PSEUDOCONDITIONING OF THE GSR

by

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The strengthening of a response to a previously neutral stimulus through repeated elicitation of the response by another stimulus without paired presentation of the two stimuli has been termed pseudoconditioning (Kimble, 1961). Pseudoconditioning was first noted by Sears (1934) in his report of the pseudoconditioning of goldfish, which he referred to as a "sensitized reflex". Grether (1938) concluded that the pseudoconditioned response (PCR) was specific to the experimental situation. There ensued in the following decade a series of studies designed largely to determine whether pseudoconditioning is a result of associative or non-associative processes.

Supporting the associative point of view, Wickens and Wickens (1942) found that when the neutral stimulus was similar, rather than dissimilar to the unconditioned stimulus, more PCRs were observed in rats engaged in an escape conditioning task. Working with the eyelid reflex, Grant, and his associates (Grant and Dittmer, 1940; Grant, 1943a, 1943b) also obtained evidence supporting the contentions that the PCR has an associative component.

Alternatively, the work of Sears (1943), Grether (1938), and Harlow and Toltzien (1940) suggested a non-associative interpretation, although much of the data would appear explicable by means of a mediational hypothesis in the context of an association theory.

Although the decade of research did not resolve the

controversy, it should be noted that a general form of the pseudoconditioning curve appears to have emerged from the data: for a number of species and a variety of stimuli, the response level remains stable or rises slightly as a function of UCS trials (an "acquisition" period), then drops sharply with repeated presentations of the CS (an "extinction" period).

Recently, however, the role of pseudoconditioning has been largely confined to its use as a control in classical conditioning studies, notably those involving the GSR. Frequently used in a variety of conditioning studies is a restricted-random presentation of CS and UCS, in which a series of UCS presentations are interspersed with CS presentations. For the purposes of this paper, this type of pseudoconditioning will be labeled procedure A. The more traditional pseudoconditioning procedure, in which the CS is presented after a consecutive series of UCS presentations, will be called procedure B. Procedure A is often used as a control group in studies which employ test trials during acquisition as a measure of conditioning (Kimmel, 1959; Prokasy and Ebel, 1964). Despite its frequency of use, there is, seemingly, little known about the processes involved in pseudoconditioning. For example, there is contradictory evidence in the literature (Champion and Jones, 1961; Grether, 1938) concerning the effect of the number of UCS trials on pseudoconditioning. The GSR

conditioning controversy serves as an illustration of how such lack of information can give rise to confusing problems. Stewart and his associates (Stewart, Stern, Winokur, and Fredman, 1961) criticized the methodology involved in studies of GSR conditioning and asserted that the majority of such work had inadequately defined the "true" CR and, consequently, had dealt with sensitization of the GSR, not conditioning. Following this indictment, replies were issued, some of which were in agreement (Leonard and Winokur, 1963; MacDonald and Johnson, 1965), others of which were not (Lockhart and Grings, 1963; Kimmel, 1964).

Much of the controversy surrounding the question of CR definition was dissipated by Kimmel's (1964) statements on the problem. He contended that a search for a "true" CR in the absolute sense is a fruitless endeavor; CRs must be operationally defined with the use of pseudoconditioning control groups. Only in this manner can one differentiate conditioning from pseudoconditioning.

But what are the various types of pseudoconditioning and how do their effects differ from one another? There are, unfortunately, few answers to these questions. The literature reveals a paucity of research aimed specifically at an understanding of the variables which underly and alter pseudoconditioning of the GSR. As Kimble (1961) has suggested, this situation has quite likely been nurtured by

the connotation of the prefixes: as though quasi- or pseudo-conditioning are, at best, merely bothersome residuals of truer stuff. Such reasoning appears to disregard the fact that these "quasi" phenomena currently form the base line for measures of conditioning and that knowledge of such behavior may shed light on the more associative processes of conditioning.

However, apart from any methodological problems, pseudoconditioning merits investigation as a genuine behavioral phenomenon. Many "contaminating" responses have been found to yield valuable information upon study, e.g., orienting reaction.

