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The effects of time, event, and quality certainty on electrodermal response magnitudes

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The effects of three types of certainty information about aversive white noise stimuli on anticipatory and unconditioned electrodermal responses (EDRs) were studied in a group of 48 subjects within a paired stimulation paradigm. Event certainty was manipulated by making UCS occurrence predictable for some groups and not for others. Time certainty was manipulated by presenting constant interstimulus intervals (ISIs) to some groups and variable ISIs to others. Quality certainty was varied within groups by having UCS intensity predictable for one CS and not for others. All three types of certainty affected anticipatory and unconditioned response magnitudes. Event certainty alone resulted in significantly larger magnitudes of anticipatory EDRs, while all three types of certainty tended to result in smaller magnitudes of response to the aversive UCS. The three types of certainty tended to summate, producing larger anticipatory responses and smaller unconditioned responses in conditions with more different classes of certainty information.

There is evidence from a wide variety of sources that the CS in classical conditioning paradigms acts as a warning signal which conveys information and may allow the subject to anticipate and prepare for the UCS. One type of information that the CS conveys is the fact that the UCS will follow. Such information could be conceptualized as an "awareness" of the CS-UCS contingency. In addition to providing information about the simple association of stimuli, the signal may inform the subject of other features of the CS-UCS relationship. such as how likely the occurrence of the UCS is, when it will occur and what its qualities will be. The last three prediction situations have been termed event, time, and quality certainties. To the extent a subject has these categories of information, his expectancy or prediction of what will follow the CS may be said to be "certain." It is the purpose of this study to elaborate the roles of these variables which determine the ability to predict a forthcoming noxious event on the basis of the signal stimulus.

Certainty about the CS-UCS relationships has been shown to be an effective determiner of electrodermal response (EDR) magnitudes. For example, in some instances, as the likelihood of UCS occurrence increased (event certainty), orienting responses (ORs), anticipatory responses (ARs), and UCS-omission response magnitudes increased. Conversely, as the probability of the UCS increased, response magnitudes to the aversive stimulus (UCS) decreased (e.g., Grings & Sukoneck, 1971; Ohman, Bjorkstrand, & Ellstrom, 1973). The response to the UCS has also been shown to be smaller when the time of occurrence of the stimulus was regular as compared to when the time of occurrence was unpredictable (e.g., Lykken, Macindoe, & Tellegren, 1972; Peeke & Grings, 1968).

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Although quality certainty has not been systematically varied, instructions about UCS intensity have been shown to be important determinants of response magnitude. Both Epstein and Clark (1970) and Ohman (1971) reported data suggesting that inaccurate expectancies about the intensity of stimuli resulted in CR and UCR magnitudes elevated over conditions where expectancies were accurate. Generally, these suggest that accurate expectancies about noxious stimuli result in diminished responding to those stimuli. However, some discussions of the relations between accuracy of expectancy and reactions to a noxious UCS suggest that situational differences may occur (e.g., Epstein, 1973).

Although the three types of information have been previously studied, they have not been simultaneously varied to permit direct comparisons of their influence. The present research was designed to manipulate the three types of certainty and to observe their effects upon both anticipatory and unconditioned response magnitudes. A second goal of the study was to evaluate the degree to which the different types of certainty would summate in affecting response measures.

METHOD

Subjects

Forty-eight students from introductory psychology classes participated in the study as partial fulfillment of a class requirement. They were separated into four groups of 12 subjects each, matched on sex, initial conductance level, and mean response magnitude on the first three preacquisition CS-alone trials.

Apparatus

The conditioned stimuli (CSs) consisted of a ground glass screen, 2.5 cm in diam, with one of five shapes projected upon it. The shapes were patterns of vertical, diagonal, or horizontal dots, a triangle, or horizontal lines presented by a Grason-Stadler (Model E 4580) multiple stimulus projector placed 1 m in front of the subject at eye level. The unconditioned stimuli (UCSs), 1 sec of white noise of either 104 dB for loud or 74 dB for soft, were delivered by a Grason-Stadler white noise generator through earphones. CS and UCS durations and interstimulus intervals (ISIs) were controlled by Hunter 111 C timers. Intertrial intervals, which varied randomly among 25, 30, 35, and 40 sec, were controlled by a tape feeding through a Gerbrands programmer.

Skin conductance was recorded through Beckman silver chloride disk electrodes filled with NASA formula electrode jell and attached to the first and third fingertips of the subject's left hand. Resistance was measured by a Darrow-type Wheatstone bridge and recorded on one channel of an Offner Type-R dynograph. Bridge current was 10 microamperes.

Design

The basic design was a 2 by 2 by 2 factorial design, with time and event certainty varied between groups and quality certainty varied within subjects. Event certainty was produced by having a discriminative stimulus (horizontal lines) indicate the trials on which no UCS would be presented. Event-uncertain groups did not know which CS+ trials would be unreinforced. Time certainty was varied by having a constant 8-sec ISI for the high-certainty groups and varying the ISI among 4, 8, and 12 sec for the low-certainty groups. Of the variable ISIs, 25% of the trials were 4 sec and 25% were 12 sec, with the remaining 50% being 8 sec.

Quality certainty was varied within subjects by having one CS (vertical dots) designate the loud UCS and a second CS (horizontal dots) designate the soft UCS. A third CS (diagonal dots) was followed by a loud UCS on 50% and by a soft UCS on 50% of the reinforced trials. In addition to the four CSs previously mentioned, a fifth CS (a triangle) was presented to all subjects. This stimulus was accompanied by UCSs but at an interval which varied among 15, 20, and 30 sec. The responses to that cue were used as reference (or control) responses in assessing the extent to which the other anticipatory responses reflected conditioning rather than sensitization.

