Philippine Journal of Psychology
1971, Vol. 4, No. 2, 79–87

OPERANT CONDITIONING OF GSR AMPLITUDE UNDER FEEDBACK AND NON-FEEDBACK SITUATIONS

RENATO B. REYES
Ateneo de Manila University

An experiment was conducted to test two hypotheses: (1) that operant conditioning of GSR would be successful and comparable under both feedback and non-feedback conditions, feedback being defined as giving the subject an indication of his GSR activity; and (2) that conditioning would be greater under a condition wherein positive reinforcement was clearly appetitive rather than under conditions where positive reinforcement was not clearly appetitive. The appetitive reinforcer used was money. A 2 x 2 factorial design used four groups (A, B, C, and D) of 21 *S*s each to make a total of 84 *S*s.

The results of the experiment indicated that feedback may not be a critical factor in operant conditioning of GSR; however, it is pointed out that this finding does not form conclusive proof that the feedback hypothesis does not hold since it is difficult to generalize the results of any single experiment to apply to the whole class of autonomic behaviors.

Instrumental learning or operant conditioning has been described by various authors as a form of learning in which the reward or reinforcement delivered is contingent on a subject's emission of some desired response. The response emitted may be simple or complex and in most operant conditioning situations the subject has to discover which behavior or set of behaviors will result in the delivery of reinforcement. The paradigm allows for wide variations in experimental plans; for example, reinforcement may be made contingent on the withholding of some response rather than on its emission, or else the subject may be taught to discriminate between stimuli presented by the experimenter (Woodworth and Schlosberg, 1954; Underwood, 1965). Eight types of instrumental conditioning have been derived from the original paradigm: reward training, discrimination training, escape training, avoidance training, omission training, punishment training, discriminated omission training, and discriminated punishment training (Deese and Hulse, 1967). In all of those types, the behavior which makes up the response have been defined as falling into a class known as "instrumental behaviors", that is, behaviors which the subject has control over (Kimble, 1961).

In the past few years, there have been a number of attempts to condition autonomic responses using operant techniques. Such behaviors, under the control of the autonomic nervous system, have been classed as reflexes, or reflex behaviors, and researchers such as Konorski and Miller (1937) and authors such as Kimble (1961) have stated flatly that since these were not instrumental behaviors, it was not possible to condition them using operant methods.

In fact, many of the studies done on conditioning of autonomic responses such as GSR have made use of classical conditioning methods. These studies have reported varying degrees of success (Kimmel and Hill, 1960; Shearn, 1962; Kimmel and Baxter, 1967). However, a series of experiments conducted by Kimmel and his associates (Fowler and Kimmel, 1962; Kimmel and Kimmel, 1963; Van Twyver and Kimmel, 1966), have attempted to condition GSR with operant techniques. These studies were reported to have effected successful conditioning and provide empirical evidence to support the hypothesis that autonomic behaviors are amenable to instrumental or operant conditioning. Other studies have followed similar lines, working with the familiar GSR, or galvanic skin response. Johnson and Schwartz (1967), for example, used an avoidance technique to suppress GSR activity. Aversive

stimuli were applied to spontaneous emissions of GSR by the subjects who were told that their behavior had something to do with the reinforcement they were receiving. The study reports a significant decline in GSR for the experimental groups over the control groups.

Many of the studies cited above have used as their measure of conditioning the rate of response by the subject. These studies have followed a common procedure, which is to reinforce spontaneously-occurring GSRs in their subjects and noting the rate of response per unit time (Kimmel and Hill, 1960; Stern, 1967; Kimmel and Goldstein, 1967). But there have also been studies reported which have used the magnitude of GSR as an index of conditioning, notably Kimmel and Baxter (1964). They used a classical avoidance technique wherein the occurrences of a response to the CS resulted in the non-occurrence of an electric shock UCS, and report a significant increase in GSR magnitude of the experimental groups over the control groups.

A study which used GSR magnitude as the index of conditioning in an operant situation is that of Helmer and Furedy (1968). They investigated the effect of positive reinforcement on GSR amplitude when the subjects did not know that GSR was the response being conditioned (the subjects were told that they were participating in time-interval judgment experiments) and where the reinforcer applied was clearly rewarding (money). They reported significant though minimal conditioning effects on GSR magnitude.

