Classical Discrimination Conditioning of Pain-Elicited Aggression

Delmar A. Ozolins

Western Michigan University

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CLASSICAL DISCRIMINATION CONDITIONING OF PAIN-ELICITED AGGRESSION

by

Delmar A. Ozolins

A Thesis
Submitted to the
Faculty of the School of Graduate Studies in partial fulfillment of the
Degree of Master of Arts

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INTRODUCTION

When brief shocks are delivered to two or more rats in a closed environment, an intense form of fighting occurs (O'Kelly and Steckle, 1939; Daniel, 1943; Ulrich and Azrin, 1962). With the onset of shock, the animals face one another in an upright position, the head thrust forward, mouth open and paws extended. From this position they strike vigorously with paws and teeth. This upright stance has been defined as the "stereotyped fighting posture" (Ulrich and Azrin, 1962) since the position is assumed by almost all paired rats when shocked. The purpose of the present study is to investigate classical conditioning of this pain-elicited aggression using a discrimination procedure.

Gormezano defines the essential features of classical conditioning to be a set of experimenter operations involving an unconditioned stimulus (UCS), which reliably evokes an unconditioned response (UCR), and a conditioned stimulus (CS) that has been shown not to elicit that unconditioned response (UCR). The CS and UCS are then presented repeatedly to the organism in a specified order and fixed temporal spacing. A response similar in form to the UCR develops in the presence of the CS and prior to the UCS which is defined as the conditioned response (CR) (Gormezano, 1966).
While there are many theoretical interpretations of classical conditioning, all theorists agree that a clear demonstration of classical conditioning requires that the acquisition process be solely determined by the temporal pairings of the CS and UCS. In order to clearly demonstrate the conditioning process, five distinct experimental procedures are required to assess the possible non-associative factors which might contribute to CR measurement.

The first of these procedures involves the recording of spontaneous responses to provide the necessary evidence to distinguish between these and conditioned responses. In the case of aggression, this procedure would involve placing two animals within a restricted space to determine the incidence of fighting responses similar in form to the aggression complex elicited by shock. Previous research indicates that little or no fighting occurs when two rats are placed in a chamber of the size used in the present study (Vernon and Ulrich, 1966). There is a very low probability therefore of spontaneous fighting contributing to the measurement of conditioned responses.

The second procedure involves the presentation of CS alone trials to measure the occurrence and definition of those responses which are evoked by the CS, and are not derived from the conditioning process. This response is similar in form to the UCR which is evoked by the UCS, but is under control of the CS.
rather than the UCS. Previous research indicates that noise up to 135 db enclosing a band from 200 – 1500 cps is ineffective in producing fighting behavior between paired rats (Ulrich and Azrin, 1962). There is a very low probability, therefore, of CS-evoked responses contributing to the measurement of conditioned responses.

In the third procedure, the UCS is presented alone to measure its eliciting potential. The reliability of foot shock as a UCS in eliciting aggression has been demonstrated by Ulrich and Azrin in 1962, who presented shocks every 1.5 sec. to paired rats. During the first 2,400 shock presentations aggression occurred to 82% of the shocks and after 7,200 presentations aggression still occurred to 70% of the shocks. Only after the presentation of nearly 15,000 shocks did the incidence of aggression fall below 40%.

The intensity of foot shock that is optimal for producing aggression between rats appears to be 2 ma. Ulrich and Azrin (1962) found that increasing the shock intensity from 0 to 2 ma produced an increase in the incidence of aggression, although the lower intensities produced a fighting response of less vigor and longer latency. At higher intensities, ranging from 3 to 5 ma, the incidence of aggression to shock decreased, apparently as a result of the debilitating effects of the shock.

The duration of foot shock that is optimal for producing aggression between rats appears to be about .5 seconds. Azrin,
Ulrich, Hutchinson and Norman (1964) found that although little
difference was shown between .5 seconds and 3 seconds in eliciting
aggression during initial exposure to shock, the brief shocks
became more effective in producing aggression with continued shock
exposure and the longer shock durations became less effective.