Therefore, it appears that a comparison of the two procedures through acquisition and extinction would yield important information in regard to (1) pseudoconditioning as a basic behavioral phenomenon, and (2) differences between procedure A and procedure B and the implications of such differences for experimental controls.

Method

Subjects

The subjects were 41 male and 46 female university students and were assigned to nine groups in a restricted random procedure in order to assure an approximately equal number of males and females in each group. Subjects were repeated across trials in all groups except those measured

under Procedure B.

Experimental design

Variables investigated were manner of stimulation and trials. The four types of stimulation were: (1) Procedure A, (2) Procedure B, (3) conditioning, and (4) CS-alone.

Group A (Procedure A) was presented with 20 UCS-only trials interspersed with CS-only trials after trials 0, 3, 7, 12, 15 and 20 followed by four extinction trials. Groups B_1 through B_6 composed the Procedure B groups, each group having received a CS-only trial after 0, 3, 7, 12, 15, or 20 UCS trials, respectively, followed by four extinction trials. Group C (conditioning) was treated in the same manner as Group A, except that CS presentations were paired with the UCS presentations. Group D (CS-only) was presented with only 10 CS trials with an intertrial interval equal to the times between the corresponding CS presentations in Group A and Group C. The dependent variable was the GSR to the CS.

Apparatus and procedure

The UCS was a 60 cycles square wave ac shock produced by an Applegate Model 230 stimulator and administered through a concentric disc electrode (described by Tursky and Watson, 1965). The CS was a 2000 cps tone produced by a Hewlett-Packard Model 200 AB oscillator and was presented through a speaker located behind S.

The UCS had a duration of 600 ms; the CS, 500 ms. The interstimulus interval was 500 ms; the intertrial interval ranged from 30 to 60 seconds with a mean of 45 seconds.

The initial UCS was 1.6 ma, the second, 2.5 ma, and the third and succeeding UCS presentations were 3.2 ma. Preliminary investigations of adaptations effects revealed the stimuli to sufficiently elicit GSRs after 20 trials. All CS presentations were 30 db, re .0002 dynes/cm^2.

The stimuli were programmed by means of a Western Union tape reader. Three Hunter timers controlled the intertrial intervals; the interstimulus intervals and stimulus durations were controlled by a Type 162 Textronix waveform generator. A Grason-Stadler white noise generator provided a 60 db (re .0002 dynes/cm^2) ambient noise level. The GSR was measured by a Fels Dermohmmeter, Model 22A, and was recorded on a Honeywell Visicorder. Finger blood volume was also measured by a photocell on the index finger, but this data will not be reported in this paper.

The experimental situation consisted of two small rooms, one containing the apparatus and E, the other containing S. The S was first seated and the following instructions were read to him:

> In this experiment we're going to measure some of your internal, physiological reactions to mild shock. You can be sure that there is no chance at all that you'll receive any harmful shocks. All you have to do is simply sit still and not move your arms and hands.
>
> One measuring device will clamp on your hands; the other will go on your right index finger. You won't feel anything from these devices; they simply measure internal physiological reactions. I'll be a few minutes preparing the apparatus, so just relax for a few minutes.

The Ss palms were then cleaned with alcohol and the two GSR electrodes were placed on them. The plethysmograph was then placed on S's right index finger. After both of these applications, S was reminded that he would feel nothing from these devices. Next, the shock electrode was placed on S's forearm and E repeated that there was no danger of receiving a harmful shock. The following final instructions were then given to S:

> These measuring devices are extremely sensitive to movement, so keep your hands and arms still. If, by chance, you feel uncomfortable and must move your hands, just tell me. This hissing sound (white noise) is merely to mask out any noises that could disturb your reactions. If you have any difficulty, just speak up. Any questions?

