Published in final edited form as:

Psychophysiology. 2009 September ; 46(5): 984–995. doi:10.1111/j.1469-8986.2009.00852.x.

An alternative scoring method for skin conductance responding in a differential fear conditioning paradigm with a long-duration conditioned stimulus

Suzanne L. Pineles^{a,b}, Matthew R. Orr^c, and Scott P. Orr^{d,e}

^aNational Center for PTSD, Women's Health Sciences Division, VA Boston Healthcare System, Boston, Massachusetts, USA

^bDepartment of Psychiatry, Boston University School of Medicine, Boston, Massachusetts, USA

^cDepartment of Physics, University of Alabama in Huntsville, Huntsville, Alabama, USA

^dDepartment of Psychiatry, Massachusetts General Hospital and Harvard Medical School, Charlestown, Massachusetts, USA

^eDepartment of Veterans Affairs Medical Center, Manchester, New Hampshire, USA

Abstract

Researchers examining skin conductance (SC) as a measure of aversive conditioning commonly separate the SC response into two components when the CS-UCS interval is sufficiently long. This convention drew from early theorists who described these components, the first- and second-interval responses, as measuring orienting and conditional responses, respectively. The present report critically examines this scoring method through a literature review and a secondary data analysis of a large-scale study of police and firefighter trainees that used a differential aversive conditioning procedure ($n = 287$). The task included habituation, acquisition, and extinction phases, with colored circles as the CSs and shocks as the UCS. Results do not support the convention of separating the SC response into first- and second-interval responses. It is recommended that SC response scores be derived from data obtained across the entire CS-UCS interval.

Descriptors

Conditioning; Electrodermal response (skin electric response); Scoring methods

Since the 1960s, researchers using electrodermal, primarily skin conductance (SC), measures of aversive conditioning in humans have maintained that there are two separate components of the response to a conditioned stimulus (CS) when the CS-UCS interval is of a sufficiently long duration, approximately seven or more seconds (e.g., Grings, Lockhart, & Dameron, 1962, Lockhart, 1966, Öhman, 1971, Stewart, Stern, Winokur, & Fredman, 1961, see Dengerink & Taylor, 1971, for a review). For the purposes of this paper, these response components will be identified as the first interval response (FIR) and second interval response (SIR). These components are also commonly referred to as the FAR (first anticipatory response) and SAR (second anticipatory response). The presumption underlying these separately identified components is that the FIR reflects an orienting response, which reflects

novelty and habituates over time, whereas the SIR represents the “true” conditioned response (CR).¹

Over the past forty years this distinction has been generally accepted, whereby many researchers have followed the convention of reporting the FIR and SIR separately for SC data obtained in studies of conditioning. However, a careful review of the early literature suggests that there is only weak and inconsistent evidence supporting the FIR and SIR as distinct processes. The focus of the current paper is to critically consider the convention of separating the SC response to a long-duration CS into FIR and SIR components. This is accomplished in two ways: first, through a review of the relevant literature of differential aversive conditioning studies in which the CS-UCS interval is of sufficient duration to score a FIR and SIR; and, second, through secondary analysis of a large dataset in which participants underwent a differential aversive conditioning procedure.

Stewart and colleagues (1961) were the first to distinguish a FIR and SIR. In a simple conditioning procedure (i.e., only a single CS was used) that used a 7.5 s duration CS, the frequency of galvanic skin responses (GSRs) for the first interval declined as conditioning progressed. This decline in GSR frequency was similar to the pattern observed during a habituation period that preceded the conditioning procedure. In contrast, the pattern for the SIR showed an inverted U shape with an initial increase in the frequency of GSRs peaking at the eighth trial. Based on these two different patterns of response, Stewart et al. (1961) argued that the FIR and SIR represented two different responses, with the former reflecting an orienting response and the latter reflecting a CR. Similar distinctions of FIRs and SIRs were later endorsed by other researchers (e.g., Sokolov, 1965; Vinogradova, 1965).

Stewart et al. (1961) used latency criteria for response onsets to distinguish between the FIR and SIR. Other researchers have supported this distinction by highlighting the low correlation between FIRs and SIRs (Prokasy & Ebel, 1967) and by comparing FIRs and SIRs in conditioning versus sensitization groups (e.g., McDonald & Johnson, 1965; Prokasy & Ebel, 1967). Arguing that neither the latency criteria nor differences between conditioning and sensitization treatments were sufficient to establish the FIR and SIR as distinct responses, Öhman (1971) theorized that the FIR and SIR should have different generalization gradients. Specifically, the FIR should have a *rising* generalization gradient (i.e., a larger response is associated with a larger stimulus change) and the FIR for paired (conditioning) versus unpaired CS-unconditioned stimulus (UCS) presentations (sensitization) *would not* show different gradients. In contrast, the SIR would show a *falling* generalization gradient (i.e., a smaller response is associated with a larger stimulus change) and conditioning and sensitization treatments *would* yield significant differences in the SIR. Results from the study by Öhman (1971) supported hypotheses related to the FIR, but only partially supported the predictions for the SIR, as there was evidence that the SIR reflected both orienting and conditioned responses (Öhman, 1971).

Not all researchers examining conditioned SC responses have endorsed the distinction between FIR and SIR. Some have argued that multiple responses do not reflect different processes, but instead represent a dynamic and adaptive response pattern to the CS-UCS relationship. For example, Kimmel (1964) proposed that the FIR and SIR are not two separate responses, but that there is an “inhibition of delay” such that the conditioned response is made closer to the UCS as the duration of the relationship is learned. Kimmel stated that “inhibition of delay in GSR conditioning operates to depress the earlier portions of the initial CR (as well as to delay its onset) and frequently may create the impression of a ‘double response’ (1964, p. 161).”

¹Historically, separate scoring of the FIR and SIR in SCR conditioning work paralleled the eyelid conditioning literature, in which CRs and non-CRs were distinguished on the basis of response latency (cf., Furedy & Poulos, 1977).

The conceptualizations of the FIR and SIR described above were based on findings from simple classical conditioning procedures. Differential conditioning procedures, which include a stimulus that is not paired (CS-) with the UCS as well as a stimulus that is paired (CS+) with the UCS, provide a more stringent test of conditioning (Lockhart & Grings, 1963). Such studies have often found evidence of electrodermal conditioning for both the FIR and SIR (e.g., Gale & Ax, 1968; Gale & Stern, 1967, see Table 1). Gale and Stern (1967) reported that participants who underwent a differential aversive conditioning procedure exhibited increased probability and magnitude of both FIR and SIR after exposure to a CS+ as compared to a CS-. Furthermore, the conditioned FIR and SIR can be maintained over a large number of trials. Gale and Ax (1968) found that conditioning of the FIR and SIR was maintained for over 300 trials. Based on a review of the literature, Dengerink & Taylor (1971) concluded that the SIR is conditional and, although the evidence was mixed, the FIR is likely also conditional.