Other variables such as size of the experimental chamber
also have been shown to have a marked effect on the rate at which
pain-elicited aggression occurs. Ulrich and Azrin (1962) showed
that with an experimental space of 6 x 6 in. aggression was
elicited by shock on 90% of the trials, while fighting occurred
on only 2% of the trials with a floor space of 24 x 24 in.

The foot shock UCS has, therefore, been shown to be a
reliable elicitor of aggression if the parameters of its inten-
sity, duration and frequency are properly controlled in an optimal
chamber size.

The fourth procedure involves pairing the CS-UCS according
to the classical conditioning paradigm. Three studies have been
reported which indicate successful classical conditioning of pain-
elicited aggression (Vernon and Ulrich, 1966; Creer, Hitzing, and
Schaefer, 1966; Farris Gideon and Ulrich, 1968). Conditioning was
obtained through the use of a delayed procedure in all these
studies, consisting of a 1 sec. CS and .5 sec. UCS, with a 10 sec.
inter-trial interval. The UCS was presented .5 sec. after the
onset of the CS, and then both stimuli terminated simultaneously.
Due to the brief CS duration used in these studies, a CS-alone
test trial was programmed after every block of ten trials to assess the course of conditioning (Vernon and Ulrich, 1966; Creer, et al, 1966; Farris, et al, 1968). A maximum of 53% responding to the CS was reported by Vernon and Ulrich (1966) while Farris, et al (1968) obtained approximately 71% conditioning.

The fifth procedure, normally used as a control for sensitization, is the classical discrimination procedure. Since two stimuli are present in such a procedure, but conditioning occurs only in the presence of one of them, the incidence of the CR cannot be accounted for in terms of a startle reaction occurring as the result of a simple change in the environment. This discriminated classical conditioning procedure has never been demonstrated with pain-elicited aggression.

Although, as reported under procedure four, classical conditioning of pain-elicited aggression has been previously demonstrated, some factors need further clarification and exploration.

First, there are two apparent disadvantages with the previously employed test-trial procedures (Vernon and Ulrich, 1966; Creer, et al, 1966; Farris, et al, 1968).

a. This procedure does not allow for a complete recording of the acquisition process, since conditioning is not recorded on every trial.

b. Gormezano suggests that a test trial procedure involves a partial reinforcement schedule, the effects of which are not completely understood (Gormezano, 1966).
Secondly, in the previously reported studies on classical conditioning of pain elicited aggression, the CS-alone duration was only .5 sec. (Vernon and Ulrich, 1966; Creer, et al, 1966; Farris, et al, 1968). The preferred demonstration of classical conditioning demands not only the presence of the CR, but a change in the temporal relationship between that CR and the occurrence of the CS and UCS, such that the CR occurs during the CS and prior to the UCS. (Gormezano, 1966). The .5 sec CS is too short to measure such anticipatory conditioning responses.

Thirdly, the results of the previous studies on classical conditioning of aggression (Vernon and Ulrich, 1966; Creer, et al, 1966; Farris, et al, 1968) could be explained in terms of sensitization. In order to obtain conditioning, the Ss were necessarily exposed to a large number of shocks, an operation which could change the Ss reactivity, sensitivity and emotionality to the point at which any change in the environment is likely to evoke a response from the animal. Such a startle reaction would not be representative of associative conditioning. Although control procedures for sensitization were used, the temporal distribution of the CS and UCS presentations for the control and experimental sessions were not equated (Vernon and Ulrich, 1966; Creer, et al, 1966; Farris, et al, 1968).

Therefore, the purpose of the present study is to:
provide a clear demonstration of classical conditioning of pain-elicited aggression by the use of a discrimination procedure.

provide a continuous measure of the acquisition process by the measurement of every trial.

use longer CS durations to enable the recording of anticipatory conditioning responses, and to explore the effects of these CS and ITI durations on conditioning.
METHOD

Subjects

Sixteen male, albino rats, 120 days old at the beginning of experimentation were divided into 8 pairs which remained intact for the duration of the experiment. Each experimental animal was housed separately. Food and water were available at all times, except during experimental sessions.