Results

The GSR was measured as the logarithm of conductance change (see Appendix I), a score frequently used in previous GSR work (Kimmel, 1964; Wittig and Wickens, 1966). Results are graphically displayed in Fig. 1, which shows

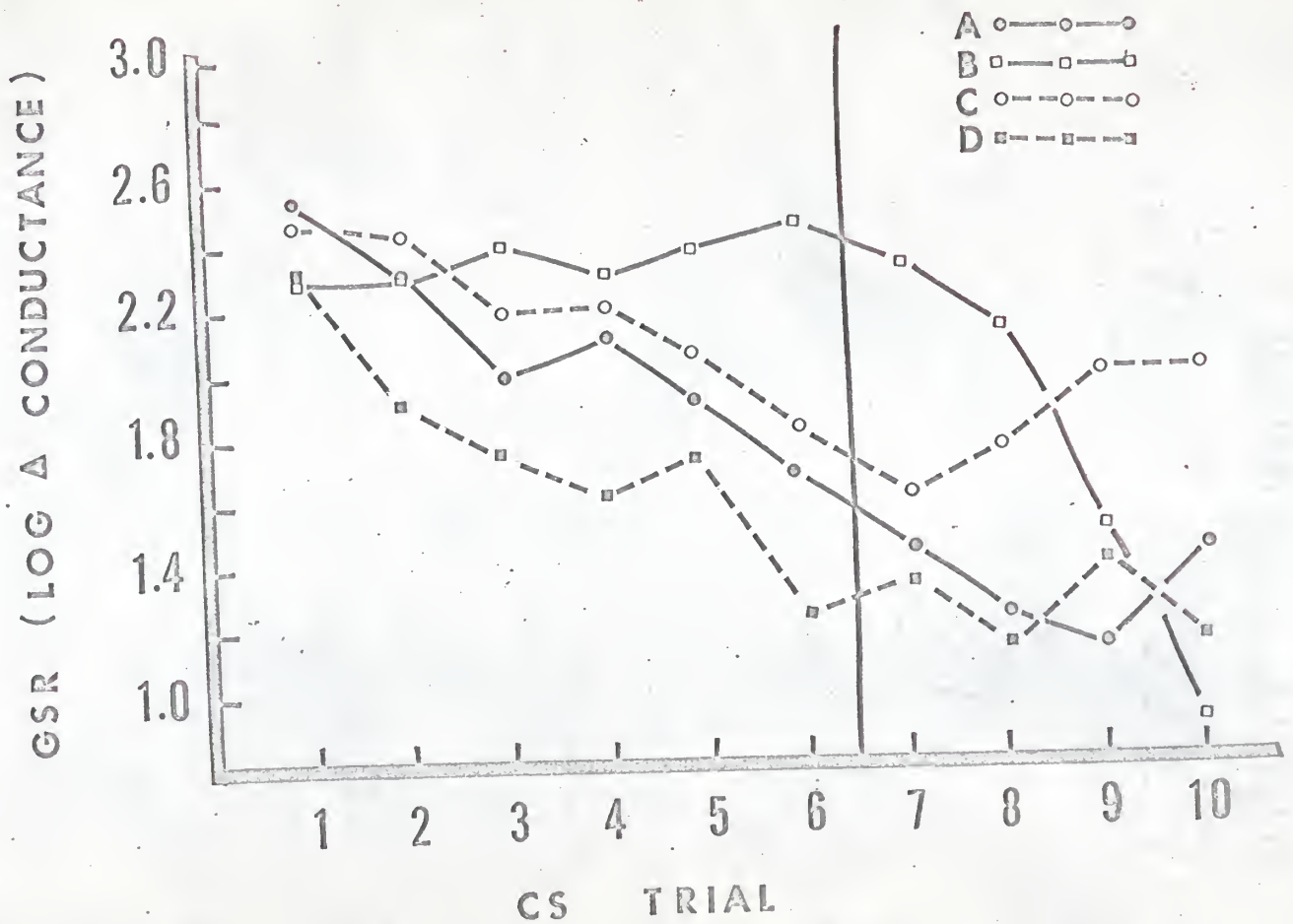

Fig. 1. Acquisition and extinction scores for Groups A, B, C and D.

the GSRs across acquisition and extinction.