The critical factor in the Helmer and Furedy study would seem to be the fact that their subjects did not know that GSR was being conditioned, and were in fact led to believe that their task involved making time-interval judgments. This use of a "blind" took the procedure of Johnson and Schwarts one step further by specifying a behavior which had nothing to do with how reinforcement was applied. However, other researchers who have worked with autonomic response conditioning, such as Kamiya (1969) who studied alpha-wave conditioning, have stressed that the key to successful operant conditioning of autonomic behaviors is a feedback system. They have hypothesized that the fact a person is unaware of the functioning of his autonomic system is what prevents him from learning to acquire control over it. They have pointed out that breathing is an autonomic behavior; but since the behavior engages a large number of muscles, the individual becomes aware of it and hence, can control it, at least up to a point where other factors enter the picture. Kamiya has supported this view by providing systems which enable a subject to keep track of his alpha-wave emissions and learn to control them.

While there has been empirical evidence gathered to support the feedback hypothesis, it is not yet clear whether it really is the critical factor in autonomic-response conditioning. One can, therefore, ask the question whether operant conditioning of autonomic behaviors be done equally well – or at least comparably – with and without feedback to the subject. The present study addresses itself to this problem.

In considering the problem, however, it is also necessary to consider the nature of the reinforcement to be applied in an autonomic-response operant conditioning situation. From the experiences of Kamiya it would seem that feedback by itself constitutes an adequate enough reinforcement to induce learning; obviously, however, this cannot apply in a non-feedback situation.

Moreover, other studies which have been reported (Kimmel and Hill, 1960; Kimmel and Kimmel, 1963, 1968), have employed as positive and negative reinforcers, stimuli whose motivational properties are somewhat difficult to define. Examples of such stimuli are dim lights or colored lights, and in one case, "pleasant" and "unpleasant" odors. In fact, other studies using similar stimuli (Stern, 1967), have reported failure in conditioning autonomic activity.

The problem would then seem to be one of finding a sufficiently appetitive reinforcer which could be used in both feedback and non-feedback situations of autonomic-response conditioning.

The Helmer and Furedy study made use of one such reinforcer; they yoked greenlight positive reinforcement indicators to monetary rewards, explaining to their subjects that each green light would be worth five cents to them. However, they did not explore differences in response to monetary and non-monetary rewards. It may be worthwhile to explore these conditions and how they relate to the feedback hypothesis stated above.

Problem

The foregoing discussion provides the basis for the present investigation of autonomic-response operant conditioning.

The present study attempts to determine whether operant conditioning of GSR in a non-feedback situation can compare with operant conditioning of GSR in a feedback situation. It is hypothesized that conditioning will be comparable between the two conditions, that is, they will not differ significantly.

The study also attempts to determine whether any differences exist between the use of a monetary reinforcer and the use of a reinforcer which is not yoked to any monetary reward. It is also hypothesized that conditioning will be greater in the monetary-reinforcement conditioning.

Definition of Terms

The autonomic response being considered in this study is the galvanic skin response, or GSR, measured in terms of *changes in resistance level.*

Feedback is defined as any indicator which allows a subject to monitor his GSR activity.

Effectiveness of conditioning will be determined by a comparison of the relative increases in GSR *amplitude* on trials following negatively-reinforced trials. The differences will be measured by *t*-test and the critical level of significance will be set at $p < 0.05$.

The mean GSR amplitude on trials following positively-reinforced trials shall be known as the PR score; the mean GSR amplitude on trials following negatively-reinforced trials shall be called the NR score. In this study, the measure of conditioning is not taken as the rate of response, but rather as the intensity of response; hence, the use of GSR amplitude as a measure. The contention of reinforcement theory that the probability of higher response is greater on trials following positively-reinforced trials than on trials following negatively-reinforced trials is considered to be applicable in this case.

Relevant Variables

Two main conditions are under study in this experiment: the feedback condition, and the reinforcement condition. In the feedback condition, one-half of the subjects will receive feedback on their GSR activity, while one-half will not receive any feedback. In the reinforcement condition, one-half of the subjects will be given monetary reinforcement, that is, the reinforcement lights will be yoked to monetary rewards. The other half will receive non-monetary reinforcement, that is, simply colored lights indicating positive or negative reinforcement. For the monetary-reinforcement group, negative reinforcement lights will simply mean no payment for a particular trial. There will be no subtractions of rewards.

