PSYCHOPHYSIOLOGY

Vol. 28, No. 2
Printed in U.S.A.

Effects of Potentially Phobic Conditioned Stimuli on Retention, Reconditioning, and Extinction of the Conditioned Skin Conductance Response

ANNE M. SCHELL,
Occidental College

MICHAEL E. DAWSON,
University of Southern California

AND KSENIJA MARINKOVIC
University of California, Los Angeles

ABSTRACT

Discriminative classical conditioning of skin conductance responses (SCRs) was studied in 163 college students as a function of four variables: CS type (potentially phobic versus neutral conditioned stimuli), Sex of the subject, Interstimulus interval (ISI) during conditioning (.5 versus 8 s), and Retention interval between conditioning and retention assessment (1 versus 6 months). CS type did not affect acquisition, retention, or reconditioning of the differential conditioned responses. The effect of CS type was highly significant during extinction, with differential SCRs to CS+ and CS− being greater with potentially phobic conditioned stimuli. This was true for both sexes, both the .5-s and the 8-s ISI, and after a 1-month or a 6-month retention interval. Moreover, SCRs conditioned to phobic conditioned stimuli with the .5-s ISI persisted even after subjects' cognitive expectancy of the UCS, which was measured on a trial-by-trial basis, had completely extinguished. The results indicate that the effect of potentially phobic conditioned stimuli on the conditioned skin conductance response is unique to resistance to extinction—they affect not learning but unlearning of the autonomic response.

DESCRIPTORS: Skin conductance response, Classical conditioning, Potentially phobic CSs, Phobia.

In the study of classical conditioning of autonomic nervous system responses in humans, one of the most intriguing series of studies in recent years has involved the demonstration that certain classes of stimuli, termed "potentially phobic" or "fear relevant," have the propensity for acquiring conditioned responses that are extremely resistant to extinction. In this body of work, carried out primarily by Öhman and his colleagues, pictures of spiders, snakes, and angry faces whose gaze is directed toward the subject, paired with aversive unconditioned stimuli, have been shown to produce in normal subjects conditioned skin conductance responses (SCR CRs), which are more resistant to extinction than are those conditioned to such neutral or fear irrelevant stimuli as pictures of flowers, mushrooms, geometric shapes, happy faces, or angry faces whose gaze is averted from the subject (see McNally, 1987; Öhman, 1986; and Öhman, Dimberg, & Öst, 1985, for reviews of this literature). In addition, these conditioned responses have been reported to be less affected than are those conditioned to neutral stimuli by instructions that inform the subject that the unconditioned stimulus will no longer be administered (Hugdahl, 1978; Hugdahl & Öhman, 1977), to be more resistant to

The authors wish to express their thanks to the following colleagues who assisted with the carrying out of this study: Sarah Lusk, for assistance with data collection; Sheree Ting and Wendy Spotts, for assistance with record reading; and Diane Filion, for preparation of figures. We also acknowledge the considerable contribution by Jeffrey Braaten, and report with sorrow the death of this friend and colleague on September 18, 1987. This research was supported by NIMH grant MH40496.

Address requests for reprints to: Anne M. Schell, Department of Psychology, Occidental College, Los Angeles, CA 90041.

extinction even after only one CS+/UCS pairing (Öhman, Eriksson, & Olofsson, 1975), to be better established by instructions that threaten the delivery of shock after CS+ in the absence of actual delivery (Hugdahl, 1978; Hugdahl & Öhman, 1977; Öhman, Eriksson, Fredrikson, Hugdahl, & Olofsson, 1974), and more resistant to extinction even when the original acquisition was only vicarious (Hygge & Öhman, 1978).

This body of research has obvious implications for the study of phobias, because by virtue of their resistance to extinction and to cognitive manipulations such as extinction instructions, conditioned responses that are conditioned to potentially phobic conditioned stimuli may provide a laboratory analog of clinical phobias. The findings have particular relevance to the preparedness theory of phobias (Seligman, 1970, 1971), which holds that evolutionary selection has created a preparedness to associate certain events (taste with illness or snakes with unpleasant tactile sensations), and an unpreparedness to associate others (e.g., flowers with shock). Responses conditioned to prepared conditioned stimuli, according to this theory, would be resistant to extinction and would not require cognitive mediation. Öhman and his colleagues have attributed their results to such a phylogenetic (genetically based) preparedness in humans (Öhman, 1986; Öhman et al., 1985; Öhman, Fredrikson, Hugdahl, & Rimmö, 1976), an interpretation supported by the finding of Cook, Hodes, and Lang (1986) that spiders and snakes acquire conditioned responses more resistant to extinction than do fear stimuli with an ontogenetic (cultural) basis, such as pictures of rifles and revolvers.

Although responses conditioned in the laboratory to potentially phobic stimuli appear to possess some aspects of phobias, notably resistance to extinction, other key characteristics of phobias have either not been investigated for parallels or their presence is ambiguous. For example, preparedness theory would presumably predict that differences between conditioning with potentially phobic and neutral stimuli would occur in acquisition as well as in extinction, that phobic conditioned stimuli would acquire conditioned responses more rapidly and/or with a greater magnitude than neutral conditioned stimuli. However, acquisition effects have been reported by only a minority of investigators (McNally, 1987). In addition, clinical phobias are retained with great strength over considerable periods of time in the absence of exposure to the phobic object (Marks, 1969; Nemiah, 1980); whether or not CRs conditioned to phobic CSs are retained better in this way is unknown. It would also be predicted that a CR conditioned to a "prepared" CS would, if weakened by the passage of time, be more strongly reinstated by a single reinforcement than would a CR conditioned to a neutral CS. Moreover, phobias are often observed even though the sufferer cannot recall the original association between the phobic object and whatever aversive event it was that established the fear (Marks, 1969; Nemiah, 1980).

Other important parallels between phobias and conditioning with potentially phobic CSs that require investigation are found in extinction. In the typical situation, a therapist is confronted with the task of extinguishing a fear that was established possibly at some quite distant time in the past. However, it is not known whether CRs conditioned to phobic CSs are still unusually resistant to extinction if a substantial interval of time separates acquisition and extinction.

Furthermore, the phobia is by definition irrational. The fear response is present and resistant to extinction even though the phobic person is aware that there is no danger from the phobic object. Although there is evidence that CRs conditioned to potentially phobic CSs may possess this irrational quality, notably the finding that extinction instructions do not abolish them (Hugdahl, 1978; Hugdahl & Öhman, 1977), not all investigators have obtained this result (Dawson, Schell, & Banis, 1986). McNally (1981) found that these CRs are affected by discrimination reversal instructions, and Dawson et al. (1986) found that if cognitive extinction (extinction of the differential expectancy of the UCS after CS+ as compared to CS−) occurs in the course of an extinction trial series, no greater retention of the CR is found post-cognitive extinction with potentially phobic than with neutral CSs. In all of these studies of cognitive effects on extinction, extinction trials followed immediately after acquisition. The role that cognitive effects might play in extinction that takes place at a time removed from acquisition has not been investigated.

Finally, the way in which CS type (potentially phobic versus neutral) interacts with other variables that may affect the strength of conditioning has not been well investigated. Previous investigators working with neutral stimuli (Mandel & Bridger, 1967) have found that CRs conditioned with short, traditionally optimal interstimulus intervals (ISIs) such as 0.5 s are more resistant to extinction instructions than are CRs conditioned with longer ISIs, such as have typically been used in the study of potentially phobic stimuli. Would the superior resistance established by the phobic CS be even greater if short ISIs were used?

