td>
<td>4.24</td>
<td>9.01</td>
<td>10.07</td>
<td>11.24</td>
</tr>
<tr>
<td></td>
<td>(2.88)</td>
<td>(2.64)</td>
<td>(2.89)</td>
<td>(2.27)</td>
</tr>
<tr>
<td><strong>POST</strong></td>
<td>3.95</td>
<td>9.58</td>
<td>9.73</td>
<td>11.57</td>
</tr>
<tr>
<td></td>
<td>(2.12)</td>
<td>(3.41)</td>
<td>(3.44)</td>
<td>(2.06)</td>
</tr>
</tbody>
</table>

* US = unconditioned stimulus, CS = conditioned stimulus
NCS = neutral control stimulus
** PRE = pre-conditioning, POST = post-conditioning

(ANOV), with both factors having repeated measures, was carried out. No significant main or interaction effects were obtained. Thus, no evidence for evaluative conditioning was found (Tab. 1).
SCLs from the left hand (mean \( \sqrt{SCL} = 2.96 \), std = 0.74), the main effect of recording site reached only borderline significance \( [F(1.21) = 2.80, p \leq 0.11] \). In addition, a main effect of period \( [F(3.63) = 13.91, p \leq 0.01] \), due to a linear increase of SCL during the experiment, was found.

**Habituation.** Mean SCRs during CS+ and CS− habituation trials are shown in the left panel of Figure 1. A 2 (recording site) × 2 (contingency: CS+ vs. CS−) × 3 (trials) ANOVA was performed on the habituation data. A main effect of trials \( [F(2,42) = 14.96, p \leq 0.01] \), caused by a steady decline of responses over trials, was found. No other significant effects emerged.

![Figure 1](image)

**Figure 1.** Mean \( \sqrt{SCR} \) to CS+ and CS− trials as a function of habituation (H), acquisition (A), and extinction (E) trials. Mean \( \sqrt{SCR} \) to US and NCS during acquisition are also shown.

**Acquisition.** SCRs to CS+ and CS− acquisition trials (middle panel Figure 1) were subjected to a 2 (recording site) × 2 (contingency: CS+ vs. CS−) × 6 (trials) ANOVA. The overall decrease in SCRs over trials resulted in a significant main effect of trials \( [F(5,105) = 7.19, p \leq 0.01] \). The main effect of contingency remained non-significant \( [F(1,21) \leq 1.0] \), indicating that successful SCR conditioning did not occur.

A 2 (recording site) × 2 (stimulus type: US vs. NCS) × 6 (trials) ANOVA showed that SCRs to the prepared US were significantly higher than those to the NCS \( [F(1,21) = 12.84, p \leq 0.01] \). As a main effect of trials made clear \( [F(5,105) = 3.08, p \leq 0.01] \), there was a decline in responding to US and con-
control slides over trials. Furthermore, a significant interaction effect of stimulus type with trials was found \( F(5,105) = 4.34, p < 0.01 \): the decline in SCR magnitudes was more pronounced on US trials than on control stimulus trials.

**Extinction.** A 2 (recording site) × 2 (contingency: CS+ vs. CS−) × 6 (trials) ANOVA showed no significant main or interaction effects: Even the main effect of trials \( F(5,105) = 1.63, p < 0.16 \) failed to reach significance.

**DISCUSSION**

In the last 15 years, several authors have attempted to broaden the concept of the "unconditioned stimulus" (US). For example, Martin and Levey (1978) repeatedly demonstrated that stimuli which are negatively or positively evaluated (e.g., photographs of landscapes or modern art) function as USs in evaluate conditioning procedures without evoking an overt physiological response. Another example can be found in Eysenck's incubation theory (1952). According to Eysenck, interceptive and proprioceptive CSs in aversive conditioning can act as partial substitutes for the US and, consequently, can induce incubation of fear. Closely related to his theory is the notion that episodes of panic attacks (which may be considered as paroxysmal panic attacks) can function as aversive USs (Ackerman & Sacher, 1974). An important psychophysiological study in this context is an experiment by Geer (1968). He reported that electrodermal conditioning by means of an US which does not involve physically painful stimulation is possible. In his experiment, the pairing of auditory stimuli (CS+) with photographs of violent death (US) resulted in conditioned electrodermal responses to the auditory stimuli.

Gray's proposal (1979, 1982) that prepared cues have to be regarded as unconditioned, innate fear stimuli fits into the tendency to extend the category of stimuli which are assumed to act as USs. However, the results presented above failed to support the hypothesis that prepared cues operate as USs in a classical conditioning paradigm. Neither subjective evaluations nor SCRs yielded reliable conditioning effects. One could counter that our findings of a consistently more negative evaluation of prepared stimuli and of significantly higher SCRs to these stimuli confirm Gray's proposal. However, the mere fact that some stimuli elicit more negative evaluations and greater autonomic orienting reactions than other stimuli does not render them automatically USs. In order to classify a stimulus as an unconditioned, innate fear stimulus, it is necessary, though not sufficient, to demonstrate that this stimulus is so aversive that it evokes reactions to a formerly neutral object which precedes the stimulus. Obviously, this could not be achieved in the present study.