All subjects will perform an identical task, which will be the estimation of a thirty-second time interval without the use of mechanical aids such as watches. The time-interval estimation will begin with the onset of a yellow stimulus light and end when the subject makes an appropriate response, i.e., pressing a key.

The time-interval judgments that the subjects will do is task rather than an independent variable; reinforcement will not depend on the accuracy of time-interval judgments. The main independent variables are, as stated above, feedback and type of reinforcement. The dependent variable is GSR amplitude.

Subjects will be tested individually in an air-conditioned room and external stimuli which may give rise to spontaneous GSRs will be minimized as far as possible. The subject will not have any contact with the experimenter during the testing period.

METHOD

Subjects

Eighty-four male undergraduates from the Ateneo de Manila University college of Arts and Sciences were used as subjects in the study, assigned at random to four groups designated A, B, C and D respectively (Fig. 1), with 21 *S*s in each group. The mean age of the *S*s was 17.6 years.

Apparatus

GSR was recorded on a T.K.K. polygraph. Resistance values in the amplifier circuit were preset and averaged 250 K Ω across *S*s, and gain was adjusted to allow the recorder pen a maximum displacement of 73 millimeters. Millimeters of displacement of the recorder pen was used as the basic unit of measurement of GSR for convenience.

Electrodes were attached to the index and little fingers of the *S*'s left hand.

Visual stimuli were presented with the use of a Stoelting Reaction Timer. A stimulus box which could present either amber, green, or red lights as called for by *E* was placed approximately 60 inches in front of *S*'s chair, to which was attached a telegraph-type key which *S* could press to turn off a given stimulus light and indicate his response. An amber light was chosen for the stimulus light and a green light for indicating positive reinforcement; red light was used as a negative reinforcer.

External auditory stimuli were minimized by having all *S*s wear a pair of padded headphones during the testing session.

FEEDBACK CONDITIONS	REINFORCEMENT CONDITIONS: monetary	REINFORCEMENT CONDITIONS: non-monetary
feedback on GSR	A (N = 21)	C (N = 21)
no feedback GSR	B (N = 21)	D (N = 21)

FIG. 1 – SCHEMATIC PRESENTATION OF BASIC 2 X 2 DESIGN USED AS THE OVERALL EXPERIMENTAL FORMAT

The experimental session was conducted in an air-conditioned room with temperature at approximately 22°G. A partition separated *S* from *E*, and there was no contact between them during the testing session.

Procedure

*S*s were tested individually in a session that lasted approximately 20 minutes per *S* (with a range of 15 to 35 minutes). All *S*s were asked to remove their watches upon entering the experimental room and were told to judge as accurately as they could, without the use of any mechanical aids, the passage of a number of 30-second time intervals, starting from the onset of an amber light in the stimulus box before them and terminating when they pressed the key to turn off the light. This procedure was previously reported to have a high probability of giving rise to spontaneous GSRs immediately after the key-press response (Doehring, Helmer, and Fuller, 1964). *S*'s pressing the key would then be followed by the onset of either a green light, indicating that they were making the proper response, or a red light, indicating that their response was incorrect.

A and C Groups. *S*s in these groups were told that E would be studying their GSRs in relation to time-interval judgments. They were given then a demonstration of how the polygraph functioned and informed that whenever their GSRs exceeded a certain value they would be shown a green light signifying that they were making the proper response. Otherwise, they would be shown a red light. *E* did not specify to *S* the value which his GSR had to attain in order to get positive reinforcement.

*S*s in group A were then told that they would be paid ten centavos for every green light they were able to get; *S*s in group C were not so informed, but were merely paid a fixed amount after the experiment.

B and D Groups. *S*s in these groups were informed that the purpose of the experiment was to study the accuracy of time-interval judgments. They were told that they were to estimate closely as possible a number of 30-second time intervals. *E* then told *S* that he was also trying to get some incidental data on sweat gland activity for another study and asked *S* to wear a pair of electrodes on the fingers of his left hand for the duration of the session. *E* stressed that these electrodes had nothing whatsoever to do with the task at hand and that *S* was to ignore their presence and concentrate on making accurate time-interval judgments.

As with the other two groups, *S*s in the B group were told that they would receive ten centavos for every green light they were able to get, and *S*s in the D group were merely paid a fixed amount after the experiment. *S*s in the C and D groups had no idea whatsoever of the amount they were to receive until the testing session was over.