The primary goal of the present report is to assess the usefulness of dividing the SC response to a long-duration CS into FIR and SIR, as opposed to simply scoring a single peak response within the CS-UCS interval (e.g., Bitterman & Holtzman, 1952; Milad, Orr, Pitman, & Rauch, 2005; Orr & Lanzetta, 1980; Orr et al., 2000; Pitman & Orr, 1986). From a conceptual standpoint, this is an important consideration if the CR to a CS is truly represented in a specific component of the SC response(s), e.g., the SIR and not the FIR. From a practical standpoint, this scoring issue serves as the basis for the methodological criticism that a given study did not adhere to the FIR/SIR scoring convention. It has been the third author's experience that some scientific reviewers consider the FIR/SIR scoring convention to be well established and, therefore, to be followed. Finally, the FIR/SIR scoring convention is not as "conventional" as it might first appear, and as becomes apparent when the literature purporting to use this convention is closely examined. For example, some studies have used baselines that may not allow for the distinction of the FIR and SIR (measuring the baseline for the SIR before the CS onset), but still discuss their findings in these terms (e.g., Michael, Blechert, Vriends, Margraf, & Wilhelm, 2007). As a first step in assessing this convention, we reviewed the aversive differential conditioning literature in which CS-UCS intervals of sufficiently long duration were used and electrodermal activity was measured (see Tables 1 and 2; Table 2 lists studies for which the FIR/SIR distinction was not used. Rather, the response was defined by the highest SCR peak regardless of where the peak fell within the CS-UCS interval. We have labeled this response as "entire-interval response" (EIR)). The results of these tables should be interpreted with caution. Although we took great care to provide complete and accurate information, some subjective interpretations were made based on the available data because the requisite contrasts were not reported.

In the vast majority of studies that have used CS-UCS intervals of long duration, differential conditioning has been observed in both the FIR and SIR. In studies examining extinction of conditioned responses, the pattern of results for the FIR and SIR were similar to those observed during acquisition. Overall, in the extinction phases of differential conditioning studies, analyses of the FIR and SIR have produced largely comparable results.

Although the conditioning researchers of the 1960s and 1970s argued that the FIR and SIR reflected orienting and conditioned responses (respectively), our review of the older and more recent literature suggests that the FIR and SIR, if they indeed reflect separate responses, are both conditionable. These conclusions are similar to those previously made by several other researchers (e.g., Gale & Ax, 1968; Gale & Stern, 1967; Lockhart & Grings, 1963; Prokasy & Ebel, 1967; see Dengerink & Taylor, 1971, and Prokasy, 1977 for reviews). In addition to its seemingly weak empirical foundation, the practice of dividing the SC response to a long-duration CS into multiple components has the potential to diminish or obscure a larger CR when the onset or peak of the response occurs near the boundary of the FIR and SIR. The purpose of the analyses reported here is to assess whether the practice of scoring the FIR and

SIR separately provides a better assessment of SC conditioning than simply obtaining the peak SC response regardless of where the peak falls within the CS-UCS interval (i.e., entire-interval response, EIR). To accomplish this aim, we analyzed the SC data obtained during a differential aversive conditioning procedure administered within a large study of police and firefighter trainees conducted by the third author and members of his research group.

Method

Participants

Police and firefighter trainees were recruited from the: *Lowell Police Academy*, Lowell, Massachusetts; training academy of the *Boston Fire Department*, Boston, Massachusetts; *Massachusetts Fire Training Academy*, Stowe, Massachusetts; and *New Hampshire Technical College Fire Technology program*, Laconia, New Hampshire. Participants were part of a larger project that will prospectively examine predictors for the risk of developing posttraumatic stress disorder (PTSD) in police and firefighters. The sample consisted of 287 individuals; approximately 10% were women, 84% Caucasian, 7% African American, 9% Hispanic, and fewer than 1% were Asian, Pacific Islander, American Indian, or Alaskan Native. The average age and education level of the sample were 26.1 ($SD = 6.2$) and 13.8 ($SD = 1.7$) years, respectively. Participants fell within the normal range of IQ (average Wechsler estimated IQ = 101.0 ($SD = 11.0$) (Shipley, 1991)) and were mentally healthy (average Beck Depression Inventory = 3.0 ($SD = 4.3$) (Beck, Rush, Shaw, & Emery, 1979); average Symptom Checklist-90-Revised, Global Severity Index = 0.32 ($SD = 0.36$) (Derogatis, 1983); and self-reported anxiety = 31.4 ($SD = 10.7$) on the state portion of the Spielberger State-Trait Anxiety Inventory (Spielberger, Gorsuch, & Lushene, 1990)) at the time of testing. Written informed consent was obtained from all participants in accordance with the requirements of the Partners Healthcare System Human Research Committee.

Equipment

A Coulbourn Labline V, Human Measurement System (Coulbourn Instruments, Whitehall, PA) was used to record the SC analog signal, which was digitized by a Coulbourn analog to digital converter (V19-16) and stored on an IBM-compatible computer system. Skin conductance was measured by a Coulbourn Isolated Skin Conductance coupler (V71-23) using a 0.5 V constant direct current through 9-mm (sensor diameter) Docxs Ag/AgCl electrodes (Docxs Biomedical Products, Ukiah, CA) filled with isotonic paste and placed on the hypothenar surface of the subject's non-dominant hand, in accordance with published guidelines (Fowles et al., 1981). The SC electrodes were separated by 14 mm, as determined by the width of the adhesive collar. SC was sampled and stored at 10 Hz, beginning 4 s prior to CS onset and ending 6 s following CS offset.

Procedure

The experimental session took place in a humidity- and temperature-controlled room located in quiet areas of the respective training academies. Due to space limitations, it was necessary to locate the participant, laboratory equipment, and technician in the same room. A screen was placed so that the participant could not see the recording equipment and technician during the conditioning procedure. The participant was seated in a chair placed 4 feet in front of a monitor that was used to display the CSs. The CS+ and CS- were represented by 6-inch diameter blue and white circles, respectively.² The UCS was a 500-ms electric shock generated by a Coulbourn Transcutaneous Aversive Finger Stimulator (E13-22; Coulbourn Instruments,

²The colors used for the CS+ and CS- were not counterbalanced because the task was part of a larger study assessing the potential usefulness of a measure of conditionability as a predictor of subsequent development of PTSD. Therefore, the investigators wanted to standardize presentation of the stimuli across all participants, such that everyone saw the same CS+ and CS-.