Procedure

The experiment began with 10 adaptation trials consisting of two trials of each CS with the order counterbalanced. Following the adaptation trials, the first 24 subjects were completely instructed about the nature of the CSs and UCSs and the relations among them. The second 24 subjects were informed that they would have a few minutes free while the experimenter determined which condition they would receive. These subjects were then assigned to groups on the basis of the previously mentioned matching criteria. They were also completely informed about the stimuli.

Fifty-four trials divided into three blocks of 18 trials each were then presented. The appropriate proportions of loud and soft UCSs, CS stimuli, unreinforced trials, and ISIs of 4, 8, and 12 sec (for the time-uncertain groups) were maintained within each block. Stimulus order was random within each block, with the restrictions that no more than two presentations of the same CS, no more than three reinforced or unreinforced trials, and no more than three loud or soft trials occur consecutively. The 7th and 13th trials of each block were designated as loud UCS test trials and the 9th and 15th as soft UCS test trials. The CS-UCS interval of these trials was 8 sec for all groups.

RESULTS

Electrodermal Measures

Three measures of skin conductance response (SCR) were recorded: the largest conductance change beginning 1 to 4 sec after CS onset (termed an OR), the change beginning 4 to 9 sec after CS onset (termed an AR), and the response starting between 1 and 4 sec after UCS onset (termed the UCR).

Test of Conditioning

In order to evaluate whether differences in response to signal stimuli are attributable to learning rather than attention or sensitization, a form of discrimination criterion was used with subjects in the event certain groups. Those subjects had received an unpaired stimulus (triangle) randomly presented three times during the acquisition series. Separate computations were made for t tests of the difference in response to that CS and to the CS+s for the quality certain and uncertain CS+s. There were no significant differences for the ORs but the differences for the ARs were significant for both stimuli ($t = 2.48$ for the quality certain stimulus and $t = 2.38$ for the quality uncertain stimulus, both with $df = 23$). These results are consistent with an interpretation which emphasizes learning for the AR measure and orientation for the OR, the interpretation which will be followed here.

Acquisition

The accompanying table summarizes the results for the acquisition period with the UCRs and responses during the interstimulus interval averaged over the three test trials.[1] Briefly, event certainty was the major determiner of the magnitude of responses occurring in the interstimulus interval. Overall effects of event certainty were significant for the AR, whereas event certainty influenced the OR only when the stimulus quality was predictable. Time certainty was the major

Table 1
Average Anticipatory Responses and Unconditioned Responses for the Various Classes of Certainty

Event Groups	OR Time Groups C	OR Time Groups U	AR Time Groups C	AR Time Groups U	UCR Time Groups C	UCR Time Groups U
Quality Certain Stimulus						
Certain	.35	.58	.31	.36	.77	1.05
Uncertain	.29	.24	.18	.23	.91	1.25
Quality Uncertain Stimulus						
Certain	.35	.39	.24	.32	.87	1.26
Uncertain	.31	.31	.15	.15	1.03	1.24

Note–Trials with loud UCS only. Values in square root of conductance change in micromhos. Subgroup Ns = 12 each. C = certain, U = uncertain.

determiner of UCR magnitude, although quality certainty was also effective.

Turning first to the responses occurring during the ISI, event certainty resulted in an elevation of AR magnitude for certain as compared to uncertain groups; $F(1,44) = 4.18$, $p < .05$, whereas time certainty and quality certainty did not produce differences.

For the OR, on the other hand, the overall effect of event certainty was not significant, but there was an interaction of Event Certainty by Quality Certainty, $F(1,44) = 4.24$, $p < .05$. The event certain groups responded more than the event uncertain groups to the quality certain stimulus but not to the quality uncertain CS. In other words, quality certainty apparently enhanced the effects of event certainty. Time certainty and its interactions did not affect orienting responding.

Again referring to Table 1, the average UCR magnitudes are related inversely to the degree of certainty which a subject has about the presentation of the UCS. For example, the smallest response is given by the group with time, event, and quality certainty. In terms of single effects, the time certainty variable produced the largest UCR differences, $F(1,44) = 6.62$, $p < .01$, although the quality certainty effect was also significant, $F(1,44) = 7.48$, $p < .01$. Event certainty differences were not significant. Unlike the anticipatory responses where interactions of certainty effects occurred, the variables did not interact in influencing the UCR; rather, main effects predominated.

There was also a tendency for the different types of certainty to summate in affecting response magnitudes. In general, groups with more types of certainty showed larger responses during the ISI and smaller UCRs than groups with fewer types of certainty (see Table 1).

DISCUSSION

Under the conditions of the present experiment, the three types of information had dissimilar effects on anticipatory and unconditioned EDR measures. Event certainty increased anticipatory responses just prior to UCS onset and also increased orienting response magnitudes when the intensity characteristics of the UCS were predictable (i.e., with quality certainty). Time or quality information alone did not alter these responses during the ISI, although both of these variables tended to enhance the effects of event certainty. Certainty influences on the magnitude of the unconditioned response were clear and more pronounced. Both time and quality information resulted in significantly smaller responses to the UCS, while the effect of event certainty just failed to reach criteria for significance. Thus, in general, the effects upon UCR magnitude were the reverse of those for behavior during the anticipatory interval. A tendency for the different types of certainty to summate in affecting response magnitudes was also noted. Generally, conditions with more types of certainty responded more during the ISI and less to the UCS than conditions with fewer types of certainty.

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NOTE

1. Only the data from the loud UCS trials will be presented in order to simplify the discussion. The data from the soft UCS trials were generally quite similar to data from loud UCS trials. Note should also be made that data are presented only from designated test trials with 8-sec ISIs, to permit equivalent measurement to be made in time-certain and time-uncertain conditions.