The present study is designed to respond to these issues by answering the following four questions:

(1) Do potentially phobic CSs exert their effects in acquisition and reconditioning of the CR? (2) Will SCR CRs conditioned to phobic CSs be retained over time better than CRs conditioned to neutral CSs, and specifically will CRs conditioned to phobic CSs be retained even if the CS+/UCS relationship has been forgotten at the cognitive expectancy level? (3) Will CRs conditioned to phobic CSs be more resistant to extinction than those conditioned to neutral CSs when there is a substantial interval of time between original conditioning and extinction? (4) Will CRs conditioned to phobic CSs persist in extinction to a greater extent than CRs conditioned to neutral CSs after the point at which the cognitive expectancy of the UCS has extinguished?

Methods

Subjects

Subjects were 163 undergraduate volunteers, aged 18–22, 75 men and 88 women. All were paid $8 for participation in the experiment. In addition, most received class credit for participation in the first session. An additional 50 subjects participated in the first session whose data were not usable for the following reasons: failure to give a consistent SCR to the shock UCS (6); discontinued during Session 1 because too uncomfortable with shock (2); equipment problems or procedural errors (9); failure to reschedule for the second experimental session within the required time interval (33).

Design

Subjects were assigned randomly (with the exception of the Sex variable) to one of sixteen experimental groups in a 2×2×2×2 factorial design. Each group was presented a classical discrimination conditioning paradigm with Adaptation and Acquisition trials presented during Session 1, and Retention, Reconditioning, and Extinction trials presented during Session 2. The independent variables varied among groups were (1) Sex of the subject, (2) CS type, either potentially phobic or neutral, (3) Interstimulus interval (ISI) between CS+ and UCS onsets used during Acquisition and Reconditioning trials, 0.5 s or 8.0 s, and (4) Delay between Session 1 and Session 2, 1 month or 6 months.

Stimulus Materials and Apparatus

Conditioned stimuli consisted of color slides projected by a Kodak Carousel projector onto a screen approximately 1.25 meters in front of the subject. The dimensions of the projected image were 80×55 cm. There were four kinds of pictures used, spiders and snakes (potentially phobic stimuli) and flowers and mushrooms (neutral stimuli). Two different sets of pictures were employed in the study (two different pictures of spiders, etc.), but each subject saw only one of each kind. These slides were copies of those used by Öhman and his colleagues and by us (Dawson et al., 1986). The DC electric shock UCSs were delivered from a Grass S-9 stimulator and administered to the subject's left leg through 1.6 cm diameter silver electrodes coated with K-Y jelly (Johnson and Johnson).

Skin conductance was recorded on a Narco Bio-Systems DMP 4 B Physiograph through a constant .5 V bridge (Lykken & Venables, 1971). SCRs were recorded from Beckman silver-silver chloride electrodes filled with isotonic electrode paste placed on the volar surface of the first and third fingers of the left hand. A ground plate was placed on the left forearm.

Stimulus durations for the slides (either 0.5 or 8.0 s) and the shock UCS (0.5 s) were controlled by Hunter timers. Intervals between trials varied randomly among 25, 30, and 35 s and were controlled by a punched tape feeding through a Gerbrands programmer.

Procedure

Session 1. Subjects were told that the purpose of the experiment was to measure consistency over time in response patterns to different kinds of stimuli. They were told that they would see pictures of spiders, snakes, flowers, and mushrooms, and that they would feel an occasional electric shock on their leg, which they would set individually at a level of "strongly annoying, but not painful." They were further told that the shock would usually, but not always, follow a particular one of the pictures, and would come at no other time. They were asked to be sure to notice which picture it was that was associated with the shock.

Subjects were presented with 8 Adaptation trials in which each of the four CSs (CS+, CS−, and the two CSs of the other type of stimulus) was presented twice in an intermixed random order. Following the Adaptation trials, 48 Acquisition trials were presented, with all four CSs being presented 12 times in an intermixed random order. The CS+ was followed at offset by the UCS on 9 of its 12 presentations. After the last Acquisition trial, the subject was asked to fill out a short recognition questionnaire regarding which of the four CSs was associated with the shock. All subjects were able to correctly identify the CS+.

Session 2. The second session was scheduled either 1 month (plus or minus 5 days) or 6 months (plus or minus 7 days) after the first session. For both retention interval groups, equal numbers of first and second sessions were scheduled for Fall and Spring academic terms.

At the beginning of the second session, we administered a *recall* questionnaire adapted from Dawson and Reardon (1973), consisting of eight questions regarding the shock UCS, to assess memory for the CS+/UCS relationship. Subjects then completed a short *recognition* questionnaire (Dawson & Reardon, 1973) which consisted of two questions: (1) "During the first session the shock usually followed (a) spider, (b) flower, (c) mushroom, (d) snake, (e) it came after different pictures at different times, (f) I don't remember"; and (2) "How certain are you that your answer to the first question is correct? (a) completely certain, (b) very certain, (c) fairly certain, (d) fairly uncertain, (e) very uncertain, (f) completely uncertain."

After the questionnaires were completed, the recording and shock electrodes were attached as in Session 1 and shock level was again individually set. Subjects were then instructed that they would be shown each of the pictures twice that they had seen during Session 1, and after each picture they were to indicate whether or not that picture was followed by the shock during Session 1. They gave their ratings during the intertrial interval using a small box on which were mounted seven buttons whose labels ran from "absolutely certain no shock" through "absolutely uncertain" to "absolutely certain shock." Subjects were then presented with 8 Retention trials, during which each of the four CSs was presented twice in an intermixed random order. No UCS was delivered during this series, and CS duration for all groups was 8.0 s, to equate the opportunity of correct recognition of the CS+. Several seconds after each CS offset, the experimenter said "report," at which time the subject pressed the button of his/her selection. A voltage signal to the polygraph indicated which button had been pressed.

Following the Retention trials, subjects were told that they would begin receiving trials "very similar to what was done in the first session," that the shock would be presented "occasionally," and that when the shock occurred, it would be only after the presentation of the *same* picture that was associated with the shock during Session 1. Subjects were asked to indicate their anticipation of the shock by continuing to use the button box after the experimenter's prompt following each trial. The four CSs were then presented once each in a random order, with the original CS+ being reinforced. The same stimulus durations were used that were employed in Session 1. After these trials, without further instruction to the subject, all CSs were presented 23 times, in 23 random permutations of four, but no further UCSs were delivered. The first four of these trials (the Reconditioning trials) yielded a measure of the reconditioning of the CR. The next 22 presentations of each CS constituted the Extinction series. Subjects continued to indicate after each CS their expectancy of the shock.

Dependent Variables

Skin conductance responses (SCRs) were measured for all CS+ and CS− trials during Adaptation, Retention, Reconditioning, and Extinction, and for only nonreinforced CS+ trials and equivalent CS− trials during Acquisition. For all subjects the magnitude of each SCR that began between 1 and 4 s after CS onset was recorded (First Interval Response, FIR). For subjects in the 8.0-s ISI groups, the Second Interval Response (SIR—beginning 4 s after CS onset to 1 s after CS offset) and Third Interval Response (TIR—beginning 1–4 s after CS offset) were also measured. In addition to the skin conductance measures, the button expectancy ratings were recorded for all subjects during Session 2 as described above.

Results

The skin conductance response results reported below are primarily for the FIR, in the interest of brevity. The results for the SIR are briefly summarized at the end of this section, and further details may be obtained from the authors on request. TIR conditioning was poor and unaffected by CS type; therefore, the results of the TIR analyses will not be reported. Thus, references to the SCR made below are to the FIR unless otherwise indicated. In all analyses reported below, a square root transformation was performed on the SCR data, in order to achieve a more normal distribution.