Apparatus

An 8 x 10 x 12 in. aluminum chamber with a plexiglass front wall was enclosed in a sound attenuated shell fitted with an air blower to provide ventilation. A 6 x 4 in. viewing window was mounted on one wall of the shell, and a 15 watt bulb was used inside the enclosure for illumination. The floor of the chamber was constructed of 1/2 in. stainless steel rods spaced 1/8 in. apart. The 2 ma, .75 sec. shock was delivered by a Grason-Stadler generator, type E1064GS.

An 87 db tone was provided by a Sonalert, Model SC628, P.R. Mallory and Co. A click generator from BRS-Foringer provided a click stimulus, set at seven clicks per sec. with an intensity of 75 db. The sound intensity of both stimuli was measured on the A scale of a type 2203 sound lever meter, Bruei and Kjaer, Co.

The experimental procedure was programmed by appropriate timers and relay circuitry.
Procedure

**General Design:** Two auditory stimuli, a tone and clicker, were alternately presented for a fixed duration and separated by a constant inter-trial interval. One stimulus designated as the "CS-plus" terminated coincidentally with the offset of a 2 ma, .75 sec. shock. In Experiment I only, a .5 sec. shock duration was used with pair #2. The other stimulus, defined as the "CS-minus" had the same duration as the "CS-plus", but terminated without shock. Each experimental session was comprised of 50 CS - shock pairings, and each pair of Ss was exposed to one experimental session per day.

**Response Definition:** In the present study, any one of three components of the aggression complex were recorded as responses; 1) raising into the "stereotyped fighting posture" from a "down" position, (See Figure 1) 2) a rapid run of three or more paw swipes directed toward the other animal, and 3) biting. These responses are so vastly different from other observed forms of behavior that there is little difficulty in distinguishing their presence. A maximum of one response was recorded during any one CS-plus, CS-minus, ITI or shock interval.

Responses were recorded by human observers by the manual closure of a microswitch on one of four electrical impulse counters, automatically programmed to coincide with the CS-plus, CS-minus, ITI and shock.
Fig. 1. A drawing of two animals assuming the "Stereotyped Fighting Posture". The picture is not intended to imply that the animals are always in physical contact.

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Experiment I: Initially 6 pairs of animals were conditioned under different durations of CS plus, CS minus and ITI. The specific conditions for each pair of animals are presented in Table I.

Experiment II: Little or no conditioning was obtained in Experiment I except for the pair of animals with a CS duration and ITI of 16 sec. Therefore, in Experiment II, pair 6 was continued on the 16-16 program, pairs 1 and 3 were then changed to the 16-16 program and two additional pairs, #7 and #8 were added with the 16-16 program. The specific programs for these animals are presented in Table II. After reaching criterion of 35% or more aggression responses to CS-plus per session for 6 consecutive sessions, the functions of the two stimuli were reversed. The stimulus which served as the CS plus was programmed as the CS-minus and the stimulus which served as CS-minus was programmed as CS-plus.

Experiment III: In an effort to determine some of the controlling variables of "warm-up", characterized by a between session decrement and a within session improvement, a series of 50 free-shocks without the conditioned stimuli were programmed prior to the conditioning sessions for pairs #1 and #6. The number of aggression responses were then measured during 10 trials with the usual 16-16 second program used in conditioning. The effects of the free-shocks were tested at each of five
### TABLE 1

Experimental procedures for pairs 1-6: For Experiment I showing the duration of the CS-plus and ITI in seconds, type of CS-plus stimulus, number of sessions, and median percentage of fights to CS-plus for the last 5 sessions.