LLC) previously determined by the participant to be “highly annoying but not painful.” The shock was delivered through electrodes attached to the second and fourth fingers of the dominant hand and consisted of a train of 1-ms square wave pulses presented at a rate of 50 Hz. The range of UCS intensities was 0.5–4.0 mA ($M = 1.74$, $SD = .53$). Because conductive properties of the hand affect the subjective experience of shock, different participants may have found the same level of shock to be relatively more or less aversive.

Once the UCS level was established, the subject was given the following instructions:

“This experiment will consist of a baseline period followed by three phases. During the baseline period, which will last 5 min, we will check our instruments and you should try to relax. At the end of this period, you will see ‘Begin Phase I’ displayed on the monitor. During this phase two different colored circles will be presented on the monitor. You should sit quietly and look at each colored circle as it is presented. At the end of the period, ‘Begin Phase II’ will appear on the monitor. During this phase the colored circles will be presented again, and some of them will be followed by the electric stimulus. Again, you should sit quietly and look at each colored circle as it is presented. At the end of Phase II, ‘Begin Phase III’ will appear on the monitor. During this phase you will see more colored circles. However, you will no longer receive any electric stimulation. Please continue to sit quietly and look at each colored circle as it is presented. It is important that you watch the screen at all times. Do you have any questions?”

After the subject indicated readiness to proceed, the technician activated the computer, which took over administration of the experiment. After a 5-min resting period, the three phases of the experiment were initiated. During each phase, the CS duration was 8 s, and the intertrial intervals (ITIs) ranged from 15–25 s, with the duration of each ITI determined at random by the computer. Habituation (Phase I) consisted of five presentations each of the to-be CS+ and CS– in pseudo-random order, i.e., no more than two consecutive presentations of the same stimulus type. Acquisition (Phase II) consisted of five presentations of each stimulus type in pseudo-random order; a 500-ms shock pulse occurred immediately following each CS+ offset. Extinction (Phase III) consisted of 10 non-reinforced presentations each of the CS+ and CS– in pseudo-random order.

Response Scoring

Skin conductance response scores were analyzed in two ways: 1) using a convention-based FIR and SIR distinction, and 2) using the entire CS-UCS interval (EIR). Scoring criteria for FIR and SIR were guided by our reading of the older literature, our presumptions about scoring decisions made by previous investigators that were not explicitly elaborated in the published reports, and practical considerations from inspection of the present data. Below, we have tried to provide a concise, but clear, description of the method arrived at for scoring the FIR and SIR. We believe that this is a good “approximation” of what the FIR/SIR proponents have/had in mind. However, we suffer no delusion that this is the final answer and that some readers will not argue with one or more of our interpretations and assumptions. A copy of the Mathematica-based scoring algorithm and program we developed is available on request; use of this program requires access to Mathematica 6 (Wolfram Research Inc., 2007).

This scoring algorithm identifies response onset for the FIR (and SIR) by finding the point of maximum curvature of the SCL data within a pre-specified onset window and then stepping forward (or backward) until the slope changes from negative to positive (or positive to negative). This point of slope change defines the response onset. A response peak is found by locating the highest SC value after the identified onset and within the window specified for the peak. In order for a response to be scored, neither its onset nor peak can be located at the first

or last data point in their respective window. If this occurs, the window is shrunk and the algorithm looks for a new onset or peak. An exception to this is when the data are flat in the vicinity of an onset that occurs at the first data point, in which case the requirement is that the data remain flat for 0.3 s prior to the identified onset. The search for an onset or peak continues until the lowest onset SCL value and highest peak SCL value are identified in their respective windows, or a window reaches zero width. A zero-width window indicates that an onset or peak cannot be found and no response for the interval is calculated. The same procedure is used for scoring the FIR and SIR, with one exception. If the value of the last data point within the SIR window exceeded the identified peak, that value was substituted for the SIR peak value. For the present study, the mathematical expression used to characterize curvature of the SC data was closely approximated by the second derivative, because the first derivative was found to be much less than one.

As determined from the extant literature, windows for potentially locating a response onset and peak were specified as follows for the FIR and SIR. For the FIR, we required that the inflection point of a response onset occur within 1–4 s, and that the response peak occur within 2–6 s, following CS onset. For the SIR, we required that the inflection point of response onset occur within 4–8 s, and that the response peak occur within 5–9.5 s, following CS onset. Skin conductance data were not collected during the actual UCS presentation (i.e., between 8.0–8.5 s following CS onset) because an electrical stimulation artifact could contaminate recordings during this period. Consequently, the SIR peak could be slightly underestimated if it occurred within the 0.5 s UCS interval. The SIR window, even though it extends to 9.5 s, does not contain any portion of the UCR due to the relatively long onset latency of an SCR.

FIRs and SIRs were quantified as difference scores between the peak and onset values. When the FIRs and SIRs were averaged over trials, zero entries were used for trials that produced no identifiable response. Scores for the EIR were calculated by subtracting the mean SC level for the 2 s immediately preceding CS onset from the highest SC level value recorded during the 8 s CS-UCS interval, as has been previously done (e.g., Orr & Lanzetta, 1980; Orr et al., 2000; Pitman & Orr, 1986). A square-root transformation was applied to all response scores.

Results

Figure 1 illustrates the SC level data recorded for each CS+ and CS– acquisition trial (respectively) and averaged across all participants. As is readily apparent in the figure, the CS-UCS interval of each CS+ trial only appears to contain a single prominent response with a peak that occurs approximately 3–4 s following CS onset.

Most participants produced an identifiable FIR and/or an identifiable SIR on at least one of the ten CS+ or CS– acquisition trials. Three participants did not exhibit a FIR or a SIR on any of the acquisition trials. In addition, 18 participants did not exhibit a SIR on any acquisition trial and four participants did not exhibit a FIR on any acquisition trial, but did exhibit a SIR on at least one of these trials. For the FIR, mean onset latency ranged from 1.8–2.1 s (*SDs*: 0.5–0.6 s) following CS onset and the mean peak latency ranged from 3.6–3.8 s (*SDs*: 0.8–0.9 s) across the 5 CS+ trials. For the SIR, mean onset latency ranged from 6.3–6.4 s (*SDs*: 1.0–1.1 s) following CS onset and the mean peak latency ranged from 7.4–7.7 s (*SDs*: 1.0–1.1 s) across the 5 CS+ trials. Based on the F-test for equality of variance, the variances for onset latencies were significantly larger for the SIR than for the FIR (*F* ratios range for the five CS+ trials: 2.89–4.15, *p*'s < .05; *dfs* for FIR range from 228–250 and *dfs* for SIR range from 180–215).

Analyses of variance (ANOVA) for repeated measures were conducted separately for the three phases of the procedure: habituation, acquisition, and extinction, and separately for each of the

three SC response scores: FIR, SIR, and EIR. See Table 3 and Figure 2 for a summary of these results.