In most of the results to be reported below, the first statistical procedure performed was a 6-way analysis of variance (ANOVA) for SCR data: Sex of the subject × CS type (phobic vs. neutral) × ISI (.5 vs. 8 s) × Delay between the sessions (1 vs. 6 months) × Conditioning (CS+ vs. CS−) × Trial (or trial block). (The Sex variable was included because the sexes have often been reported to differ in electrodermal activity, with men being more labile; see Schell, Dawson, & Filion, 1988, for a recent review.) In order to avoid overwhelming the reader, we will report below all significant main effects and simple (2-way) interactions, and all significant higher order interactions that involved the CS type variable. Higher order interactions that did not involve the CS Type variable were few and will not be discussed. Greenhouse-Geisser epsilon corrections were used to adjust probabilities for repeated measures effects. For these, we report the uncorrected degrees of freedom and the epsilon-corrected p value.

Group size varied from 9 to 14 across the 16 groups in this experiment, due to a larger number of female subjects entering the experiment than males (87 vs. 76) and to slight variation across groups in subjects who returned for Session 2. (See Table 1 for the Ns of the various groups.) In reporting means of SCR magnitude for sets of subjects that involved collapsing across individual groups (such as all male vs. all female subjects, or all phobic CS subjects vs. all neutral CS subjects), we adjusted the overall means to give equal representation to each individual group contributing to that mean regardless of size.

Several main effects in the SCR data were significant in most or all stages of the experiment that are not of themselves of great interest here, because they have been reported often and were not of central focus in this study. They will be summarized here and not mentioned further. The sex effect was significant in all stages, with males being more responsive than females. The effect of interstimulus interval was significant in all stages, with subjects conditioned with the 0.5-s ISI being more responsive (this was even true during Retention testing, when all subjects received CSs of 8.0-s duration).

The trials effect was significant in all sections except Reconditioning (which had only one trial), reflecting in each case a decline in overall responsiveness (averaged over CS+ and CS−) over trials. Finally, the main effect of CS type was significant during Adaptation, Retention, and Extinction, with subjects receiving the phobic CSs being more responsive than those receiving the neutral CSs; during Acquisition this was observed among female subjects, but not among males. These effects can generally be observed in Tables 1, 2, and 3.

Adaptation

The 6-way ANOVA revealed only those significant effects mentioned above. None of the variables that affected general responsiveness to the CSs acted differentially between the to-be-CS+ and the to-be-CS−. Mean responses of all groups are shown in Table 1.

Acquisition

Mean SCR magnitudes to CS+ and CS− averaged over all three pairs of test trials during Acquisition are shown in Table 2 for all 16 groups of subjects. The 6-way ANOVA performed on data taken from the three pairs of test (CS+ nonreinforced) trials revealed that the conditioning (CS+ vs. CS−) effect was highly significant, $F(1/147)=180.95$, $p<.001$, reflecting greater responsiveness to the CS+. The Conditioning variable did not interact significantly with Sex, CS Type, ISI, or Delay, although there was a marginal tendency, $F(1/147)=3.43$, $p<.07$, for women to show greater differential responding, in spite of the fact that men were more generally responsive. The men gave responses of 1.05 and .76 μS to CS+ and CS−, whereas the values for the women were .88 and .53 μS. Phobic and neutral CS groups, .5-s and 8.0-s ISI groups, and 1-month and 6-month Delay groups conditioned equally well.

The Trials × ISI interaction was also significant, $F(2/294)=3.12$, $p<.05$; decline in response magnitude (to CS+ and CS− combined) was greater in the 8.0-s than in the 0.5-s ISI groups. It should be noted here that the significant trials effect found in Acquisition, $F(2/294)=5.83$, $p<.004$, represents as in other sections of the experiment a decline in overall responding over pairs of test trials. The tendency of SCR magnitude to decline over trials during an acquisition trial series, as opposed to following the prototype learning curve, is well-known (Prokasy & Kumpfer, 1973). However, it should

Table 1

Means of first-interval skin conductance responses (FIR) during adaptation

		Males				Females			
		Potentially Phobic CS		Neutral CS		Potentially Phobic CS		Neutral CS	
Delay	ISI	n	FIR (μS)	n	FIR (μS)	n	FIR (μS)	n	FIR (μS)
1-month	.5 s	10	.95	9	1.05	10	.97	10	.61
	8.0 s	10	.91	10	.91	10	.55	11	.55
6-month	.5 s	9	.92	9	.80	14	1.02	12	.75
	8.0 s	9	.81	10	.71	9	.78	11	.42

Table 2

Means of first-interval skin conductance responses to CS+ and CS− and discrimination scores (D) during acquisition

		Potentially Phobic CS				Neutral CS			
Delay	ISI	n	CS+	CS−	D	n	CS+	CS−	D
					Males				
1-month	.5 s	10	1.22	.96	.26*	9	1.46	1.14	.32*
	8.0 s	10	.74	.40	.34*	10	.81	.56	.25*
6-month	.5 s	9	1.19	.92	.27*	9	1.26	.97	.29*
	8.0 s	9	.84	.61	.23*	10	.92	.49	.43*
					Females				
1-month	.5 s	10	1.18	.81	.27*	10	.78	.39	.39*
	8.0 s	10	.73	.36	.37*	11	.97	.41	.56*
6-month	.5 s	14	1.32	.85	.47*	12	1.06	.62	.44*
	8.0 s	9	.85	.60	.25*	11	.49	.21	.28*

*significantly greater response to CS+ than to CS− ($p<.05$, 1-tailed t-test).

also be noted that conditioned SCR discrimination, assessed by the differential response to CS+ and CS−, did not decline over trials. The Conditioning × Trials interaction did not approach significance, and discrimination scores averaged over all groups were .37, .34, and .35 μS respectively for the first, second, and third pairs of test trials.

In order to ascertain that significant classical discrimination conditioning had occurred in each individual group, a repeated measures *t*-test was done for each group comparing response to the CS+ averaged over test trials with averaged response to CS−. Because of the strong *a priori* assumption that conditioning would occur in all groups, one-tailed probability levels were used to determine significance. In Table 2 an asterisk beside a discrimination score indicates that the *t*-test was significant at or beyond the .05 level. As can be seen in Table 2, significant SCR conditioning occurred in all 16 groups.

Retention

In examining the Retention trial series, ISI was retained as a variable in the analyses to determine whether the ISI used during original conditioning affected retention of the CR and/or the conscious memory of the CS+/UCS contingency.

Memory for the CS+/UCS contingency. On the basis of the questionnaires administered at the beginning of Session 2 and the button expectancy data obtained during the Retention trials, subjects were classified with respect to their memory of the CS+/UCS contingency as Rememberers, Forgetters, or Ambiguous. *Rememberers* were those who (1) on the recognition questionnaire indicated that the CS+ (and only the CS+) had been associated with the shock, and were at least fairly certain that their answer was correct, and (2) using the buttons rated CS+ on both its presentations as having been followed by the shock (fairly to absolutely certain), and rated the CS− on both its presentations as not having been followed by the shock (fairly to absolutely certain). *Forgetters* were those who (1) failed to identify the CS+ as having been followed by the UCS on the questionnaire, and (2) rated the CS− as likely or more likely to have been followed by the shock on both pairs of Retention trials using the button measure. *Ambiguous* subjects were those who did not fall into either of the above categories.

Of the 163 subjects, 133 (82%) remembered the CS+/UCS contingency, 15 (9%) forgot it, and 15 were ambiguous. Chi-square analyses were performed to determine whether any of the experimental variables affected memory of the contingency. For these analyses, subjects were grouped into either rememberers or non-rememberers (forgetters and ambiguous subjects). The sex and ISI variables did not affect memory for the CS+/UCS contingency. However, significant effects were found for delay ($\chi(1)=18.80$, $p<.01$) and CS type ($\chi(1)=3.94$, $p<.05$). In the 1-month delay condition only 4 of 80 subjects (5%) failed to remember the contingency, whereas in the 6-month delay condition 26 of 83 subjects (31%) failed. Only 10 of 81 subjects (12%) receiving phobic CSs failed to remember, whereas 20 of 82 neutral CS subjects (24%) failed.

