Electrodermal and Plethysmographic CR Components: Repetition of and Change from UCS-CS Trials with Surrogate UCS

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Electrodermal and Plethysmographic OR Components: Repetition of and Change from UCS-CS Trials with Surrogate UCS*

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Abstract

For 40 Ss a tone and a light were repeatedly paired (P) in the same order (e.g., tone-light) for 15 trials, after which the 2nd member of the pair (e.g., light) was presented alone as the change trial. For another 40 Ss the repetition consisted of 15 single (S) tone (or light) presentations followed by the light (or tone) as the change trial. The duration of both stimuli and the interstimulus interval (on P trials) was .3 sec. and .75 sec., respectively, while the mean intertrial interval approximated 45 sec. GSR and digital-blood-volume-pulse-change (VPC) were recorded. The GSR habituated reliably and at the same rate to both repeated patterns over trials 1-15, but the VPC did not habituate to either pattern. Change from both S and P repetition produced response increases, but the increase under the P condition was not so pronounced as to inspire confidence in explanations of UCS-CS conditioning in terms of OR reinstatement to change.

A recent report (Furedy, 1968) has outlined the troubles caused by orienting reaction (OR) theory (e.g., Sokolov 1960, 1963) to Es who attempt to demonstrate classical conditioning in autonomic responses with interstimulus intervals (ISIs) which do not exceed the latency of those responses. The problem, briefly, is that the associative pairings of the conditioned stimulus (CS) with the unconditioned stimulus (UCS) may, in Sokolov's terms, build up a "neuronal model" for a paired pattern of stimulation. The interpolated CS-alone test trials constitute a change from that pattern. Hence, through the resulting disconfirmation of the neuronal model, the test trials elicit enhanced ORs. Consequently, the autonomic response changes customarily attributed to classical conditioning may reflect only the influence of these "disinhibited" ORs. However, contrary to

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expectations from OR theory, neither the electrodermal nor the plethysmographic components of the human OR increased to a change from a repeatedly alternating pattern of stimulation consisting of tones and lights (Furedy, 1968). The main purpose of the present experiment was to answer the obvious question arising from this apparent failure of simple alternation to establish a neuronal model: would a paired pattern of stimulation similar to that used in short-ISI classical conditioning be simple enough for the formation of a neuronal model and for the ensuing OR reinstatement following a change from the pattern?

The ISI pattern which the experiment sought to duplicate was a "backward" one in which CS onset follows UCS onset at a .75 sec. interval. Such short-interval UCS-CS autonomic conditioning is of theoretical interest inasmuch as its acceptance suggests an S-R rather than an S-S view of classical conditioning (Champion & Jones, 1961; Jones, 1962). The phenomenon is also one whose factual basis is not generally accepted (e.g., Kimble, 1961; Cautela, 1965), although positive findings are available in the literature (e.g., Champion & Jones, 1961; Trapold, Homzie, & Rutledge, 1964). The main reason for examining this type of ISI pattern was that the studies interpreted as supportive of backward conditioning are particularly vulnerable to OR explanations, inasmuch as the response increases reported to CS-alone test trials have not typically been maintained over a long series of trials. The present experiment therefore used repeated pairings of two stimuli (e.g., tone followed by light), where the first member of the pair served as the "surrogate" UCS (Allen, Hill, & Wickens, 1963), and the change from repeated paired stimulation was provided by presenting the second member alone.

For comparison purposes, a separate group was presented with a repeated single pattern of stimulation (e.g., tone, tone, tone, ...) which was followed by a change (e.g., light). This condition, on the basis of the previous study

(Furedy, 1968), was expected to provide a reliable increase to change in both OR components. The experiment also allowed a check on the other unexpected finding of that study: the failure of the plethysmograph to decrease as a function of initial repeated stimulation. Finally, the presence vs. absence of a continuous time-estimation task was varied between Ss, as in the previous study, where this type of distraction did not affect the amount of OR increase to change.

Method

Subjects.--Eighty students from an introductory psychology course at Indiana University served as Ss. They signed up either to fulfill a class requirement or to earn "at least" $1.50, but on arrival at the experiment they were told that they could earn up to another $1.50 "depending on performance".