Acquisition

The nature of the experimental arrangement imposed some limitations on the statistical design. Specifically, the acquisition data were collected from independent groups, and therefore could not be analyzed in the same design with the repeated measures Groups A, C, and D. Consequently, Groups A, C, and D were analyzed in a 3 x 6 repeated measures factorial and Group B was analyzed in a completely randomized design. As Table 1 shows, there were no differences among Groups A, C, and D but the analysis did show a significant trials effect. However, the Group B analysis, shown in Table 2, did not show any trials effect. Upon comparison of Group B and Group A at CS Trial 6, divergent variances were noticed; a Hartley's F_{max} revealed the variances to be significantly heterogeneous, F_{max} (2, 9) = 19.73, p .01. Therefore, a Welch's approximation to the t-test for heterogeneous variances was performed between Groups A and B at CS Trial 6, and showed a significant difference between the two groups, $t_8 = 2.41$, $p < .05$. Furthermore, a similar comparison of Group B with Group C at CS Trial 6 also revealed a significant difference, $t_8 = 3.158$, $p < .01$.

Table 1

Summary of Analysis of Variance for Acquisition Data of Groups A, C, and D

Source	df	MS	F	p
Between Subjects	26			
Groups	2	259.42	2.429	n.s.
Subjects/Grps.	24	106.78		
Within Subjects	135			
Trials	5	213.90	16.916	<.01
G x T	10	8.82	.697	n.s.
T x Subjects/Grps.	120	12.64		
Total	161			

Table 2

Summary of Analysis of Variance for Acquisition Data of Group B

Source	df	MS	F	p
Trials	5	.034	.330	n.s.
Error	54	.103		
Total	59			

Extinction

Heterogeneity also precluded a single analysis of the extinction data. A 3 x 5 repeated measures factorial on Groups A, C, and D (Table 3) showed neither trials nor procedures to be significant. (It should be noted that the extinction data also included the final CS-only trial during acquisition.

Table 3

Summary of Analysis of Variance for Extinction Data of Groups A, C and D

Source	df	MS	F	p
Between Subjects	26			
Groups	2	418.57	1.34	n.s.
Subjects/Grps.	24	313.05		
Within Subjects	108			
Trials	4	19.80	.98	n.s.
G x T	8	27.23	1.35	n.s.
T x Subjects/Grps.	96	20.07		
Total	134			

In addition, a t-test between the Group B mean and the Group C mean at Trial 10 also indicated no difference between the final means, $t_{16} = .998$, $p < .05$. On the other hand, a t-test between the Group B mean and the Group C mean revealed a significant difference between the two, $t_{16} = 2.713$, $p < .01$.

Discussion

The analyses lead one to conclude that procedures A and B represent two different phenomena. During the acquisition period, Group B maintained a stable response level, while Group A decreased across trials. This finding, coupled with the difference between the CS Trial 6 means suggest an interaction between the two variables. Similarly, an interaction may also be inferred from the analyses of the extinction data, with Group B sharply decreasing and Group A maintaining a low level of responding.

The Procedure B data are similar to those obtained from the early investigations of pseudoconditioning. Harlow (1939) found that PCRs in goldfish were obtained more frequently and in greater magnitude as the number of UCS trials increased. A later study (Harlow, 1940), using cats, indicated that the number of PCRs is a negatively accelerated increasing function of the number of UCS trials. More recently, however, Champion and Jones (1961) concluded that pseudoconditioned GSRs in humans decreased over acquisition, but they employed Procedure A. The functional differences between the two procedures found here reconciles these disparate results and points to a need for a more specific labeling of the procedure used, rather than simply "pseudoconditioning".

The acquisition data do not provide any evidence of

conditioning for Group C. Furthermore, largely because of the high variance during extinction trials, there is only, at best, a suggestion of conditioning from the extinction data. The reason for the lack of conditioning probably lies in the low intensity (30 db) of the CS. Most GSR conditioning studies that employ sound as the CS (Prokasy and Ebel, 1964; Prokasy, Hall, and Fawcett, 1962) have used tones in excess of 50 db. It was believed that the use of a less intense tone would reduce the noxious, startle component of the CS.