For subjects in the 1-month delay condition, CS type did not affect memory for the contingency; 2 out of 40 subjects (5%) in both the phobic and neutral CS groups failed to remember. However, CS type had a significant effect on the 6-month delay subjects: 8 of 41 (20%) phobic CS subjects and 18 of 42 (43%) neutral CS subjects failed to remember ($\chi(1)=5.26$, $p<.05$). Thus, when the long delay intervened between conditioning and assessment of memory for the CS+/UCS contingency, subjects who received a phobic CS+ were more likely to show recall than were subjects who received a neutral CS+.

SCR. A 6-way ANOVA was performed on the data of the Retention trial series. In addition to the significant main effects discussed at the beginning of this section, the conditioning effect was highly significant, $F(1/147)=35.33$, $p<.001$, indicating that the differential SCR was well retained over the 1-month and 6-month retention intervals. The CS type × ISI interaction was also significant, $F(1/147)=4.26$, $p<.05$: there was little difference in responsiveness between phobic and neutral CS groups who received the 8.0-s ISI, but a large difference between the phobic and neutral CS groups who received the 0.5-s ISI.

We next assessed the effect on the SCR of remembering versus forgetting the original CS+/UCS contingency. The data of the Ambiguous subjects were discarded, and given that only 2 subjects in the 1-month delay condition were classified as Forgetters, only the Rememberers (n = 57) and Forgetters (n = 13) from the 6-month delay groups were used. In order to achieve adequate group size for the Forgetters, we also collapsed the 0.5-s and 8.0-s ISI groups, a decision that seemed reasonable in view of the fact that ISI did not affect retention of the SCR CR (the *F* value for the Conditioning × ISI interaction was .03).

A Sex × CS Type × Rememberer versus Forgetter × Conditioning × Trial ANOVA revealed that the Remembering versus Forgetting variable did not have a main effect on the FIR, nor did it interact with the Conditioning variable or with any other experimental variable. Average responses to

the CS+ and CS− among the Rememberers were .79 and .57 μS respectively, and among the Forgetters .58 and .40 μS respectively. Because we had originally formulated experimental questions regarding retention of the CR in the absence of memory for the CS+/UCS relationship, we then examined retention of the CR among both Rememberers and Forgetters separately, carrying out two Sex × CS Type × Conditioning × Trial ANOVAs. For the Rememberers, there was significant retention of the SCR CR, $F(1/53)=10.69$, $p<.002$, but for the Forgetters there was not, $F(1/9)=2.40$). For neither Rememberers nor Forgetters, nor for the entire set of 163 subjects, was there a significant CS Type × Conditioning interaction; phobic CS subjects did not retain the SCR CR better than neutral CS subjects.

In order to carry out a more sensitive test of whether or not retention of the CR might occur in the absence of memory of the CS+/UCS contingency, we combined the Ambiguous subjects and the Forgetters, regardless of Delay condition. There were 30 such subjects, 13 who had received phobic CSs and 17 who had received neutral CSs. A CS Type × Sex × Conditioning × Trial ANOVA of these data again produced a nonsignificant conditioning effect, $F(1/26)=1.76$, and also a nonsignificant Conditioning × CS Type interaction, $F(1/26)=.32$. When the data for the 13 nonremembers who had received phobic CSs were examined separately, a *t*-test indicated nonsignificant differential responding to CS+ and CS− specifically among them.

Reconditioning

During Reconditioning the CS Type × Delay interaction was significant, $F(1/147)=4.88$, $p<.03$. With a 1-month delay between original conditioning and reconditioning, subjects receiving the phobic and neutral CSs were equally responsive (.73 vs. .74 μS respectively); however, with a 6-month delay, subjects receiving the phobic CSs were more responsive to both CS+ and CS− than those receiving the neutral CSs (1.01 vs. .75 μS respectively).

The conditioning effect was highly significant, $F(1/147)=115.62$, $p<.001$; overall responses to CS+ and CS− were 1.08 and .58 μS respectively. None of the experimental variables, CS Type, Sex, ISI, or Delay, interacted significantly with the Conditioning variable.

Extinction

Following the Reconditioning trials, which themselves also constituted a first set of extinction trials because CS+ was not reinforced, each picture was presented an additional 22 times, with no further reinforcement of the CS+. Because the CR had been reinstated, all subjects were used in the Extinction analyses.

Button expectancy data. In order to determine the effects of experimental variables on level of cognitive expectancy of the UCS during Extinction, a Sex × CS Type × ISI × Delay × Conditioning × Trial Block ANOVA was carried out on the button expectancy data using means taken over adjacent pairs of trials of each CS, resulting in 11 trial blocks.

The conditioning effect was highly significant, $F(1/147)=854.40$, $p<.001$, indicating much higher expectancy of the UCS following CS+ than following CS− throughout extinction. Also significant were the trial block effect, $F(10/1470)=303.57$, $p<.001$, the CS Type × Trial Block interaction, $F(10/1470)=2.44$, $p<.05$, the Conditioning × Trial Block interaction, $F(10/1470)=255.30$, $p<.001$, and the Conditioning × Trial Block × CS Type interaction, $F(10/1470)=3.92$, $p<.004$. These effects reflect the decreased expectancy of the UCS across nonreinforced trials, the decrease being greater for the CS+ than the CS−, and the fact that, at least during the first third of the Extinction trial series, greater overall expectancy and greater differential expectancy to CS+ versus CS− was expressed by the phobic CS subjects. This was supported by *t*-tests revealing greater differential expectancy of the UCS following CS+ than following CS− among the phobic group than among the neutral group during the first three trial blocks.

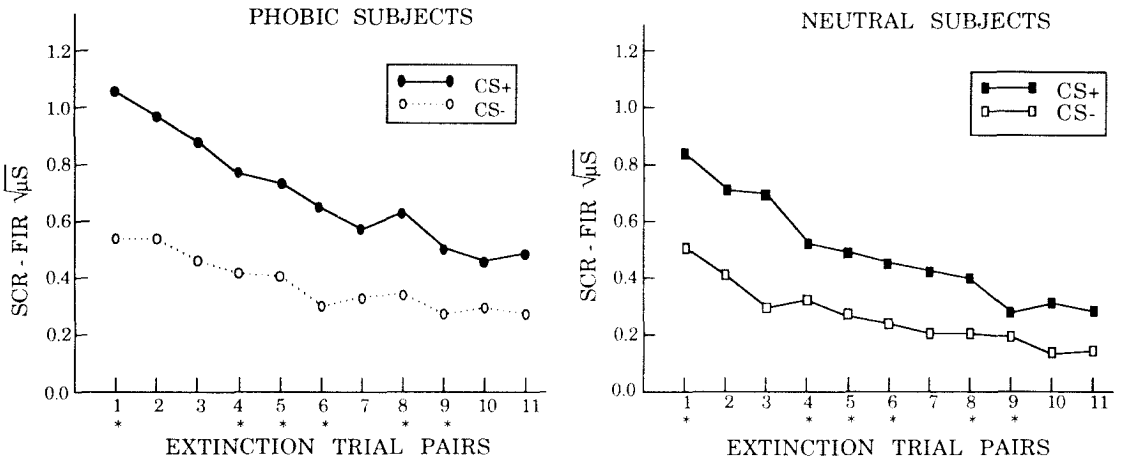
SCR. Mean response magnitudes to CS+ and CS− are shown for each group in Table 3. The 6-way ANOVA indicated that the conditioning effect remained highly significant during Extinction, $F(1/147)=200.28$, $p<.001$. As during Acquisition, a repeated-measures *t*-test was performed on the data of each individual group; as indicated by the asterisks in Table 3, each of the 16 groups showed significant SCR discrimination during Extinction.