After *S* had placed his hand in the most comfortable position, done to minimize movements which would disturb the connected electrodes, he was given a chance to ask any questions regarding instructions given to him by *E*. Once *E* had answered all the questions of *S*, he then summarized the instructions once more and placed a pair of padded headphones over the ears of *S*. *E* then went behind the partition.

A four-minute interval then followed, during which *E* calibrated the polygraph and allowed *S*'s GSR to

stabilize. Each *S*'s basal GSR was corrected to a displacement of approximately 20 mm. on the recorder paper (ranging from 15 to 25 mm.) by a mechanical adjustment of the pen. Such an adjustment is possible without affecting the resistance and gain settings on the amplifier circuit and allows *E* to gain comparable readings of GSR.

Three trials then followed which were automatically given positive reinforcement by *E*. The mean of the GSRs following the key-press response was calculated and set as *S*'s criterion. GSRs in subsequent trials which reached or exceeded this criterion were given positive reinforcement; GSRs which failed to reach it were negatively reinforced. The criterion of each *S* was recorded as a steady line on the polygraph chart paper by a second recorder pen adjusted manually to the proper level. In this way *E* was able to tell quickly and accurately whether *S*'s GSR attained criterion or not.

Thirty test trials then followed the automatically-reinforced trials. The GSR which was to attain criterion in order to receive positive reinforcement was the one immediately after *S*'s key-press response to indicate the end of the perceived 30-second time interval. This response usually appeared within ten seconds of the key-press. If no GSR resulted within ten seconds, negative reinforcement was delivered.

The test trials were conducted in one sitting, that is, no break was given although some *S*s had specifically requested for one before the start of the session.

Two readings of GSR per trial were taken. The initial reading consisted of *S*'s GSR level immediately prior to the key-press response, and the second reading consisted of *S*'s GSR following the key-press response. These two readings were taken in order to allow *E* to correct for any sensitization effects which may have occurred while the amber stimulus light was on. The procedure for making this correction is discussed in the Measures and Analysis section.

Spontaneous GSRs arising after the key-press response were considered valid responses for the operant conditioning situation. A response which was not considered valid was a purely spurious one arising from a sudden movement of the fingers to which the electrodes were attached. Such a response is not indicative of GSR at all and hence, could not be considered as a valid response. Since the shape of the trace characteristic of such finger movements is easily identifiable, *E* was able to ignore them, while taking down GSR readings.

No reinforcement light was kept on for longer than five seconds, and the inter-trial intervals (the interval between the offset of the reinforcement light and the onset of the next stimulus light for the succeeding trial) were varied unsystematically and ranged from 5 to 20 seconds. If an *S*'s GSR remained peaked after the offset of the reinforcement light, *E* waited until the trace fell close to basal level before activating the amber stimulus light for the next trial.

In brief informal discussions after the testing session, *S*s in the A and B groups told *E* that they were trying to find some sort of overt response which would give rise to strong GSRs, but most confessed that they were unable to find a response which seemed to work consistently. *S*s in the C and D groups did not reveal any suspicion that the purpose of the experiment was different from what they were told by *E*.

Experimental Design

The basic design format used in the experiment was the 2 x 2 factorial. This allowed the testing of both hypotheses with the use of only two groups (see Fig. 1). Group A *S*s were given feedback with monetary reinforcement; Group B *S*s were also given monetary reinforcement, but no feedback on their GSR.

Group C *S*s were given feedback on GSR, but were not given monetary reinforcement; Group D *S*s were given neither feedback on GSR nor monetary reinforcement.

Measures and Analysis

As mentioned above, GSR levels were recorded in terms of millimeters of displacement of the polygraph recorder pen. The displacement represented a drop in skin resistance and could have been measured in *micro-ohms* (Woodworth and Schlosberg, 1954; Gringe, 1954), but limitations imposed by the available equipment prevented accurate and finely-discriminated readings by this method. Since there is a direct relationship between the drop in *S*'s skin resistance and the displacement of the recorder pen, it was decided that a measure of pen displacement would suffice for the purpose of the experiment.

The two readings of GSR taken per trial (GSR level immediately before key-press response and GSR level following key-press response) represent changes from basal level rather than absolute readings of skin resistance.

Since sensitization reactions to the amber stimulus light could easily occur, each *S*'s trial scores were corrected by getting the difference between the GSR level after key-press responses and GSR level immediately prior to key-press. This procedure (Helmer and Furedy, 1968) allows for comparable scores across subjects.