In each of the nine repeated-measures ANOVAs conducted for the CS-UCS interval responses, two variables were analyzed as within-subjects effects: Stimulus Type (CS+, CS-) and Trials. The Trials effect contained 5 levels (5 CS+ and 5 CS-) for the habituation, acquisition, and extinction phases. Although there were ten CS+ and CS- trials during extinction, the majority of extinction occurred within the first few trials; therefore, only the first five CS+ and CS- trials were included in the analyses. All significance levels reported for analyses that included the Trials effect reflect the Greenhouse-Geisser correction for violation of the sphericity assumption. However, in order to minimize possible confusion arising from different degrees of freedom being reported for similar analyses, we report the degrees of freedom associated with the unadjusted tests.

Habituation Phase

EIR—As can be seen in Table 3 and Figure 2, a repeated-measures ANOVA for the EIR during the Habituation Phase produced a significant Trials main effect. Skin conductance response magnitude showed an overall decrease over trials. The Trials main effect was modified by a Stimulus Type $\times$ Trials interaction. A series of paired *t*-tests that compared SC response magnitude for CS+ versus CS- trials confirmed that SC response magnitude differed between the first CS+ and CS- presentations ($t(286) = 2.87, p < .01$), but not between subsequent CS+ versus CS- trial pairings ($t(286)$'s $< 1.73, n.s.$). The larger mean response to CS- trials was likely due to the effect of randomization that resulted in approximately twice as many participants viewing the CS- as the first stimulus in this phase, and the impact that initial orienting response magnitude to the CS- had on the overall mean response to CS- trials.

FIR—The repeated-measures ANOVA for the FIR produced a significant Trials main effect which reflected a general decrease in SC response magnitude over trials. Neither the main effect of Stimulus Type nor the interaction of Stimulus Type $\times$ Trials was significant (Table 3, Figure 2).

SIR—The repeated-measures ANOVA for the SIR produced a significant Trials main effect which reflected a general decrease in SC response magnitude over trials. Neither the main effect of Stimulus Type nor the interaction of Stimulus Type $\times$ Trials was significant (Table 3, Figure 2).

Acquisition Phase

EIR—As can be seen in Table 3 and Figure 2, the repeated-measures ANOVA for the EIR produced significant Stimulus Type and Trials main effects. There was a larger mean SC response magnitude for CS+ ($M = 0.58, SD = 0.37$) versus CS- trials ($M = 0.43, SD = 0.32$) and SC response magnitude showed an overall decrease over trials. These main effects were modified by a Stimulus Type $\times$ Trials interaction. A series of paired *t*-tests comparing SC response magnitude for CS+ versus CS- trial pairings confirmed that SC responses to the stimuli differed for trial-pairings 2–5 ($t(286)$'s $> 3.11, p$'s $< .01$), but not between the first presentations of these stimuli ($t(286) = 1.18, n.s.$).

FIR—The repeated-measures ANOVA for the FIR produced significant Stimulus Type and Trials main effects, with effect sizes of similar magnitude to the respective EIR main effects. These effects reflected a larger mean SC response magnitude to CS+ ($M = 0.53, SD = 0.32$) compared to the CS- ($M = 0.42, SD = 0.27$) and a decrease in SC response magnitude over trials. As was found for the EIR, these main effects were modified by a Stimulus Type $\times$ Trials interaction and the effect size for this interaction was similar in magnitude to the effect size

for the EIR Stimulus Type $\times$ Trials interaction (Table 3, Figure 2). A series of paired t -tests comparing SC response magnitude to CS+ versus CS- trials confirmed that magnitude of the SC response to the stimuli differed for trial pairings 2–5 ($t(286)$'s > 3.84 , p 's $< .001$), but not for the first presentations of these stimuli ($t(286) < 1$).

SIR—The repeated-measures ANOVA for the SIR produced significant Stimulus Type and Trials main effects, reflecting a larger mean SC response magnitude to CS+ ($M = 0.29$, $SD = 0.22$) compared to the CS- ($M = 0.21$, $SD = 0.19$) and decreasing SC response magnitude over trials. However, these effect sizes were smaller than the respective effect sizes for the EIR and FIR. As with the EIR and FIR, the Stimulus Type and Trials main effects were modified by a Stimulus Type $\times$ Trials interaction. The effect size for this interaction was similar in magnitude to the Stimulus Type $\times$ Trials interaction for the EIR and the FIR (Table 3, Figure 2). A series of paired t -tests comparing SC response magnitude to the CS+ versus CS- confirmed that the magnitude of the SC response to the CS+ was larger than the magnitude of the SC response to the CS- for trial pairings 2–5 ($t(286)$'s > 4.22 , p 's $< .001$). In contrast, the SC response magnitude for the CS- was larger than that for the CS+ for the first presentation ($t(286) = 3.22$, $p < .01$). The larger response to the CS- than the CS+ was likely due to randomization that resulted in approximately twice as many participants viewing the CS- before the CS+ in the acquisition phase.

Extinction Phase

As noted above, analyses of the extinction phase only included the first five CS+ and CS- trials.

EIR—The repeated-measures ANOVA for the EIR produced a significant Trials main effect, which appeared to have a repeated pattern of increases and decreases over the course of the trials. Neither the main effect of Stimulus Type nor the interaction of Stimulus Type $\times$ Trials was significant (Table 3, Figure 2).

FIR—The repeated-measures ANOVA for the FIR produced a significant Trials main effect, which reflected a general decrease in SC response magnitude over trials. Neither the main effect of Stimulus Type nor the interaction of Stimulus Type $\times$ Trials was significant (Table 3, Figure 2).

SIR—The repeated-measures ANOVA for the SIR produced a significant Stimulus Type $\times$ Trials interaction. A series of paired t -tests that compared SC response magnitude for CS+ versus CS- trials confirmed that SC response magnitude differed between the last CS+ and CS- presentations ($t(286) = 2.36$, $p < .05$), but not between the first four CS+ versus CS- trial pairings ($t(286)$'s < 1.50 , $n.s.$). The main effects of Stimulus Type and Trials were not significant (Table 3, Figure 2).

Correlations Between the Different Response Scores

In order to assess the relationships amongst the EIR, FIR, and SIR as measures of differential conditioning, difference scores were calculated for the FIR, SIR, and EIR wherein the average SC response magnitude for CS- trials was subtracted from the average SC response magnitude for CS+ trials during the Acquisition Phase. The EIR and FIR difference scores were highly correlated, $r(285) = .62$, $p < .001$. The SIR difference score was also significantly positively correlated with both the EIR and FIR difference scores, but these correlation coefficients were not as robust ($r(285) = .44$, $p < .001$; $r(285) = .19$, $p < .01$, respectively).