The basic effect of greater differential responding during extinction by the phobic CS groups was replicated in this study. The Conditioning × CS Type interaction was significant, $F(1/147)=9.46$, $p<.003$, and as shown in Table 3, in seven of the eight pairs of Phobic CS and Neutral CS groups, the Phobic CS group showed greater differential responding during Extinction ($p=.032$ using the Sign Test). SCR magnitudes to CS+ and CS− on each trial block are shown in Figure 1 for all Phobic and all Neutral CS subjects. As can be seen, the Phobic CS subjects generally show greater differential responding to CS+ and CS− than do the Neutral CS groups at the outset of Extinction (after the one nonrein-

Table 3
Means of first-interval skin conductance responses to CS+ and CS− and discrimination scores (D) during extinction

		Potentially Phobic CS				Neutral CS			
Delay	**ISI**	**n**	**CS+**	**CS−**	**D**	**n**	**CS+**	**CS−**	**D**
				Males					
1-month	.5 s	10	1.25	.72	.53*	9	.76	.51	.26*
	8.0 s	10	.52	.20	.33*	10	.42	.19	.23*
6-month	.5 s	9	1.02	.70	.31*	9	.87	.67	.20*
	8.0 s	9	.65	.27	.38*	10	.60	.28	.32*
				Females					
1-month	.5 s	10	.71	.39	.32*	10	.39	.19	.20*
	8.0 s	10	.23	.09	.15*	11	.37	.13	.24*
6-month	.5 s	14	.89	.53	.36*	12	.45	.27	.18*
	8.0 s	9	.50	.27	.23*	11	.09	.04	.05*

*significantly greater response to CS+ than to CS− ($p<.05$, 1-tailed t-test).



* Trials on which Phobic subjects show significantly better discrimination than Neutral subjects.

Figure 1. SCR magnitude during extinction among subjects receiving potentially phobic and neutral conditioned stimuli.

forced presentation of the CS+ during which Reconditioning was measured), and this was generally maintained throughout the Extinction trial series (i.e., the Conditioning × CS Type × Trial Blocks interaction was nonsignificant). None of the higher-order interactions of the Conditioning and CS Type variables with Sex, ISI, or Delay were significant. Phobic CSs produced greater differential responding during Extinction in both sexes, with both ISIs, and after both delays between Acquisition and Extinction.

In order to determine at precisely which points during Extinction the Phobic CS and Neutral CS subjects differed in retention of the CR, a conditioning measure was computed for each subject during each trial block by subtracting the SCR to the CS− from the SCR to the CS+ for that block. The conditioning measures of all Phobic CS subjects were then compared to those of all Neutral CS subjects for each block using two-tailed t-tests. Asterisks in Figure 1 indicate those blocks on which the difference in conditioning was significant. Although these results should be interpreted conservatively because of the number of t-tests performed, on six of the eleven pairs of trials, the Phobic CS group shows significantly greater discrimination than the Neutral CS group. As can be seen, the significant difference between the groups begins in early Extinction and is maintained until late in the trial series.

Other significant effects were the Conditioning × Sex interaction, $F(1/147)=7.57$, $p<.007$ (men showed greater differential responding than women), the Conditioning × Trial Block interaction,

$F(10/1470)=9.71$, $p<.001$ (the decline in SCR magnitude over trials was greater for the CS+), and the Trial Blocks × ISI interaction, $F(10/1470)=5.30$, $p<.001$ (the magnitude of the decline was greater in the 0.5-s ISI groups, apparently due to their larger response magnitudes early in Extinction).

Retention of the CR Post-Cognitive Extinction

Examination of the extinction data of the SCR and the button expectancy measure reveals an interesting lack of parallel between the two. For the expectancy measure, the phobic CS subjects show greater retention of differential responding to CS+ and CS− only during the first three pairs of extinction trials. However, for the SCR CR, phobic CS subjects show greater retention of conditioning until the tenth trial pair. This would seem to indicate that the effect of CS type on the autonomic CR is more lasting than is its effect on cognitive expectancy. This is relevant to the issue of whether CRs conditioned to potentially phobic CSs may persist to a greater degree than do those conditioned to neutral CSs in the absence of cognitive expectations of the UCS, as indicated by the results of Hugdahl (1978) and Hugdahl and Öhman (1977). In order to investigate this possibility, we identified a subgroup of 54 subjects who reached the point of complete extinction of the cognitive expectancy that the UCS would follow the CS+, based on the button measure, consistently expressing themselves as "absolutely certain no shock" would follow the CS+.

This criterion was reached by 28 of 81 (35%) phobic CS subjects and 26 of 82 (32%) neutral CS subjects, so CS type did not affect whether or not this degree of cognitive extinction occurred. A Sex × CS Type × ISI × Delay ANOVA of the number of trials required to reach cognitive extinction revealed that men take longer to do so than do women, $F(1/38)=6.01$, $p<.02$ (17.6 trials for men vs. 14.9 for women). The effect of CS type did not approach significance; phobic and neutral CS subjects who reached the cognitive extinction criterion did so at approximately the same point in the Extinction trial series.

For each subject who reached the cognitive extinction criterion, an average was taken of post-extinction SCRs to CS+ and to CS−, and a Sex × CS Type × ISI × Delay × Conditioning ANOVA was carried out on these averages. The conditioning effect remained highly significant for these subjects as a whole, $F(1/38)=13.85$, $p<.001$, as did the Conditioning × CS Type interaction, $F(1/38)=4.43$, $p<.05$, with differential SCRs to CS+ and CS− being greater among phobic CS subjects. The

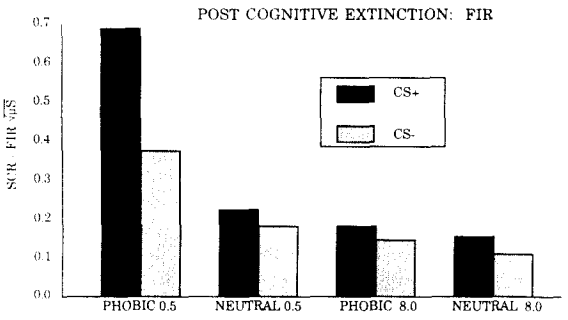


Figure 2. SCR magnitude post-cognitive expectancy extinction in potentially phobic and neutral CS groups conditioned with .5-s and 8.0-s interstimulus intervals.

Conditioning × CS Type × ISI interaction was also significant for these post-cognitive extinction data, $F(1/38)=7.90$, $p<.008$. This latter interaction is displayed in Figure 2. As can be seen, the phobic CS group conditioned with the 0.5-s ISI shows greater retention of the differential SCR CR after cognitive extinction than does the phobic CS group conditioned with the 8.0-s ISI or either of the neutral CS groups. Sex × Delay × Conditioning ANOVAs of the post-cognitive extinction data in each of these four groups showed a significant conditioning effect for the phobic CS, 0.5-s ISI group, $F(1/11)=19.86$, $p<.001$, whereas the conditioning effect did not approach significance for the other three groups. Thus, it appears that subjects exposed to phobic CSs and the ISI that is traditionally considered optimal for producing conditioning develop CRs that, in this paradigm, persist after the point at which cognitive extinction has been reached. The length of the delay between acquisition and extinction did not affect the degree to which these subjects retained the SCR CR after cognitive extinction.