<table>
<thead>
<tr>
<th>Pair #</th>
<th>CS-plus</th>
<th>ITI</th>
<th>CS-plus</th>
<th>No. Sessions</th>
<th>Mdn. Fights</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>10</td>
<td>Clicker</td>
<td>22</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>10</td>
<td>Clicker</td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>16</td>
<td>Tone</td>
<td>21</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td>4</td>
<td>Tone</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>4</td>
<td>Tone</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>16</td>
<td>16</td>
<td>Clicker</td>
<td>20</td>
<td>50</td>
</tr>
</tbody>
</table>
TABLE 2
Experimental Procedures for Experiment II

<table>
<thead>
<tr>
<th>Pair</th>
<th>CS-plus Stimulus</th>
<th>Number of Sessions Acquisition</th>
<th>Number of Sessions Reversal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Clicker</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>Tone</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Clicker</td>
<td>35</td>
<td>18</td>
</tr>
<tr>
<td>7</td>
<td>Tone</td>
<td>37</td>
<td>13</td>
</tr>
<tr>
<td>8</td>
<td>Tone</td>
<td>26</td>
<td>16</td>
</tr>
</tbody>
</table>
inter-shock intervals presented in the following sequence: 64, 4, 8, 16 and 32 sec. The effects of the free-shock were tested during 5 sessions at each free-shock interval. A criterion of 35% or more responses to the CS-plus for two consecutive sessions was re-established before proceeding to test the next free-shock interval. Note that the 64 sec. inter-shock interval was identical to the interval used in conditioning, since two 16 sec. CS presentations and two 16 sec. ITI's occurred between each shock.

Pair #3 was not exposed to this procedure since a substantial degree of conditioning was not obtained with these animals, nor were data obtained from pair #8 since the behavior declined during the reversal procedure. Data were obtained for only two free-shock frequencies with pair #7, after which the baseline could not be re-established. These data are not reported.
RESULTS

**Experiment I:** The percentage of fights to CS-plus, CS-minus, ITI and shock were calculated for each session. The median percentage of responses to the CS-plus for the last five sessions are presented in the last column of Table I for each pair of animals, numbers 1 through 6. Clearly, the only appreciable conditioning was obtained with the pair #6, which had been exposed to the 1 sec. CS; 16 sec. ITI program.

**Experiment II:** The percentage of fights per session to each CS, ITI and shock are presented as a function of sessions in Figs. 2 through 6. These data were recorded from animal pairs 1, 3, 6, 7 and 8. In general the data in each figure show a very high percentage of fights to shock. Except for the results in Fig. 3, all pairs show a progressive increase in fights to CS-plus and a decrease in fights to CS-minus, with an appropriate change in the distribution of fights following the reversal of the functions of these stimuli.

The data presented in Fig. 2 for pair #1 shows little or no conditioning with a 4 sec. CS and a 10 sec. ITI after 23 sessions. There is a rapid increase in the percentage of conditioned responses following the introduction of the 16 sec. CS; 16 sec. ITI program. Following the reversal of the two stimuli, there was a rapid change in response distribution, with an increase in responses to the new CS-minus. There was no general
Fig. 2. Percentage of fights to CS+, CS−, during the ITI and to shock as a function of sessions during acquisition and reversal phases. No data were recorded for sessions 1–4.
disruption of the discrimination in terms of increase in the responses during the ITI. (See Figure 2)

The data presented in Fig. 3 were obtained from pair #3. Initially these animals were exposed to a 4 sec. CS and a 16 sec. ITI. Under these conditions the highest percentage of fights occurred during the ITI. Following the introduction of the 16-16 program there was a decrease in fighting during the ITI, and an increase during the CS-plus and CS-minus. By the last session however, the data suggest a partial discrimination. At this point, the Ss were in such a physically weakened condition that the experiment had to be terminated. (See Figure 3)

The data presented in Figs. 4 and 5 represents pairs #6 and #7. In general the data in both figures indicate the percentage of fights increased to CS-plus and decreased to CS-minus and ITI as conditioning progressed. (See Figures 4 and 5) Following the reversal there was a rapid increase in fights to the new CS-plus and a decrease to the new CS-minus.