The data were further broken down by adding up the scores on trials following positively-reinforced trials and getting their mean; the same was done for scores on trials following negatively-reinforced trials. The formulas used to yield these scores are:

$$\text{PR Score} = \frac{\Sigma\ (\Delta G_{kp} - \Delta G_{y1})}{n_{pr}} \qquad (1)$$

for scores on trials following positively-reinforced trials, and

$$\text{NR Score} = \frac{\Sigma\ (\Delta G_{kp} - \Delta G_{y1})}{n_{nr}} \qquad (2)$$

for scores on trials following negatively-reinforced trials, where

ΔG_{kp} – GSR following key-press response of *S*

ΔG_{yl} – GSR immediately prior to key-press response of *S*

n_{pr} – number of trials following positively-reinforced trials

n_{nr} – number of trials following negatively-reinforced trials

Following this procedure, each subject ends up with two scores, the PR score (mean of the differences of GSR levels on trials following positively-reinforced trials) and the NR score (mean of the differences of GSR levels on trials following negatively-reinforced trials). These scores were recorded for all subjects and *t*-tests were run between PR and NR scores to determine effectiveness of conditioning. A 0.05 level of significance was set as the critical level for all statistical tests.

If conditioning was found to have been effective, then an analysis of variance using the 2 x 2 format could be run on the PR scores of each group to determine any differences between groups and thus, test the two hypotheses.

RESULTS

On each trial, two readings of GSR were taken at the points mentioned above. The GSR prior to key-press response was found to differ slightly from *S*'s basal level due to minimal sensitization reactions. From these readings, taken over the thirty test trials (scores on the three autoreinforced trials were not included), *S*'s PR and NR scores were derived according to the procedure described above.

The initial *t*-tests on PR and NR scores in each group to check on the effectiveness of conditioning are given in Table 1. The highest *t* was found for group D (2.4524) and the lowest *t* was found for group C (1.8417). All *t*'s were significant at the 0.05 level.

The 2 x 2 analysis of variance performed on the PR scores of the four groups yielded an *F* ratio of 3.032 (not significant) for the feedback conditions and an *F* ratio of 4.1354 for the reinforcement conditions. The second *F* is significant at the 0.05 level. The *F* for interaction effects was found to be 0.6365 (not significant). The results of the analysis are given in Table 2.

DISCUSSION

The *t*-tests which were performed on the PR and NR scores of the four groups were found to be significant at the 0.05 level; this may be taken as evidence for successful operant conditioning of the GSR response, following reinforcement theory which states that there is a greater probability of larger response on trials following reinforced trials. While some subjects showed great variation in response intensity during the experiment, response for the most part followed a fairly predictable pattern, rising progressively and then leveling off towards the end of the test series. There was no evidence found to support the findings previously reported (Kimmel and Baxter, 1964; Helmer and Furedy, 1968) that response magnitude steadily decreased in the course of the trials. This finding was also reported by Gringe and Carlin (1966) and has been used as evidence for habituation effects. Its absence in this study might have been due to some other factors which will be discussed later.

The analysis of variance performed on the PR scores of the four groups confirm the hypotheses under study. The non-significant *F* for feedback, taken in conjunction with the significant *t*'s for conditioning, indicate that feedback and non-feedback groups showed comparable operant conditioning, as predicted. The significant *F* for reinforcement, on the other hand, reveals a difference between the monetary and non-monetary reinforcement groups, and shows that the monetary-reinforcement group had significantly greater response to conditioning, also as predicted. This may be taken as evidence for appetitive operant conditioning of the GSR. The results support the findings of Helmer and Furedy in this respect.

All subjects showed a consistent change in GSR level at the onset of the amber stimulus light and although sudden responses tended to level off during the time-interval estimation period, for a large number of subjects, GSR did not return to the basal level. This highly-consistent response emphasizes the importance of using the $(\Delta G_{kp} - \Delta G_{yl})$ subtraction method

to control for changes as a result of reactivity or sensitization during trials.

A source of sensitization which was not completely controlled for as it was unexpected was the sensitization of *S*s to the red-light negative reinforcement applied by *E* whenever GSR failed to reach criterion. Reactions of this sort resulted in a relatively intense response after key-press following a string of negatively-reinforced trials and may be the reason why there was no observable decrease in amplitude of response as have been reported in other studies mentioned above. This sensitization response was observed to occur after a number of trials in which negative reinforcement was applied in succession and could not be completely controlled for in the analysis of data. Had this phenomenon been controlled, the analysis might have shown a higher response to conditioning than what the *t*-tests reveal.