Summary of SIR Analyses

In each section of the experiment, analyses of the SIR (second-interval response) SCR data were performed that paralleled the analyses of the FIR (first-interval response) data, except of course that the ISI variable was not included. As with the FIR, the effect of sex was generally significant, with male subjects being more responsive. Significant conditioning of the SIR was observed during Acquisition, but significant retention of the SIR CR did not occur. Even among rememberers of the CS+/UCS contingency, only marginal differential responding to CS+ and CS− was seen during Retention. The SIR was significantly reconditioned by one reinforcement of the CS+, and the conditioning effect remained significant during Extinction. A significant Conditioning × CS Type × Delay interaction was also observed during Extinction. In the 6-

month delay condition, Phobic CS subjects showed greater differential responding to CS+ and CS− than did Neutral CS subjects, but this was not true in the 1-month delay condition. For the SIR, there was no retention of the CR post-cognitive extinction in any group.

Discussion

Experimental Questions

Do potentially phobic CSs exert their effects during acquisition and reconditioning of the SCR? The answer to this question, based on the present data, is no. Although phobic CSs elicited greater overall responsiveness than did neutral CSs, in neither Acquisition nor Reconditioning was a Conditioning × CS Type interaction observed, nor were any higher order interactions involving Conditioning and CS Type significant.

This apparent lack of an effect during acquisition is consistent with most previous findings. McNally (1987), in a review of this research, reported that four published studies out of nineteen found differential responding to be greater during acquisition with phobic CSs: Fredrikson, Hugdahl, and Öhman (1976), Öhman and Dimberg (1978, Experiment 1), Öhman et al. (1975), and Öhman, Fredrikson, and Hugdahl (1978). To these can be added the study by Siddle, Power, Bond, and Lovibond (1988). What distinguishes these five studies is the poor, even nonsignificant, conditioning in the neutral CS groups. By contrast, experimenters reporting no effects of CS type on conditioning in acquisition typically find significant conditioning in both phobic and neutral CS groups, the present study being an example.

It is interesting to note that in four of the studies reporting acquisition effects, Öhman and Dimberg (1978) being the exception, greater general responsiveness to phobic than to neutral CSs was reported in either acquisition, a preceding adaptation phase, or both, something that we also observed. It may be that when conditioning is poor because responsivity to the CSs is low, perhaps for some reason idiosyncratic to a particular procedure or subject pool, and this leads to a "bottoming-out" effect when substantial numbers of subjects respond to neither CS+ nor CS−, in that circumstance the greater responsiveness to phobic CSs yields significant conditioning but neutral CSs do not. In circumstances such as those in the present study, with good conditioning in both phobic and neutral groups, an acquisition effect of CS type is not found.

Are SCRs conditioned to phobic CSs better retained over time, and are they better retained in the absence of cognitive expectancy of the UCS? Although phobic CS subjects were more likely than neutral CS subjects to remember the CS+/UCS contingency as indicated by the questionnaire and button measures, we found no effect of CS type on retention of the SCR CR. Furthermore, significant retention of the differential CR to CS+ and CS− was not retained by subjects who did not remember the CS+/UCS contingency, regardless of CS type.

Our results for both phobic and neutral CSs are consistent with those of Hammond, Baer, and Fuhrer (1980) and Williams and Carlton (1983), who found with neutral CSs that when an interval of approximately one month intervened between acquisition and retention testing, only those subjects who could recall the original CS+/UCS contingency retained a differential SCR CR to CS+ and CS−. However, it should also be noted that Forgetters retained the differential SCR CR as well as the Rememberers, as evidenced by the insignificant Rememberer vs. Forgetter × Conditioning interaction during retention. The mean discrimination scores and the variance in those scores were quite similar for the Rememberers and the Forgetters. Therefore, the failure of the Forgetters to show significant retention while the Rememberers did may be due simply to the fact that there were more Rememberers (57) than Forgetters (13), and thus the power of the test for discrimination among the Rememberers was much greater.

It is also interesting to note that the Delay variable did not affect retention of the differential CR, nor did it interact with CS Type. Thus with neither type of CS did subjects retain the CR less well after six months than after one month, nor was there any evidence of incubation of fear, with retention better after six months than after one month.

Will SCRs conditioned to phobic CSs be more resistant to extinction than responses conditioned to neutral CSs when there is a substantial interval of time between original conditioning and extinction? Differential FIR SCR responding to CS+ and CS− was superior with the potentially phobic CSs with both one and six months intervening between acquisition and extinction, for both the 0.5-s and 8.0-s ISIs, and for both male and female subjects. In the six-month delay condition, the SIR also shows greater resistance to extinction when phobic CSs are employed. The effects of phobic versus neutral CSs on differential SCR responding during extinction that we observed with this paradigm, in which a delay intervened between acquisition and extinction, appear to have been stronger than the effects we obtained using a similar paradigm in which no delay intervened (Dawson et al., 1986). Although maintenance of the CR during extinction was superior with the phobic CSs, as with Retention, there

was no evidence of incubation processes at work. The CR was maintained no better after six months delay than after one month.

The finding that ISI does not significantly influence the greater resistance to extinction of the CR conditioned to potentially phobic CSs when all extinction trials of all subjects are considered is consistent with the results of Hugdahl and Öhman (1980), who worked with three ISIs which would all be considered long in classical conditioning. They found superior resistance to extinction with phobic CSs at ISIs of 2.0, 8.0, and 16.0 s, with no significant difference across ISIs. Our data indicate that this nonsensitivity to ISI occurs even when one extends to the short 0.5-s ISI which is traditionally regarded as optimizing conditioning. The ISI becomes important only as described below, after the point of cognitive extinction.

Our finding that the potentially phobic CSs do not show a stronger effect in female than in male subjects seems inconsistent with the finding that fears of spiders and snakes and small animal phobias are far more likely to be reported by women than by men (Marks, 1969). If this is so, why do we find better retention of the conditioned CR during extinction in males, with both the potentially phobic and neutral CSs? This may be due in part to the response system monitored here; men are frequently found to be more electrodermally labile than women in a variety of situations, a finding that has received both physiological and psychosocial explanations (Schell et al., 1988). Furthermore, as pointed out by Fredrikson et al. (1976), who found no sex differences in conditioning with potentially phobic CSs, although animal fears are much more likely to be reported by adult women than by adult men, sex differences are not well defined before puberty. They suggested that such fears may in fact be equally common to both sexes, but that social learning processes lead males to be less willing to report them. Marks also acknowledges such influences as a possible factor in the sex difference in phobia incidence. Such an interpretation would be consistent with our data.

Will SCRs conditioned to phobic CSs persist in extinction to a greater extent than responses conditioned to neutral CSs after the point at which the cognitive expectancy of the UCS has extinguished? The present results strongly support the continuation of the SCR CR after the point of expectancy extinction, but only among those subjects who were conditioned with the phobic CSs and with the 0.5-s ISI. This group behaved in marked contrast to the phobic CS group conditioned with the 8.0-s ISI and to neutral CS groups conditioned with either ISI, none of whom maintained differential responding to CS+ and CS− after expectancy extinction.

The importance of the short, traditionally optimal 0.5-s ISI in obtaining this "irrational" continuation of the CR is consistent with the findings of earlier investigators who worked entirely with neutral CSs (simple lights or tones). Both Mandel and Bridger (1967) and Wickens and Harding (1967) found that extinction instructions had less effect in reducing SCR CRs conditioned with the 0.5-s ISI than with longer (5.0-s or 2.0-s) ISIs. Mandel and Bridger (1967, 1973) concluded that their results supported a two-level theory of human autonomic conditioning, one level mediated by conscious expectancies and the other not, a level of "true" conditioning. Based on their findings with extinction instructions, Hugdahl and Öhman (1977) concluded that use of phobic CSs, in their case with an 8.0-s ISI, may promote "true" (nonexpectancy mediated) conditioning. Our results indicate that when cognitive expectancy extinguishes naturally, in the course of nonreinforced trials, both CS type and ISI are of critical importance.