The orienting response

In describing the recent Russian work on various unconditioned responses, Berlyne (1961) distinguished between the orientation reaction (OR), the complex of investigatory reactions to novel stimuli, and the adaptive reaction, those more specific responses which act in opposition to the OR to diminish the impact of stimulus change. Berlyne maintains that, in general, the OR occurs at the beginning of training and is later replaced by the adaptive reaction. The Russians, notably Sokolov (1963), have also separated a defensive reaction, a set of generalized responses which, though similar to the OR, is readily distinguishable from the OR. Both the OR and the defensive reaction are multi-faceted--whole constellations of physiological processes which are manifested in a variety of responses, all presumably intended to prepare

the organism for incoming stimuli.

There are a number of ways in which these reactions may be distinguished from one another. For example, the OR may be differentiated from the defensive reaction by means of overt responses: unlike the receptive posture of the OR, the defensive reaction consists of such actions as blinking, withdrawing, etc. At the physiological level, the vasomotor component of the OR comprises a dilation of the blood vessels of the head and a constriction of vessels in the limbs. The defensive reaction, on the other hand, produces a constriction of vessels in both head and limbs.

Turning to the two procedures employed in this experiment, it would appear that the concept of the OR could account for the shape of both the Procedure A and Procedure B functions.

One would assume that there is a sensitization component in the responses of Procedure A (from the lack of conditioning in Group C, it would appear that any associative bonds are at a minimum). Initially, then, the responses of Group A were probably sensitized responses augmented by an orienting component. As training progresses and the tone becomes less novel, the orienting component decreased and the adaptive response grew stronger, continuing through extinction.

A similar analysis of Procedure B would conclude that these responses were also sensitized, but, in addition,

there was undoubtedly a large OR component across acquisition because, during acquisition, the CS occurred only once, and was therefore a novel stimulus that should elicit a large OR. However, during extinction, the OR component dropped out rapidly because of the recurring stimulus. Razran (1961) has stated that the OR displays rapid extinction with higher organisms and a low intensity CS; and that, furthermore, the GSR is particularly quick to extinguish.

As an alternative explanation, it is possible that the responses were, instead of ORs, defensive responses. If so, then perhaps at the onset of the six "first" CS trials, the CS was, in some manner, perceived as similar to the noxious UCS (an interpretation close to the associative point of view mentioned above). The issue could be solved by observing one or more of the differentiating responses such as the vasomotor response in the forehead.

Implications for conditioning

Although failure to find a significant amount of conditioning in Group C places a limit on generalizations, it is evident that the control procedure employed is of importance, whether one is testing across acquisition or during extinction. For example, it is possible that one could employ Procedure B as the pseudoconditioning control and find no evidence of conditioning, whereas the use of Procedure A may, as found by others (Prokasy and Ebel,

1964), yield results supporting conditioning. The problem of criterion selection and measurement has been noted in GSR work (Stewart, Stern, Winokur, and Fredman, 1961) and other areas of conditioning (Kimble, 1961) and it apparently is a problem that requires additional investigation.

In any case, these results indicate that there is much to learn concerning the processes which underly pseudo-conditioning and related phenomena.

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APPENDIX 1

GSR Transformation

The GSR, the galvanic skin response, is commonly measured directly from the skin in ohms. For analytical purposes, both statistical and psychological, the raw score was transformed into the logarithm of conductance change by the formula

$$\log_{10} \left[\left(\frac{1}{\text{OHMS AFTER}} - \frac{1}{\text{OHMS BEFORE}} \right) 100000000 + 1 \right]$$

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In the past, two different pseudoconditioning procedures have been employed, one (A) used mainly as a control group in recent studies of conditioning, and the second (B) used primarily in investigations of the pseudoconditioning phenomenon itself. In Procedure A, S is presented with a series of UCS trials interspersed with CS trials. In Procedure B, S is presented with a neutral stimulus after a series of consecutive UCS trials.

In the present study, the two procedures were compared over acquisition and extinction. Results showed that during acquisition Group B maintained its high response level, but that during extinction performance level sharply decreased. On the other hand, the response level for Group A decreased during acquisition and maintained a low response level during extinction.

The difference in the groups was explained by invoking the concept of the orienting reflex (OR). Specifically, Procedure B responses during acquisition were proposed to contain a large OR component. Procedure A responses, however, were thought to contain an OR component only initially. Implications of results for GSR conditioning were also discussed.