The relationships amongst the EIR, FIR, and SIR, as general measures of anticipatory reactivity, were also examined. Reactivity scores were calculated by averaging SC response

magnitudes across the five CS+ trials during the Acquisition Phase separately for the EIR, FIR, and SIR. The average magnitude of the EIR and FIR scores were very highly correlated with each other ($r(285) = .86, p < .001$), and less strongly with the SIR ($r(285) = .67, p < .001$; $r(285) = .58, p < .001$, respectively).

Characteristics of Individuals Who Consistently Exhibited Either a Larger FIR or SIR

Another set of analyses focused on testing individual differences between those who responded more strongly at the beginning of the CS-UCS interval (FIR) and those who responded more strongly towards the end (SIR). In order to minimize the potential effect of novelty responses, FIR and SIR magnitudes were averaged over the last three CS+ trials during acquisition for each participant. Based on these data, participants were divided into two groups: those with relatively larger mean FIR scores ($n = 210$) and those with relatively larger SIR scores ($n = 76$) (See Table 4). Comparisons of these groups indicated that they did not differ on measures of psychological distress (Derogatis, 1983), depression (Beck et al., 1979), state and trait anxiety (Spielberger et al., 1990), IQ (Shipley, 1991), or any of the Big 5 factors (Costa & McCrae, 1992) (Cohen's d 's $< .32, n.s.$).

Conclusions

The present work examined the convention of assessing electrodermal reactivity to a long-duration CS by separating the SC response into FIR and SIR components. Based on our comprehensive review of the differential aversive conditioning literature and the cumulative findings from these studies, differential conditioned responses appear to be observable in both the FIR and SIR. In addition to this review, we addressed the utility of separately scoring the FIR and SIR through a secondary analysis of SC data obtained from a differential aversive conditioning procedure administered in the context of a large study of police and firefighter trainees. The primary outcome of the secondary analyses is clearly evident in Figure 1, where it can be seen that the SC responses to the 8-s duration conditioned stimuli are primarily characterized by a single, prominent peak that occurs around 3–4 s following CS onset. It is worth noting that the latency of this peak remained remarkably stable across trials. As can be seen in the figure, there is almost no displacement of this peak from early to late trials. The stability of the response peak in the present study does not support Kimmel's (1964) proposition that there is an “inhibition of delay” such that the conditioned response is made closer to the UCS as conditioning progresses. However, a longer CS-UCS interval than that used in the present study, or more conditioning trials, may be necessary to reveal a progressive shift in the response peak, if one exists.

Although Figure 1 suggests a single SC response peak, statistical analyses indicate that effect of differential conditioning can be detected in the SIR, as well as the FIR. Thus, both a FIR and SIR can be scored and used to differentiate responses to a CS+ versus CS– even though the FIR is the more visually prominent of these components. It is possible that the absence of a more distinctive SIR peak in the figures is due, at least in part, to greater variability in the SIR peak latency, i.e., “latency jitter,” which would have the effect of flattening the SC level curve when averaging over a large number of subjects.

As with the FIR and the SIR, differential conditioning can be detected with the EIR, a measure that is relatively simple to score. It is interesting to note through visual inspection of Figure 2 that the patterns of the SC responses to the CS+ and CS– over trials, particularly during the acquisition phase, were very similar for the FIR, SIR, and EIR. This is further reflected in the effect sizes for differential conditioning, which were comparable for the three measures.

The EIR and FIR are more strongly correlated with each other than with the SIR. These results support the use of either the FIR or EIR to detect differential aversive conditioning effects and

suggest that there is no substantive difference between the scores generated by the method used to calculate the EIR and that used to calculate the FIR. Both scoring methods seem capable of adequately representing conditioned SC responses generated by a differential aversive conditioning procedure that uses a long CS-UCS interval. It is worth noting that there was a moderately strong relationship between the EIR and SIR, which was substantially stronger than between the FIR and SIR. This supports the EIR's sensitivity to SC reactivity across the entire CS-UCS interval, regardless of where the peak response(s) occur(s). The FIR and SIR scores showed only a weak correlation with each other ($r = .19$), which would be expected if they are relatively independent measures of conditioning. However, from an individual-differences perspective, individuals who show relatively larger FIRs, compared to those who show relatively larger SIRs, do not appear to differ on measures commonly thought to influence differential conditioning (e.g., anxiety, neuroticism). The lack of meaningful psychological differences between individuals who preferentially exhibit a FIR or SIR suggests that separate measurement of these two responses may be unnecessary.

Although the results produced by the EIR, FIR, and SIR are very similar, there are conceptual and practical advantages to using the EIR. First, the EIR makes no assumptions about where a response is likely to occur within the CS-UCS interval. This eliminates the risk of underestimating a larger CR when the onset or peak of the response occurs near a previously established boundary between the FIR and SIR or when the latency of the peak response shifts over trials. In addition, the EIR represents the cumulative maximum conductance change elicited by the CS. In contrast, if a SIR begins with an inflection point near the peak of the FIR, the FIR and SIR may appear as two moderate-sized responses when the cumulative conductance change was large. Furthermore, the EIR avoids the conceptual dilemma of where to establish the boundary between the FIR and SIR when the duration of the CS-UCS interval varies. For example, would 6-s FIR and SIR durations be used for a 12-s CS-UCS interval, while 4-s FIR and SIR durations would be used for an 8-s CS-UCS interval?

Second, from a practical standpoint, the method used to calculate the EIR reflects a much simpler way of scoring data. This method, as applied in the present study, simply calculates a pre-stimulus-onset SC level by averaging data over a brief duration (we used 2 s), identifies the highest SC level (i.e., peak) during the CS-UCS interval, and then subtracts the pre-stimulus value from the peak value. Because SC responses have relatively long onset latencies, it would also be reasonable to use the SC level immediately following stimulus onset (e.g., up to 1 s post-stimulus onset) as the initial level to subtract from the peak value. Scoring is easily accomplished within one of the currently available spreadsheets (e.g., Microsoft Excel, Microsoft Corp.), within a data analysis package (e.g., Statistical Analysis System, SAS Institute Inc.) or by means of a very simple computer program. Most importantly, this method does not require undertaking the complex process of mathematically modeling SC data curves, identifying points of inflection that define a response onset and creating, or learning to use, software that can accomplish this process.

Although there appear to be advantages to using the EIR rather than the FIR and SIR, it is important to note some potential limitations to the generalizability of our findings. First, because there were only five acquisition trial pairs, we are unable to assess whether similar results would be observed for longer acquisition phases that included a greater number of trials. Similarly, because the CR extinguished very quickly for most participants, likely due to the extinction instructions, we were unable to assess the utility of the EIR vs. the FIR/SIR distinction for extinction. Finally, because this dataset is derived from one study, it is possible that specific aspects of the procedures may have contributed to the results. Therefore, more data are necessary to establish the generalizability of our conclusions regarding the relative usefulness of the EIR, compared to the FIR and SIR. However, we believe this study to be an

important initial step in establishing the utility of the EIR and challenging the FIR/SIR convention.