The present results regarding continuation of the SCR CR after expectancy extinction differ from our earlier findings (Dawson et al., 1986). In the previous study, which employed an 8.0-s ISI and no delay between acquisition and extinction, we found small (compared to pre-expectancy extinction levels) but still significant SCR discrimination during the post-expectancy extinction period in both phobic and neutral CS groups, with CS type not affecting the degree of discrimination. Why did we observe post-expectancy extinction SCR CRs among neutral CS subjects in our previous study but not in the present study? The most likely explanation is the presence of a delay between acquisition and extinction.

We have suggested (Dawson & Schell, 1985) that continuation of the CR after expectancy extinction is due to the existence in long-term memory of two contrasting elements, one that the CS+ is a signal for the UCS (developed during acquisition), and one that it is not (developed during extinction). When the CS+ is presented, pre-attentive information processing mechanisms access both elements. Following a model developed by Öhman (1979), the pre-attentive mechanisms will call for controlled processing of the CS+, and a CR will occur, if the "CS+/UCS" element more strongly influences these mechanisms than does the "CS+/no UCS" element. Factors that determine the relative influence of the two elements may include CS type, ISI, and recency. In our earlier study the CS+/UCS element would have been only slightly less recently formed than the CS+/no UCS element,

recent enough to mediate continued performance of the differentially conditioned SCR in both phobic and neutral CS groups. In the present study, the CS+/no UCS element is much more recently formed than the CS+/UCS element, and the contribution of the phobic CS and short ISI to the influence of the CS+/UCS element becomes critical.

The present results, which reinforce the findings that the effects of potentially phobic CSs on the CR appear only in extinction, suggest not so much that a particular type of learning (excitatory conditioning) is facilitated with the use of these CSs, but rather that another type of learning is retarded. Extinction is itself a learning process, involving the weakening of the association between CS+ and the UCS formed during acquisition (Rescorla & Wagner, 1972), or the build-up of a separate inhibitory process (Mackintosh, 1975) associated with an expectation that the UCS *will not* follow the CS+. Such an inhibitory process or processes appear to be slowed when phobic CSs are employed; the "CS+/no UCS" memory element may be slow to develop and may have a reduced influence on information processing mechanisms that govern the CR.

Support for this viewpoint, other than the extinction findings themselves, is mixed. McNally and Reiss (1984) used both potentially phobic and neutral stimuli as safety signals in nonreinforced compounds with a CS+, and obtained some evidence that the phobic CS was less effective in suppressing conditioned electrodermal responding. However, Booth, Siddle, and Bond (1989) found that preexposure to the CS+ did not retard subsequent acquisition of the SCR CR to any lesser extent with phobic than with neutral CSs. Clearly, the nature of the presumed inhibitory processes needs further investigation.

Similarities between CRs Conditioned to Phobic CSs and Clinical Phobias

On balance, the present findings are supportive of the idea that conditioning with potentially phobic CSs may provide investigators with a laboratory analog of clinical phobias. Extinction was slower even with the delay between acquisition and extinction, and, most important, "irrational" retention of the CR after expectancy extinction was observed.

The failure to observe CS type effects during Acquisition or Retention, and the failure of subjects who did not remember the CS+/UCS relation to retain the CR, may not seriously weaken the analogy. As McNally (1987) points out, SCR conditioning is well-known to be a rapidly occurring, all or none process which appears promptly when the subject realizes the CS+/UCS contingency (Dawson & Biferno, 1973). In the usual paradigm in which the contingency is not masked, one-trial learning is common. Thus there is little opportunity for phobic CSs to show an effect of yielding more rapid acquisition. Furthermore, as McNally also points out, it is an oversimplification to view all phobias as being rapidly acquired; in fact, rates of acquisition vary.

It is also an oversimplification to assume that all phobics who retain a learned fear response while failing to recall the original association between the phobic object or situation and an aversive outcome and/or extreme fear, are in fact failing to recall a real event. Several studies have demonstrated that instructions that shock will follow a CS+ result in greater responding to phobic than to neutral CSs, even when shock is not delivered (Hugdahl, 1978; Hugdahl & Öhman, 1977; Öhman et al., 1974). Furthermore, Hygge and Öhman (1978) found that potentially phobic CSs acquired CRs that were more resistant to extinction in a *vicarious* conditioning paradigm, in which the subject only observed another subject being conditioned. Hygge and Öhman suggested that clinical phobias themselves may result from this sort of vicarious learning, rather than from an actual conditioning experience. Thus retention of a phobia when an original conditioning event cannot be recalled may be a less common phenomenon than is generally believed.

The potentially phobic CS paradigm may have its greatest usefulness in allowing the investigator to examine CRs that persist after expectancy extinction, which are in that sense "irrational," without having to use extremely aversive UCSs or very large numbers of acquisition trials. They thus allow access to processes with a long history of interest in the study of learning and emotion.

REFERENCES

Booth, M.L., Siddle, D.A.T., & Bond, N.W. (1989). Effects of conditioned stimulus fear relevance and preexposure on expectancy and electrodermal measures of human Pavlovian conditioning. *Psychophysiology, 26*, 281–291.

Cook, E.W.,III, Hodes, R.L., & Lang, P.J. (1986). Preparedness and phobia: Effects of stimulus content on human visceral conditioning. *Journal of Abnormal Psychology, 95*, 195–207.

Dawson, M.E., & Biferno, M.A. (1973). Concurrent mea-

surement of awareness and electrodermal classical conditioning. *Journal of Experimental Psychology, 101*, 55–62.

Dawson, M.E., & Reardon, D.P. (1973). Construct validity of recall and recognition postconditioning measures of awareness. *Journal of Experimental Psychology, 98*, 308–315.

Dawson, M.E., & Schell, A.M. (1985). Information processing and human autonomic classical conditioning. In P.K. Ackles, J.R. Jennings, & M.G.H. Coles (Eds.), *Advances in psychophysiology* (Vol. I, pp. 89–165). Greenwich, CT: JAI Press.

Dawson, M.E., Schell, A.M., & Banis, H.T. (1986). Greater resistance to extinction of electrodermal responses conditioned to potentially phobic CSs: A noncognitive process? *Psychophysiology, 23*, 552–561.

Fredrikson, M., Hugdahl, K., & Öhman, A. (1976). Electrodermal conditioning to potentially phobic stimuli in male and female subjects. *Biological Psychology, 4*, 305–314.

Hammond, G.S., Baer, P.E., & Fuhrer, M.J. (1980). Retention of differential autonomic conditioning and memory for conditional stimulus relations. *Psychophysiology, 17*, 356–362.

Hugdahl, K. (1978). Electrodermal conditioning to potentially phobic stimuli: Effects of instructed extinction. *Behaviour Research and Therapy, 16*, 315–321.

Hugdahl, K., & Öhman, A. (1977). Effects of instruction on acquisition and extinction of electrodermal responses to fear relevant stimuli. *Journal of Experimental Psychology, 3*, 608–618.

Hugdahl, K., & Öhman, A. (1980). Skin conductance conditioning to potentially phobic stimuli as a function of interstimulus interval and delay versus trace paradigm. *Psychophysiology, 17*, 348–355.

Hygge, S., & Öhman, A. (1978). Modeling processes in the acquisition of fears: Vicarious electrodermal conditioning to fear-relevant stimuli. *Journal of Personality and Social Psychology, 36*, 271–279.

Lykken, D.T., & Venables, P.H. (1971). Direct measurement of skin conductance: A proposal for standardization. *Psychophysiology, 8*, 656–672.

Mackintosh, N.J. (1975). A theory of attention: Variations in associability of stimuli with reinforcement. *Psychological Review, 87*, 276–298.

Mandel, I., & Bridger, W. (1967). Interaction between instructions and ISI in conditioning and extinction of the GSR. *Journal of Experimental Psychology, 74*, 36–43.