Apparatus.--This was identical to that described previously (Furedy, 1968) but for the following exceptions. Two electronic timers were added to allow control of stimulus durations and the ISI on paired-stimulus trials; the electrodermal or galvanic-skin response (GSR) was measured by a Fels Dermohmmeter and recorded on an Esterline-Angus milliameter run continuously at 6 in. per minute; the plethysmographic digital blood volume pulse change (VPC) measures for all Ss were taken through the photoelectric transducer.

Procedure.--The time-estimation task of the previous study was given to half the Ss (T group), and the instructions to both the T and the no-task (NT) group were the same as those described previously (Furedy, 1968) except that: (a) the stake was only $1.50; (b) the colored lights were not mentioned to either group, since E did not present these lights at any stage during the experiment. Within each of the T and NT groups, half the Ss received the repeated single (S) pattern of stimuli consisting of 15 tone or light trials, followed by a light or tone on the 16th trial; the other half of the Ss received a repeated paired (P)

pattern consisting of 15 tone-light or light-tone trials, followed by a light or a tone on the 16th trial. The duration of the tone and the light was .3 sec., the ISI on paired presentations was .75 sec., and the intertrial interval (ITI) varied randomly between 37½, 45, and 52½ sec. The nature of the stimulus (tone vs. light) was counterbalanced over the 80 Ss. For the T and NT groups, Ss were run successively in pairs, with the performance of the S in the T group determining the earnings for both members of the pair. The allocation of each pair to other conditions was random.

Results

Response measures.--The definitions and transformations of the GSR and VPC were the same as in the previous study (Furedy, 1968) except that on P trials stimulus onset was defined as the onset of the first stimulus (surrogate UCS). Presumably because of the short ISI, the form of the response either for the GSR or for the VPC did not differ between S and P trials. In particular, no signs of response repetition were observed on P trials.

Pattern repetition.--Mean electrodermal and plethysmographic performance during the 15 repetition (R) trials is shown in Fig. 1 in blocks of 3 trials as a function of the pattern-type (S-P) and task (T-NT) factors. A trials x task x pattern-type analysis of variance for the GSR (left panel of Fig. 1 excluding 16th trial) showed a significant trials effect, F (4, 304) = 17.777, $p < .001$, with a monotonic decrease of responding over trials, and a significant task x pattern-type interaction, F (1, 76) = 6.151, $p < .05$, with the relationship between T and NT reversed as a function of pattern type; for all other effects, $F < 1$. The same analysis for the VPC (right panel of Fig. 1 excluding 16th trial) showed no significant trials effect, F (4, 304) = 1.536, $p > .2$, there being no monotonic decrease over trials. The task x pattern-type interaction of