Whether this reactivity phenomenon extended itself to affect more than one trial after the string of negatively-reinforced trials is not entirely clear. There may be reason to suspect that it was in fact so, but this is not borne out by statistical tests which were performed on the data. All that is clear is that most of the subjects showed this sudden reactivity when faced with a string of negatively-reinforced trials.

The high consistency of occurrence of this reactivity phenomenon makes it desirable that some form of control be introduced into the procedure of similar experiments. Such a control may be worked into the procedure by simply eliminating the negative reinforcer entirely; that is, use positive reinforcement when GSR attains criterion, otherwise proceed to the next trial. This alternative procedure may cause some reactivity to the amber stimulus light, but the present study has already shown that such initial sensitization effects tend to decrease and level off in the course of the time-interval judgment task, and the procedure may allow the experimenter to control reactivity effects so that they do not seriously affect the experiment. This procedure should minimize the sudden massive changes in GSR after key-press following a string of successively non-reinforced trials as well as allowing the initial stimulus-sensitization effects to decrease before readings are taken. This procedure is suggested for future studies of a similar nature.

The results of this experiment suggest rather strongly that there are factors other than feedback at work in the operant conditioning of GSR. This is indicated by the fact that although the *F* for feedback conditions was not significant, the value is close enough to the critical 0.05 level to suggest borderline significance, and this difference seems to lie in the direction of the non-feedback condition. Though not entirely evident from the data on hand, there is a distinct possibility that this difference will increase significantly if more trials were run per subject. The data offer no clear-cut explanations why this should be so; however, it is hypothesized that subjects in the feedback condition may have actually succeeded in suppressing to some extent their GSR in their effort to produce greater response, so that their actual responses were of lesser magnitude than the responses of the non-feedback groups. A study has previously been reported (Johnson and Schwartz, 1967) showing that GSR can be suppressed through operant methods, so that this hypothesis may not be all that far-fetched; however, further research along this line is strongly suggested.

While the present study does suggest that feedback may not be a critical factor in the operant conditioning of GSR, it should not be taken as conclusive proof that the feedback hypothesis as espoused by Kamiya and others does not hold. Several points need to be taken into consideration here. Perhaps the most important is the fact that there are a number of autonomic responses which have been shown to be amenable to operant conditioning methods, notably alpha-waves, GSR, heartbeat, and to a lesser extent vasoconstriction and vasodilation. The findings of any one study, therefore, should not be generalized to the whole class of autonomic behaviors. It must be noted that Kamiya formulated the feedback hypothesis as a result of his experiments on alpha-wave conditioning.

It is entirely possible that the hypothesis may hold for some autonomic responses and not for others.

This experiment provides further support for the contention that autonomic behaviors are modifiable through operant conditioning methods, contrary to theoretical predictions put forth by Kimble and others; furthermore, it can be concluded here that the use of appetitive reinforcements (in this case, money) provides a reliable means for the operant conditioning of such responses.

As often happens, this experiment raises more questions than it answers. In addition to the suggestions for further research already mentioned above, other variables which may be explored in connection with the operant conditioning of GSR are: effects of instructions to subjects; use of different sense modalities (hearing, touch, etc.) in the presentation of stimuli and reinforcement; suppression, rather than emission or intensification of GSR. In addition, it may be worthwhile to consider experiments which make use of a within-*S* design rather than the present between one. Such a design may yield greater significance than what was attained in the present experiment.

TABLE 1

MEAN PR AND NR SCORES FOR EACH OF FOUR GROUPS AND T-TEST RESULTS ON PR VS. NR SCORES IN EACH GROUP ($N_g = 21$; TOTAL N = 84).

Groups	Mean PR Score	Mean NR Score	T*
A	23.6299	20.1807	2.0436
B	26.4128	22.6228	2.1181
C	22.2755	19.4427	1.8417
D	23.3095	19.8822	2.4524

* – all t's significant at the level of $p < 0.05$.