In sum, based on the existing electrodermal conditioning literature and secondary data analysis, it appears that separating SC responses into FIR and SIR components in differential aversive conditioning studies may not be warranted. Instead, use of the EIR to capture the SC response is recommended, at least in studies that administer relatively few acquisition trials. The EIR reflects a more parsimonious approach to data scoring than the traditional FIR/SIR distinction, and this first investigation suggests that the EIR, FIR, and SIR are approximately equally robust in detecting conditioning effects.

Acknowledgments

This research was supported by U.S. Public Health Service grant R01-MH60315 and Department of Veterans Affairs Merit Review grant to Scott P. Orr. Additional support was provided to Suzanne Pineles by the Department of Veterans Affairs, Clinical Sciences R&D Service, Career Development Award Program. We thank Heike Croteau, Michael Macklin, Sgt. Thomas Flemming, Sheeva Mostoufi, and Erin Rowe for their assistance with this project. We would also like to express our appreciation to the police and firefighters for their willingness to participate.

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Figure 1.

Skin conductance level for CS+ and CS- trials in the acquisition phase averaged across all participants. Each line denotes the average SC levels over time for each of the 10 trials. The CS+ trials are depicted with solid lines and the CS- trials are depicted with dotted lines. In addition, the CS+ and CS- trials are paired such that each respective pair is depicted in the same shade of gray.

Figure 2.

Square root transformed average EIR, FIR, and SIR to the CS+ and CS- over trials.

Table 1
FIR and SIR Results from Differential Conditioning Studies Using a CS Interval of At Least 7 Seconds

Study	N*	Acq trials CS+/CS-	CS-UCS interval	UCS	Acq Interval 1 CS+ >CS-	Acq Interval 2 CS+ >CS-	Ext trials CS+/CS-	Ext Interval 1 Main effect?	Ext Interval 1 Interaction?	Ext Interval 2 Main effect?	Ext Interval 2 Interaction?
Bjorkstrand (1990) (exp 1)	64	8/8	8s	shock	1-4s (yes)	4-9s (yes)	15/15	yes	no	yes	yes
Bjorkstrand (1990) (exp 2)	64	8/8	8s	shock	1-4s (yes)	4-9s (yes)	20/20	no	yes	no	no
Booth et al. (1989) (exp 1)	48	8/8	8s	shock	1-5s (yes)	5-9s (not reported)	8/8	yes	no	not reported	not reported
Cheng et al. (2006) (exp 1)	17	20/20	10s	shock	not scored	5-10s (yes)	N/A	N/A	N/A	N/A	N/A
Dawson et al. (1979)	64	20/20	7s	shock	1-4s (yes)	4-8s (yes)	N/A	N/A	N/A	N/A	N/A
Dawson et al. (1982) (exp 1)	32	20/20	7s	shock	1-3.5s (yes)	3.6-7.9s (yes)	N/A	N/A	N/A	N/A	N/A
Dawson et al. (1982) (exp 2)	44	20/20	7s	shock	1-3.5s (yes)	3.6-7.9s (yes)	N/A	N/A	N/A	N/A	N/A
Dimberg & Öhman (1983) (exp 1)	24	8/8	8s	shock	1-4s (yes)	4-9s (yes)	16/16	yes	no	yes	no
Dimberg & Öhman (1983) (exp 2)	24	8/8	8s	shock	1-4s (yes)	4-9s (yes)	16/16	N/A	N/A	N/A ****	N/A *****
Fredrikson (1981)	24	12/12	8s	shock	1-4s (yes)	not scored	20/20	yes	no	not scored	not scored
Fredrikson & Öhman (1979)	32	8/8	8s	shock	1-4s (yes)	4-9s (no)	20/20	yes	no	no conditioning	no conditioning
Fredrikson et al. (1993)	28	8/8	8s	white noise	1-4s (yes)	4-9s (yes)	8/8	yes	no	yes	yes
Fredrikson et al. (1993b)	28	8/8	8s	shock	1-4s (yes)	4-9s (yes)	8/8	no	no	yes	no
Fredrikson et al. (1976)	48	8/8	8s	shock	1-4s (yes)	4-9s (yes)	20/20	yes	no	yes	yes
Fuhrer & Baer (1969)	67	17/16	8s	shock	1-5s (yes)	5-9s (yes) **	N/A	N/A	N/A	N/A	N/A
Fuhrer & Baer (1980)	20	30/30	8s	shock	1-5s (yes)	5-9s (yes)	10/10	yes	yes	no	no
Fuhrer et al. (1973)	71	13/12	8s	shock	1-5s (yes)	5-9s (yes)	6/6	yes	no	yes	no
Furedy (1970)	80	15/15	7.5s	shock	1-4s (yes)	4-8.5s (yes)	5/5	not reported	not reported	no	no
Furedy et al. (2000)	80	10/10	8s	white noise	1-5s (yes)	5-8s (yes)	10/10	yes	no	no	no
Gale & Ax (1968)	7	150/150	9.5s	shock	1-4.5s (yes)	4.5-10.5s (yes)	N/A	N/A	N/A	N/A	N/A
Gale & Stern (1967)	16	30/30	7.8s	shock	1.5-4.5s (yes)	4.5-8.5s (yes)	10/10	not reported	not reported	not reported	not reported
Grillon (2002)	133	8/8	8s	shock	1-4s (yes) **	not scored	N/A	N/A	N/A	N/A	N/A
Grings (1969) (exp 1)	10	not reported	10s	shock	1-4s (yes)	4-8 s and 8-10s (no)	N/A	N/A	N/A	N/A	N/A
Hammond et al. (1980)	40	16/16	8s	shock	1-5s (yes)	5-9s (yes)	N/A	N/A	N/A	N/A	N/A
Hedlund & Chambless (1990)	45	10/10	10s	car horn	1-4s (yes)	6-11s (yes)	10/10	not tested	yes	not tested	yes
Hettema et al. (2003)	346	8/8	8s	shock	1-4s (yes)	not scored	8/8	yes	yes	N/A	N/A
Hugdahl (1978)	40	12/12	8s	shock or threat of shock	1-4s (yes)	4-9s (yes)	20/20	yes	yes	yes	yes
Hugdahl et al. (1977)	64	8/8	8s	shock	1-4s (yes)	4-9s (yes)	20/20	yes	yes	yes	yes