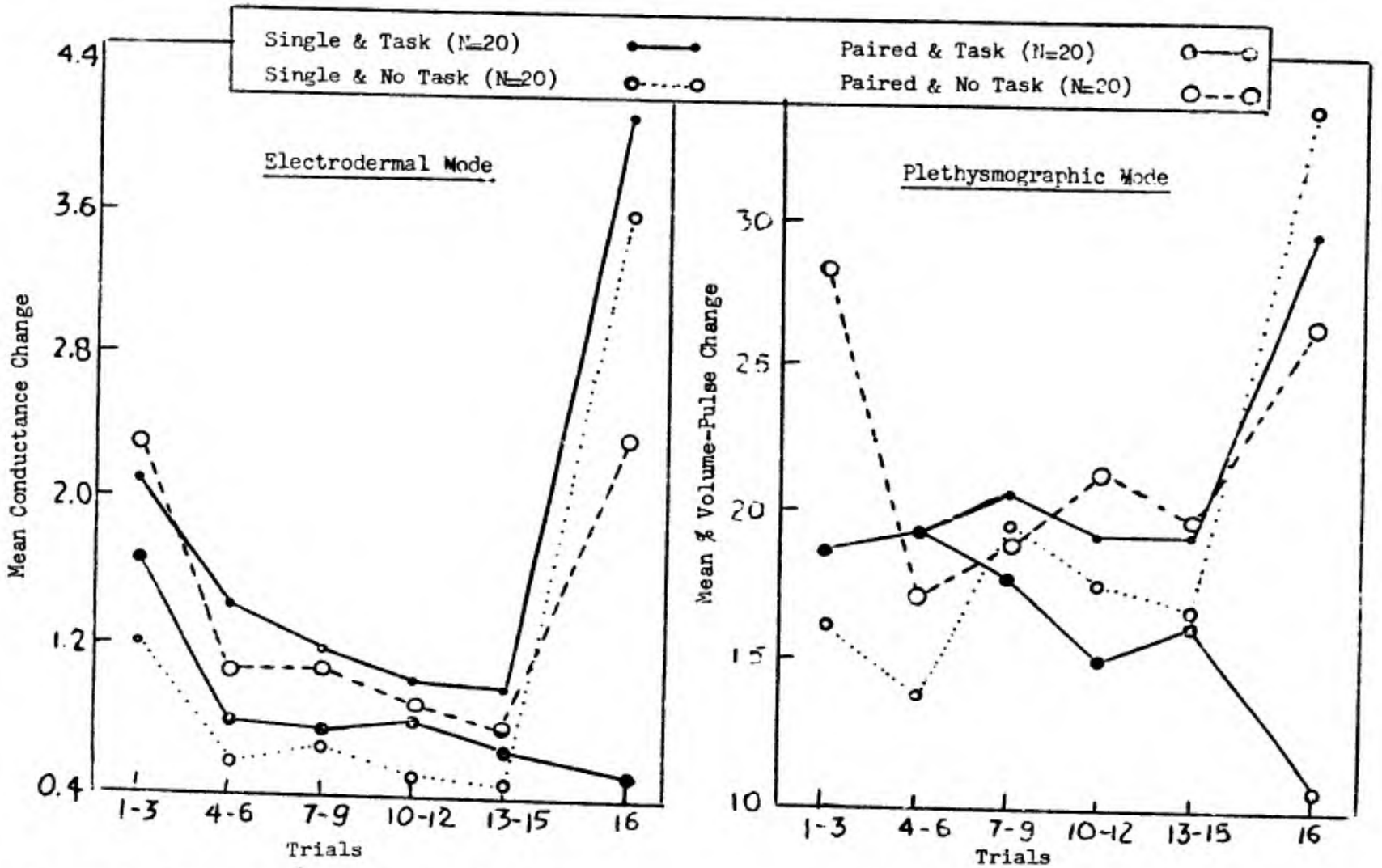

Figure 1. Mean electrodermal and plethysmograghic responses to pattern repetition (trials 1 - 15) and change (trial 16) as a function of the pattern-type and task factors.

the sort obtained with the GSR approached significance, F (1, 76) = 3.710, $p < .1$; all remaining effects failed to approach significance, $p > .1$.

To compare the amount of response decrease to repetition between the two response modes, a common ordinate for them was established by expressing each score as a percentage of the mean score for that response mode over the first three R trials. Fig. 2 shows the data plotted as a function of response mode, task, and pattern type. The difference in slopes between the electrodermal and plethysmographic modes, as represented by the response-mode x trials interaction, was significant, F (4, 304) = 15.131, $p < .001$. Neither task, nor pattern type, nor any interactions involving trials and the other two effects as terms approached significance, $p > .1$, but there was a significant task x pattern-type interaction, F (1, 76) = 10.020, $p < .01$. Inspection of Fig. 2 shows that this interaction exhibits the same interrelationship between the task and pattern-type effects as that noted in the separate GSR and VPC functions in Fig. 1.