In several respects the results presented above confirm conclusions drawn from earlier research. First, as in the study by Ohman, Eriksson, Fredrikson, Hugdahl, and Olofsson (1974, experiment 2), SCRs to prepared stimuli were significantly larger than those to neutral stimuli. Second, the absence of electrodermal conditioning effects seems to be in line with the results reported by Siddle, Bond, and Friswell (1997, experiment 1). Although, in their study, statistical tests relevant to the issue under consideration here are lacking, the results presented by these authors strongly suggest that in a second-order conditioning paradigm, conditioned SCRs to neutral stimuli which are paired with a prepared stimulus only appear when the prepared stimulus has previously been paired with a physically painful US. Third, since, in the present study, the basic requirements for evaluative conditioning were met (i.e., subjects evaluated the prepared US as more negative than the neutral, CS+, and the CS+ was paired with the US in a classical conditioning procedure) the absence of evaluative conditioning in the present study seems, at first sight, to be at variance with the research by Martin and Levey (1978). However, working primarily with weak USs which were selected on the basis of their positive or negative connotations rather than their physiological effects, Martin and Levey (1973) demonstrated that similarity of content and form between CS+ and US enhances evaluative conditioning, whereas dissimilarity eliminates evaluative conditioning. While it is
difficult to determine independently and in advance the degree of similarity or dissimilarity between CS+ and US, the most likely explanation for the absence of evaluative conditioning in the present study is a combination of the relatively weak impact of the US and the dissimilarity in content between CS+ and US. However, as the earlier mentioned experiment by Geer (1968) makes perfectly clear, the negative effects of dissimilarity between CS+ and US on conditioning can, in principle, be overruled by a strong though, painless, US.

A much discussed issue is whether or not effects of cerebral laterality can be observed in SCRs (see review by Hugdahl, 1984). This issue is of potentially great importance because it is conceivable that discrepancies between studies arise as a consequence of different recording sites (left hand vs. right hand). Recently, Meeyns and Smith (1987) reported greater right hand SCRs during emotional processing and greater left hand SCRs during cognitive processing. Except for marginally greater SCLs from the right hand than from the left hand, the present study found no differences between electrodermal activity as a function of recording site. It may well be that the lack of sensitivity of the between-subjects design, as well as the lack of differentiation between cognitive and affective elements of the experimental task, contributed to this. Clearly, further research should pursue the relationship between cerebral laterality and SCR.

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Ganti, Pavlov and Freud: A Comparison — William G. Reese, M. D., Marie Wilson Howells Professor and Chairman Emeritus, Univ. of Arkansas for Med. Sci., 4301 West Markham, Little Rock, AR 72205–7199. Contrasts between classical Pavlovianism and classical psychoanalysis have been emphasized, but there are also significant similarities of which I write. A recent edition of a textbook of psychiatry which is widely used in the United States (Kaplan and Sadock 1985) indexes neither Pavlov nor Gantt, although it provides extensive coverage of psychoanalysis.


Horsley Gantt: Through the Camera Eye — William G. Reese, — Univ. of Arkansas for Med. Sci., 4301 West Markham, Little Rock, AR 72205–7199. The following comments were made on some forgotten occasion honoring Gantt in 1968. I submit them now in memory of the anniversary of his birth on October 24, 1933.


A Brainstem "Mini-Discharge" Syndrome (Anesthesia Dolorosa) — Orlando J. Andy, M. D., — Dpt. of Neurosurgery, Univ. of Mississippi Med. Centr., 2500 North State Street, Jackson, MS 30215–4505. Chronic pain consisting of anesthesia dolorosa secondary to bilateral interruption of trigeminal nerves is presented as a brain stem reticular denervation syndrome. Electrothalamograms revealed fast frequency discharges in the mesothalamic prerubral and centromedian reticular formation. Mesothalamic electrical stimulation attenuated the discharges. Pain and other symptoms presumably of brainstem origin also were attenuated or abolished by therapeutic electrical stimulation twice daily. It is postulated that brain stem-represented behavioral generators are implicated by the reticular discharges in order to produce the complex symptomatology. Consequently the symptom complex is collectively identified as a brainstem "mini-discharge" syndrome. A theoretical discussion is presented to defend the thesis that reticular denervation-induced low threshold discharge system account for the episodic states of pain, dyskinesia, mood, and memory disturbances.

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