Study	N*	Acq trials CS+/CS-	CS-UCS interval	UCS	Acq Interval 1 CS+ >CS-	Acq Interval 2 CS+ >CS-	Ext trials CS+/CS-	Ext Interval 1 Main effect?	Ext Interval 1 Interaction?	Ext Interval 2 Main effect?	Ext Interval 2 Interaction?
Hugdahl & Öhman (1977) (exp 1)	56	10/10	8s	shock	1-4s (yes)	4-9s (yes)	14/14	yes	no	yes	no
Hugdahl & Öhman (1977) (exp 2)	30	12/12	8s	shock	1-4s (yes)	4-9s (yes)	N/A	N/A	N/A	N/A	N/A
Hugdahl & Öhman (1980)	80	12/12	8s and 16s	shock	1-4s (yes)	4-9s in 8s group and 9-17s in 16s group (yes)	16/16	yes	not tested	no	not tested
Hugdahl & Karker (1981)	45	12/12	8s	shock	1-4s (yes)	4-9s (no)	16/16	yes	no	no conditioning	no conditioning
Kirsch & Boucsein (1994)	28	12/12	8s	shock	1-5s (yes)	5-9s (no)	12/12	no	***** no	no conditioning	no conditioning
Leonard & Winokur (1963)	10	20/20	7.5s	shock	1.5-3.5s (no)	3.5s-8.5s (yes)	N/A	N/A	N/A	N/A	N/A
Lipp et al. (1997) (exp 1)	48	16/16	8s	shock	1-4s (yes)	4-9s (yes)	8/8	yes	no	no	no
Lipp et al. (1998) (exp 3)	72	16/16	8s	shock	1-4s (yes)	4-9s (yes)	8/8	no	no	no	no
Lipp et al. (2003) (exp 1)	64	16/16	8s	shock	1-4s (yes)	4-9s (not reported)	8/8	yes	no	not reported	not reported
Lipp & Vaitl (1990)	36	16/16	8s	shock	1-4s (yes)	4s-9s (yes)	6/6	yes	no	no	no
Lovibond (1992) (exp 1)	76	4/4	9.5-39.5s	shock	1-5s (yes)**	not scored	N/A	N/A	N/A	N/A	N/A
Lovibond (1992) (exp 2)	29	4/4	9.5-39.5s	shock	1-5s (yes)	not scored	N/A	N/A	N/A	N/A	N/A
Lovibond et al. (1993) (exp 1)	75	4/8	9.5s	shock	1-4s (yes)	not scored	N/A	N/A	N/A	N/A	N/A
Lovibond et al. (1993) (exp 2)	96	6/5	9.5s	shock	1-4s (yes)	not scored	N/A	N/A	N/A	N/A	N/A
Merckelbach et al. (1987)	41	6/6	8s	shock	1-4s (yes)	4-8s (yes)	10/10	no	no	yes	no
Michael et al. (2007)	72	6/6	8s	shock	not reported	4-8s (yes)	6/6	not reported	not reported	not reported	not tested
Neumann & Waters (2006) (exp 1)	48	12/12	8s	shock, aversive noise, or loud tone	1-4s (yes)	4-9s (yes)	12/12	no	no	no	no
Öhman & Bohlin (1973)	55	20/20	8s	shock	1-4s (yes)	5-9s (yes)	8/8	yes	no	yes	no
Öhman & Dimberg (1978) (exp 1)	32	8/8	8s	shock	1-4s (yes)	4-9s (yes)	16/16	yes	no	yes	no
Öhman & Dimberg (1978) (exp 2)	48	8/8	8s	shock	1-4s (yes)	4-9s (yes)	16/16	yes	no	yes	no
Öhman et al. (1975)	64	10/20	8s	shock	1-4s (yes)	4-9s (yes)	10/20	yes	not tested	yes	not tested
Öhman et al. (1978)	56	8/8	8s	shock	1-4s (yes)	4-9s (not reported)	20/20	yes	yes	not reported	not reported
Öhman et al. (1976) (exp 1)	60	5/5	8s	shock	1-4s (yes)	4-9s (yes)	10/10	yes	no	yes	no
Öhman et al. (1976) (exp 2)	32	8/8	8s	shock	1-4s (yes)	4-9s (yes)	8/8	yes	no	yes	no
Öhman et al. (1976) (exp 3)	40	8/8	8s	shock	1-4s (yes)	4-9s (yes)	20/20	yes	yes	yes	no
Packer et al. (1991)	28	12/12	8s	shock	1-4s (yes)	4-8s (yes)	12/12	yes	no	no	no
Sandin & Chorot (2002)	79	8/8	8s	aversive noise	1-4s (yes)	4-9s (yes)	12/12	yes	not tested	yes	not tested
Schell et al. (1991)	163	12/12	8s	shock	1-4s (yes)	4-9s (yes)	22/22	yes	yes	yes	no
Schiffman & Furedy (1972)	40	15/15	8s	shock	1-5s (yes)	5-9s (no)	N/A	N/A	N/A	N/A	N/A
Siddle et al. (1985) (exp 2)	48	16/16	8s	white noise	1-5s (yes)	5-9s (yes)	8/8	yes	no	no	no
Vansteenwegen et al. (1998)	38	8/8	8s	shock	1-4s (yes)	not scored	12/12***	no	no	N/A	N/A

Study	N*	Acq trials CS+/CS-	CS-UCS interval	UCS	Acq Interval 1 CS+ >CS-	Acq Interval 2 CS+ >CS-	Ext trials CS+/CS-	Ext Interval 1 Main effect?	Ext Interval 1 Interaction?	Ext Interval 2 Main effect?	Ext Interval 2 Interaction?
Vansteenwegen et al. (2005)	34	10/10	8s	loud noise	1–4s (yes)	not scored	10/10	not tested	yes	N/A	N/A
Vaughan & Lanzetta (1980) (exp 1)	16	10/10	10s	facial look of pain	0–5s (yes)	5–10s (no)	N/A	N/A	N/A	N/A	N/A
Vaughan & Lanzetta (1980) (exp 2)	19	10/10	10s	facial look of pain	0–5s (yes)	5–10s (no)	N/A	N/A	N/A	N/A	N/A
Veit et al. (2002)	15	16/16	7s	painful stimulus	1–5s (yes)	not scored	8/8	no	not reported	N/A	N/A
Vervliet et al. (2005)	32	4/4	8s	shock	1–4s (yes)	not scored	4/4	yes	not tested	N/A	N/A
Vervliet et al. (2004)	36	4/4	8s	shock	1–4s (yes)	not scored	4/4	yes	not tested	N/A	N/A
Wilson et al. (1974)	102	19/18	8s	shock	1–5s (yes)	5–9s (yes)**	N/A	N/A	N/A	N/A	N/A

Note. N = number of participants; Acq trials CS+/CS- = number of acquisition trials, with number of CS+ trials presented on left of the slash mark and number of CS- trials presented to the right of the slash mark; CS-UCS interval = duration of CS-UCS interval; Ext trials CS+/CS- = number of extinction trials, with number of CS+ trials presented on left of the slash mark and number of CS- trials presented to the right of the slash mark. In studies comparing different parameters of conditioning (e.g., trace vs. delay; different types of stimuli), if there was any evidence of acquisition or extinction, this was coded with a “yes.”