Change from repeated pattern.--In Fig. 1 the change (C) and repetition (R) levels of the change factor consist, respectively, of trials 16 and 13-15. For the GSR, the change x pattern-type x task analysis of variance yielded significant, $p < .001$, effects due to change, F (1, 76) = 57.273, pattern type, F(1, 76) = 13.553, and an interaction between change and pattern type, F (1, 76) = 22.376, with the change effect being larger under the S than under the P condition. However, separate analyses of this interaction showed that the change effect was significant not only with the single pattern, F (1, 38) = 33.602, $p < .001$, but also with the paired pattern, F (1, 38) = 4.352, $p < .05$. Another significant interaction yielded by the main GSR analysis of variance was that between pattern type and task, F (1, 76) = 5.134, $p < .05$. Separate analyses of this interaction showed that while performance on all S trials was significantly superior to that on all P trials for the NT group, F (1, 38) = 21.803, $p < .001$,

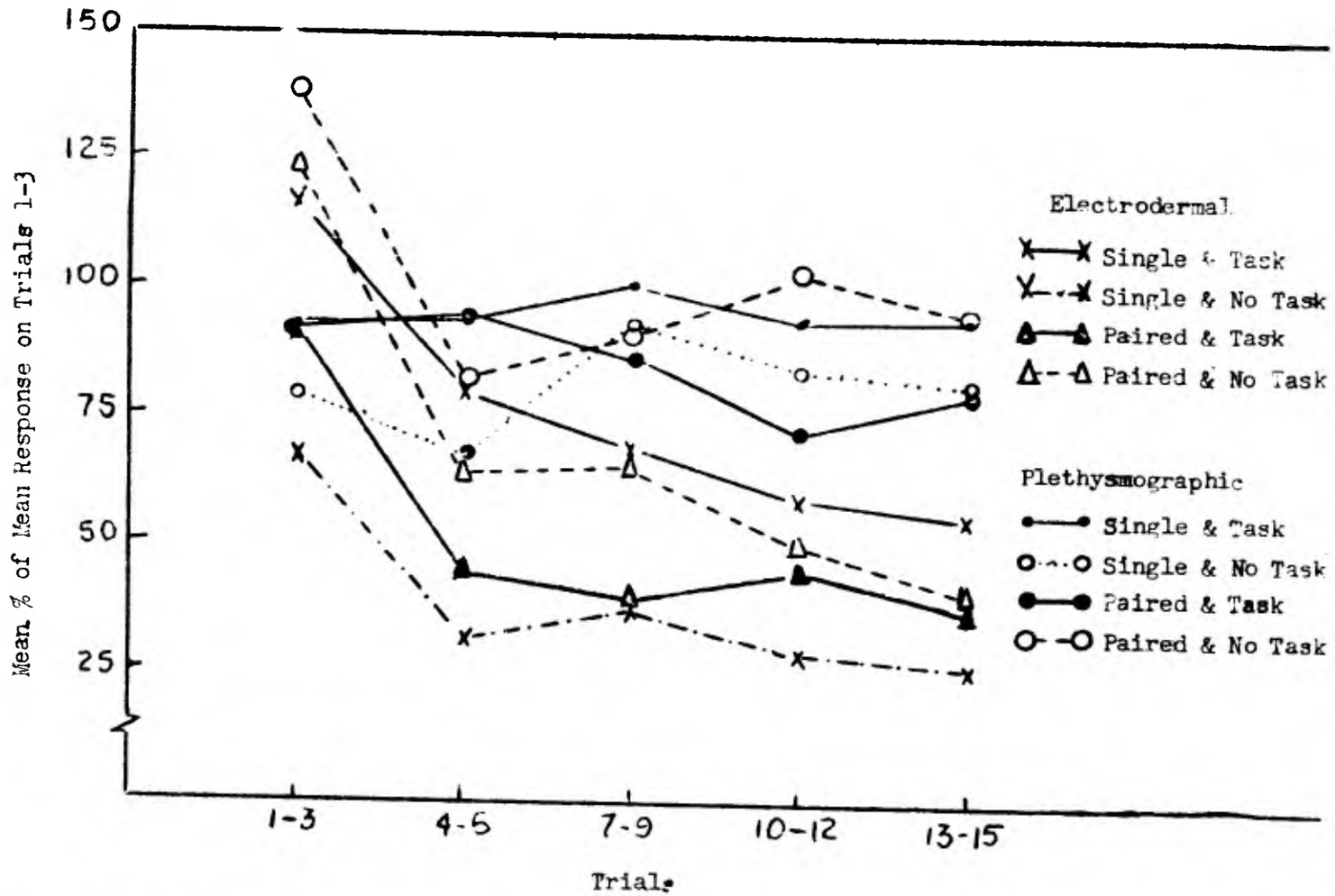

Figure 2. The effect of pattern repetition as a function of the pattern-type, task, and response-mode factors. (Scores for each response mode are expressed as a percentage of the mean score on trials 1-3 for that mode.)