Mandel, I., & Bridger, W. (1973). Is there classical conditioning without cognitive expectancy? *Psychophysiology, 10*, 87–90.

Marks, I. (1969). *Fears and phobias*. New York: Academic Press.

McNally, R.J. (1981). Phobias and preparedness: Instructional reversal of electrodermal conditioning to fear-relevant stimuli. *Psychological Reports, 48*, 175–180.

McNally, R.J. (1987). Preparedness and phobias: A review. *Psychological Bulletin, 101*, 283–303.

McNally, R.J., & Reiss, S. (1984). The preparedness theory of phobias: The effects of initial fear level on safety-signal conditioning to fear-relevant stimuli. *Psychophysiology, 21*, 647–652.

Nemiah, J.C. (1980). Phobic disorder. In H. Kaplan, A. Freedman, & B. Sadock (Eds.), *Comprehensive textbook of psychiatry* (3rd ed., pp. 1493–1503). Baltimore, MD: Williams & Wilkins.

Öhman, A. (1979). The orienting response, attention, and learning: An information-processing perspective. In H.D. Kimmel, E.H. van Olst, & J.F. Orlebeke (Eds.), *The orienting reflex in humans* (pp. 443–471). Hillsdale, NJ: Erlbaum.

Öhman, A. (1986). Face the beast and fear the face: Animal and social fears as prototypes for evolutionary analyses of emotion. *Psychophysiology, 23*, 123–145.

Öhman, A., & Dimberg, U. (1978). Facial expressions as conditioned stimuli for electrodermal responses: A case of "preparedness"? *Journal of Personality and Social Psychology, 36*, 1251–1258.

Öhman, A., Dimberg, U., & Öst, L.G. (1985). Animal and social phobias: Biological constraints on learned fear responses. In S. Reiss & R.R. Bootzin (Eds.), *Theoretical issues in behavior therapy* (pp. 123–175). New York: Academic Press.

Öhman, A., Eriksson, A., Fredrikson, M., Hugdahl, K., & Olofsson, C. (1974). Habituation of the electrodermal orienting reaction to potentially phobic and supposedly neutral stimuli in normal human subjects. *Biological Psychology, 2*, 85–93.

Öhman, A., Eriksson, A., & Olofsson, C. (1975). One-trial learning and superior resistance to extinction of autonomic responses conditioned to potentially phobic stimuli. *Journal of Comparative and Physiological Psychology, 88*, 619–627.

Öhman, A., Fredrikson, M., & Hugdahl, K. (1978). Orienting and defensive responding in the electrodermal system: Palmar-dorsal differences and recovery rate during conditioning to potentially phobic stimuli. *Psychophysiology, 15*, 93–101.

Öhman, A., Fredrikson, M., Hugdahl, K., & Rimmö, P.A. (1976). The premise of equipotentiality in human classical conditioning: Conditioned electrodermal responses to potentially phobic stimuli. *Journal of Experimental Psychology: General, 105*, 313–337.

Prokasy, W.F., & Kumpfer, K.L. (1973). Classical conditioning. In W.F. Prokasy & D.C. Raskin (Eds.), *Electrodermal activity in psychological research* (pp. 157–202). New York: Academic Press.

Rescorla, R.A., & Wagner, A.R. (1972). A theory of Pavlovian conditioning: Variations in the effectiveness of reinforcement and nonreinforcement. In A.H. Black & W.F. Prokasy (Eds.), *Classical conditioning II: Current research and theory* (pp. 64–99). New York: Appleton-Century-Crofts.

Schell, A.M., Dawson, M.E., & Filion, D.T. (1988). Psychophysiological correlates of electrodermal lability. *Psychophysiology, 25*, 619–632.

Seligman, M.E.P. (1970). On the generality of the laws of learning. *Psychological Review, 77*, 400–418.

Seligman, M.E.P. (1971). Phobias and preparedness. *Behavior Therapy, 2*, 307–321.

Siddle, D.A.T., Power, K., Bond, N., & Lovibond, P.F. (1988). Effects of stimulus content and post-acquisi-

tion devaluation of the unconditioned stimulus on retention of human electrodermal conditioning and relational learning. *Australian Journal of Psychology, 40*, 179–193.

Wickens, D., & Harding, G. (1967). Effects of ISI, forewarning, and instructions on the extinction of the GSR. *Journal of Experimental Psychology, 74*, 363–369.

Williams, W.C., & Carlton, B.L. (1983, September). *Retention of electrodermal discrimination conditioning to CVC trigrams 34 days after training.* Paper presented at the 23rd annual meeting of the Society for Psychophysiological Research, Pacific Grove, CA.

(Manuscript received September 18, 1989; accepted for publication May 20, 1990)

Announcements

Psychophysiologist/Physiological Psychologist

The Colorado College is accepting applications for a tenure-track position at the Assistant Professor level beginning Fall semester, 1992. We are seeking an individual with Ph.D. who is committed to excellence in undergraduate teaching and has the skill and willingness to involve capable undergraduates in a range of human and animal research in physiological psychology, statistics, and research design, and other courses in the psychology curriculum. We welcome applicants who can teach outside psychology in the general college curriculum, in such areas as the perspectives of minorities and women, and the history of science. The Colorado College is a private undergraduate institution which, since 1874, has been dedicated to distinction in teaching and scholarship. To apply, send a letter with your ideas about teaching and research, resume, graduate transcript, and three letters of recommendation to: Dr. Doug Freed, Chair, Physiological Psychologist Search Committee, Department of Psychology, The Colorado College, 14 E. Cache La Poudre, Colorado Springs, CO 80903. Deadline for application is November 1, 1991. The College is an Equal Opportunity Employer and encourages applications from minorities and women.

Postdoctoral Position in Event-Related Potentials

Applications are now being accepted at the Research Institute of Scripps Clinic in La Jolla, California, for a well-qualified cognitive psychologist seeking to develop research expertise with event-related brain potentials (ERPs). This position will provide training in the use of ERPs for assessing cognitive function as part of a large scale project on the inheritability of alcoholism. Ample opportunities for collaborative research on normals and a variety of neurological patient populations are also available. Previous experience with ERPs is desirable but not necessary. Competency with computer operating systems, especially UNIX and DOS, is critical and programming ability in C or Pascal is highly desirable. The individual must also have good interpersonal and organizational skills. The initial appointment is for one year beginning as early as January 1991, with continued funding expected for up to two years but contingent upon performance and mutual agreement. Salary range is based on NIMH guidelines with excellent fringe benefits. Please send (1) a letter of application describing interests and experience, (2) curriculum vitae and representative reprints, and (3) three letters of reference to: John Polich, Department of Neuropharmacology (BCR1), Research Institute of Scripps Clinic, La Jolla, CA 92037.

EEG Systems Laboratory: Three Unique Opportunities

The EEG Systems Laboratory in San Francisco, California, is offering three unique opportunities to join a cutting-edge research program developing and applying state-of-the-art functional and anatomical imaging methods to study human cognition. Positions available: (1) *Psychophysiologist* specializing in human evoked potentials. Requires Ph.D. and exceptional research and people skills. (2) *Neuroscientist/Engineer* to study nonlinear dynamics of mass neural action in the human brain. Requires Ph.D. and expertise in DSP, neural networks, programming in C under UNIX, and expertise in physiological data collection and analysis. (3) *Research Associate* to assist scientists with various projects. Perform data collection and analysis of electrophysiological data. Assist with subject recruitment, testing, and documentation. B.A./B.S. in psychology, neuroscience, or other physical science is required. UNIX scripting and statistical knowledge are highly desirable. Knowledge of EEG/event-related potential recording techniques would be helpful. Send curriculum vitae/resume to: Personnel Department, EEG Systems Laboratory, 51 Federal Street, San Francisco, CA 94107, fax 415/546-7121, or USENET maggie@eeg.com.