* N reflects the number of participants in the analyses that are directly relevant to the results presented in the table.

** Differential conditioning only found for participants who reported being aware of the CS-UCS contingency.

*** Although skin conductance was only measured in the latter 12 CS+ and CS- trials, there were 4 CS+ and CS- trials that were not reinforced that preceded these trials.

**** The stimuli were changed in the extinction phase and, as a result, was not a clear test of extinction. Therefore the extinction results were coded as N/A.

***** Although the interaction was significant, this was due to a more rapid decrease in FIRs to the CS-.

Table 2
EIR Results from Differential Conditioning Studies Using a CS Interval of At Least 7 Seconds

Study	N*	Acq trials CS+/CS-	CS-UCS interval	UCS	Acq CS+ >CS- ?	Ext trials CS+/CS-	Ext Main effect?	Ext Interaction?
Milad et al. (2005)	20	5/5	12s	shock	0-12s (yes)	10/10	yes	no
Orr & Lanzetta (1980)	26	5/5	8s	shock	2-8 (yes)	7/7	not tested	not tested
Orr et al. (2000)	33	5/5	8s	shock	0-8s (yes)	10/10	yes	no
Pitman & Orr (1986)	40	5/5	8s	shock	.5-8s (yes)	10/10	yes	no

Note: N = number of participants; Acq trials CS+/CS- = number of acquisition trials, with number of CS+ trials presented on left of the slash mark and number of CS- trials presented to the right of the slash mark; CS-UCS interval = duration of CS-UCS interval; Ext trials CS+/CS- = number of extinction trials, with number of CS+ trials presented on left of the slash mark and number of CS- trials presented to the right of the slash mark.

* N reflects the number of participants in the analyses that are directly relevant to the results presented in the table.

Table 3
Results from the Series of ANOVAS Examining the FIR, SIR and EIR of the Habituation, Acquisition, and Extinction Phases

	EIR	FIR	SIR
Habituation			
Stimulus Type	$F(1,286) = 2.93, \eta^2 = .01$	$F(1,286) < 1, \eta^2 < .01$	$F(1,286) < 1, \eta^2 < .01$
Trials	$F(4,1144) = 44.61, \eta^2 = .14^{***}$	$F(4,1144) = 72.92, \eta^2 = .20^{***}$	$F(4,1144) = 3.80, \eta^2 = .01^{**}$
Stimulus Type $\times$ Trials	$F(4,1144) = 2.67, \eta^2 = .01^*$	$F(4,1144) < 1, \eta^2 < .01$	$F(4,1144) < 1, \eta^2 < .01$
Acquisition			
Stimulus Type	$F(1,286) = 67.49, \eta^2 = .19^{***}$	$F(1,286) = 63.41, \eta^2 = .18^{***}$	$F(1,286) = 40.83, \eta^2 = .13^{***}$
Trials	$F(4,1144) = 70.79, \eta^2 = .20^{***}$	$F(4,1144) = 62.36, \eta^2 = .18^{***}$	$F(4,1144) = 4.38, \eta^2 = .02^{***}$
Stimulus Type $\times$ Trials	$F(4,1144) = 12.98, \eta^2 = .04^{***}$	$F(4,1144) = 7.35, \eta^2 = .03^{***}$	$F(4,1144) = 14.42, \eta^2 = .05^{***}$
Extinction			
Stimulus Type	$F(1,286) < 1, \eta^2 < .01$	$F(1,286) < 1, \eta^2 < .01$	$F(1,286) < 1, \eta^2 < .01$
Trials	$F(4,1144) = 2.83, \eta^2 = .01^*$	$F(4,1144) = 3.47, \eta^2 = .01^*$	$F(4,1144) < 1, \eta^2 < .01$
Stimulus Type $\times$ Trials	$F(4,1144) < 1, \eta^2 < .01$	$F(4,1144) < 1, \eta^2 < .01$	$F(4,1144) = 3.17, \eta^2 = .01^*$

Note: $N = 287$. For extinction trials, only the first five CS+ and CS- trials are included in the analyses. All significance levels reported for analyses that included the Trials variable reflect the Greenhouse-Geisser correction; however, the original degrees of freedom are presented when reporting the statistical tests.

*
 $p < .05$,
**
 $p < .01$,

 $p < .001$.

Table 4
Psychometric Group Means, SDs, and Results of t-Tests Comparing Participants Who Exhibited Either Larger Mean FIRs or Larger Mean SIRS

	Larger mean FIRs <i>n</i> = 210		Larger mean SIRS <i>n</i> = 76	
	<i>M</i>	(<i>SD</i>)	<i>M</i>	(<i>SD</i>)
SCL-90-R	0.28	(0.26)	0.33	(0.40) <i>t</i> (177) < 1, <i>n.s.</i>
BDI	3.23	(4.80)	2.46	(2.70) <i>t</i> (175) = 1.06, <i>n.s.</i>
WAIS-R EST-IQ	101.04	(11.46)	100.89	(10.04) <i>t</i> (156) < 1, <i>n.s.</i>
STAI-S	30.84	(9.91)	32.84	(12.52) <i>t</i> (181) = 1.14, <i>n.s.</i>
STAI-T	31.77	(8.50)	31.50	(7.82) <i>t</i> (176) < 1, <i>n.s.</i>
NEO-PI-R Neuroticism	46.85	(9.69)	49.22	(9.63) <i>t</i> (159) = 1.40, <i>n.s.</i>
NEO-PI-R Extraversion	54.76	(8.01)	53.91	(9.05) <i>t</i> (159) < 1, <i>n.s.</i>
NEO-PI-R Openness to Experience	48.05	(10.11)	45.11	(7.85) <i>t</i> (159) = 1.76, <i>n.s.</i>
NEO-PI-R Agreeableness	47.47	(9.45)	48.36	(6.70) <i>t</i> (159) < 1, <i>n.s.</i>
NEO-PI-R Conscientiousness	48.63	(8.96)	48.58	(8.00) <i>t</i> (159) < 1, <i>n.s.</i>

Note. SCL-90-R = Symptom Checklist 90-Revised, Global Severity Score; BDI = Beck Depression Inventory; WAIS-R EST-IQ = Estimated WAIS-R Full Scale IQ from Shipley Institute of Living Scale; STAI-S = State/Trait Anxiety Inventory-State score; STAI-T = State/Trait Anxiety Inventory-Trait score; NEO-PI-R = Revised NEO Personality Inventory.