this superiority of S relative to P did not approach significance for the T group, $F < 1$. The main GSR analysis also yielded near-significant, $p < .1$, effects due to a change x task interaction, F (1, 76) = 3.156, with an apparently larger change effect in the NT group, and a change x pattern-type x task interaction, F (1, 76) = 3.244. Inspection of Fig. 1 indicates that the source of this second-order interaction is that the increase due to change is eliminated only by the combination of the P and T levels of the pattern-type and task factors, respectively.

For the plethysmograph, the three significant effects were those due to change, F (1, 76) = 7.926, $p < .01$, pattern type, F (1, 76) = 5.308, $p < .05$, and the change x pattern-type interaction, F (1, 76) = 6.597, $p < .05$. Separate analyses of this interaction indicated that while change from single repetition produced a significant performance increase, F (1, 38) = 9.476, $p < .01$, change from paired repetition did not, $F < 1$. The main plethysmographic analysis also yielded near-significant, $p < .1$, effects due to task, F (1, 76) = 3.249), with superior performance in the NT group, and to a change x task interaction, F (1, 76) = 3.369, with an apparently greater change effect for the NT group than for the T group.

Discussion

The pattern repetition results essentially replicate those obtained in the previous study (Furedy, 1968), in that they show that (a) while the GSR decreased monotonically and reliably over the R trials, the VPC did not, and (b) the rate of decrease over trials was independent of pattern type. The interaction between task and pattern type over all trials, on the other hand, is specific to this experiment. Although statistically reliable in the case of the GSR, the interaction is difficult to interpret psychologically. The fact that

it is a between-Ss effect suggests that it may be due to sampling differences between the groups receiving the four combinations of the task x pattern-type treatments. In any case, since there were no interactions between task or pattern type with the trials effect in either response mode, the presence of the task x pattern-type interaction does not complicate the evidence regarding the differential effects of pattern repetition on the electrodermal and plethysmographic components of the OR. The significance and reliability of the failure of the latter OR component to habituate to repetition has been discussed previously (Furedy, 1968). Briefly, the phenomenon is inconsistent with OR theory, and the available experimental evidence, when critically examined, suggests that plethysmographic habituation to initial repetition only occurs, if it does at all, under restricted conditions.

As in the previous study (Furedy, 1968), change from single repetition produced a highly reliable increase in both OR components. Change from paired repetition also produced some response increase, in contrast to the previously examined change from alternation which produced none. However, the increase resulting from change from paired repetition was more tenuous than the effect observed under the S condition. Thus, the reliable change x pattern-type interactions in both response modes indicated a smaller change effect under the P than the S condition, and, in the case of the plethysmograph, the separate analyses of this interaction showed the change effect to be absent under the P condition. In addition, in both response modes there appeared to be a second-order change x pattern-type x task interaction, whose interpretation suggested that the change effect was eliminated under the P condition provided that the time-estimation task was used.

The present results concerning the effect of change from paired repetition therefore raise doubts as to whether this effect is sufficiently pronounced

for it to be used to support explanations of short backward conditioning in terms of OR reinstatement to change. Moreover, these doubts are increased by considering that both the number and the regularity of repetitions employed here (15 unchanging pairings) were far greater than in the case of most conditioning experiments, where UCS-CS trials are seldom repeated more than 6 times without an interpolated CS-alone test trial. However, these cautions against confident applications of OR explanations to apparent backward UCS-CS conditioning phenomena should not be taken to suggest that there are any reasons for complacency either about the adequacy of our understanding of the behavior of the OR, or about the status of short backward autonomic conditioning as a reliably reproducible laboratory phenomenon.

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