TABLE 2

SUMMARY TABLE OF 2 x 2 ANALYSIS OF VARIANCE PERFORMED ON PR SCORES OF ALL GROUPS

Source of Variance	SS	df	MS	F
Feedback conditions (rows)	76.4879	1	76.4879	3.0320 n.s.
Reinforcement conditions (columns)	104.3239	1	104.3239	4.1354*
Interaction	16.0589	1	16.0589	0.6365 n.s.
Error	2018.1324	80	25.2266	
Total	2215.0031	83		

*$p < 0.05$.

REFERENCES

DEESE, J. and HULSE, S. H. *The psychology of learning*, (3rd ed.). New York: McGraw-Hill, 1967.

DOEHRING, D., HELMER, J., and FULLER, E. Physiological responses associated with time estimation in a human operant situation. *Psychological Record*, 1964, *14*, 355–62.

EDWARDS, A. L. *Experimental design in psychological research.* New York: Holt, Rinehart and Winston, 1968.

FUREDY, J. Novelty and measurement of the GSR. *Journal of Experimental Psychology*, 1968, *76*, 501–3.

FOWLER, R. and KIMMEL, H. D. Operant conditioning of the GSR. *Journal of Experimental Psychology*, 1962, *63*, 563–67.

FRIED, R., KORN, S., and WELCH, L. Effect of change in sequential visual stimuli on GSR adaptation. *Journal of Experimental Psychology*, 1966, *72*, 325–27.

GRINGE, W. *Laboratory instrumentation in psychology.* California: The National Press, 1954.

GRINGE, W., and CARLIN, S. Instrumental modification of autonomic behavior. *Psychological Record*, 1966, *16*, 153–59.

HELMER, J. E. and FUREDY, J. Operant conditioning of GSR amplitude. *Journal of Experimental Psychology*, 1968, *78*, 463–67.

JOHNSON, H. and SCHWARTZ, G. Suppression of GSR activity through operant reinforcement. *Journal of Experimental Psychology*, 1967, *75*, 307–12.

KAMIYA, J. Conscious control of brain waves. *Readings in psychology today.* California: GRM Books, 1969.

KIMMEL, E. Judgments of UCS intensity and dimunition of the UCR in classical GSR conditioning. *Journal of Experimental Psychology*, 1967, *73*, 532–43.

KIMMEL, E. and KIMMEL, H. D. A replication of operant conditioning of the GSR. *Journal of Experimental Psychology*, 1963, *65*, 212–13.

KIMMEL, E. and KIMMEL, H. D. Instrumental conditioning of the GSR seredipitous escape and punishment training. *Journal of Experimental Psychology*, 1968, *77*, 48–51.

KIMMEL, H. D. Adaptation of the GSR under repeated applications of a visual stimulus. *Journal of Experimental Psychology*, 1964, 421–22.

KIMMEL, H. D. and BAXTER, R. Avoidance conditioning of the GSR. *Journal of Experimental Psychology*, 1967, *73*, 482–85.

KIMMEL, H. D. and GOLDSTEIN, A. J. Retention of habituation of the GSR to visual and auditory stimulation. *Journal of Experimental Psychology*, 1967, *73*, 401–4.

KIMMEL, H. D. and HILL, F. A. Operant conditioning of the GSR. *Psychological Reports*, 1960, *7*, 555–62.

KIMBLE, G. A. *Hilgard and Marquis' conditioning and learning*, (2nd ed.). New York: Appleton-Century-Crofts, 1961.

KONORSKI, J. and MILLER, S. On two types of conditioned reflex. In Helmer and Furedy. Operant conditioning of GSR amplitude, *Journal of Experimental Psychology*, 1968, *78*, 463–67.

MCGUIGAN, F. J. *Experimental psychology: A methodological approach.* New Jersey: Prentice-Hall, 1960.

SHEARN, D. S. Operant conditioning of heart rate. *Science*, 1962, *137*, 530–31.

STERN, R. M. Operant conditioning of spontaneous GSRs: Negative results. *Journal of Experimental Psychology*, 1967, *75*, 128–30.

UNDERWOOD, B. J. *Experimental psychology.* New York: Appleton-Century-Crofts, 1965.

VAN TWYVER, H. B. and KIMMEL, H. D. Operant conditioning of the GSR with concomitant measurement of two somatic variables. *Journal of Experimental Psychology*, 1966, *72*, 841–46.

WOODWORTH, R. S. and SCHLOSBERG, H. *Experimental psychology.* New York: Holt, 1954.