As indicated in Fig. 5 the animals avoided shock on two different occasions. Typically one or both animals would assume a prone position on their backs with their paws in the air, away from the floor grid. This problem was solved by removing the hair from the back and hind quarters of both animals.

The data presented in Fig. 6 for pair #8 also show an increase in fights to the CS-plus and a decrease to the CS-minus and ITI in acquisition. The percentage of fights during the re-
Fig. 3. Percentage of fights to CS+, CS−, during the ITI and to shock as a function of sessions during acquisition. No data were recorded for sessions 1–4.
Fig. 4. Percentage of fights to CS+, CS-, during the ITI and to shock as a function of sessions during the acquisition and reversal phases. Data were not recorded during the period in which films were taken, although the animals were exposed to the regular conditioning program. No data were recorded for sessions 1-6.
Fig. 5. Percentage of fights to CS+, CS-, during the ITI and to shock as a function of sessions during the acquisition and reversal phases. See text for explanation of the "avoiding" periods.
Fig. 6. Percentage of fights to CS+, CS-, during ITI and to shock as a function during the acquisition and reversal phase. No data were recorded for the first 14 sessions.
versal procedure shows an increase to the new CS-plus and a decrease to the new CS-minus followed by a general decrease in the total fights per session. This decline is unexplained as there was no apparent increase in other escape behaviors or a general decline in the animals' physical condition. (See Figure 6)

It may be noted in Figs. 2 through 6 that the percentage of fights to CS-plus seldom exceeded 50%. While the percentage of fights per session may appear to be low, there was a change in the percentage of fights to the CS-plus within each session. The percentage of fights to CS-plus as a function of 10 trial blocks are presented in Figs. 7, 8 and 9 for pairs #6, #1 and #7. These data were taken from six sessions during acquisition and three sessions during the reversal procedure. The data are typical of all pairs, and indicate a general increase in the percentage of fights to CS-plus as conditioning progresses, and a within session improvement during each session. This between session decrement and within session improvement in the percentage of fights to CS-plus is defined as warm-up. For the last ten trials during each of the later conditioning sessions the percentage of fights to the CS-plus seldom fell below 80%. (See Figures 7, 8 and 9)

Experiment III: This experiment was designed to explore the effects of "free-shock" on the warm-up phenomenon shown in Figs. 7, 8 and 9. The median and mean percentage of fights to the first ten CS-plus trials for all sessions of conditioning and
Figs. 7, 8, and 9. Percentage of fights to the CS\(^+\) as a function of 10 trial blocks. Data represents six sessions during acquisition and three sessions during the reversal phase.
reversal and from the five sessions following the administration of free-shock at each free-shock interval were calculated for pairs #1 and #6. These data are presented in histogram form in Figs. 10 and 11. (See Figures 10 and 11)

The figures show a low mean percentage of conditioned responses to CS-plus during the first 10 trials for all sessions during the acquisition and reversal phase. The administration of "free-shock" prior to the conditioning procedure produced a substantial increase in the mean percentage of conditioned responses only when "free-shock" was delivered at 64 sec. intervals.
Fig. 10. The mean number of fights during the first ten trials of each session for all sessions in acquisition, reversal and the five sessions following each exposure to free-shock for pair #1.
Fig. 11. The mean number of fights during the first ten trials of each session for all sessions in acquisition, reversal and the five sessions following each exposure to free-shock for pair #6.
Mean

Median

Acquisition

Reversal

Free Shock

64 sec.

32

16

8

4

0

10 9 8 7 6 5 4 3 2 1 0

NO. FLIGHTS TO CS+ IN 1ST 10 TRIALS

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DISCUSSION

The use of the discrimination procedure in which the percentage of responses increased to the CS-plus and decreased to the CS-minus, coupled with the successful reversal of discrimination, provides a demonstration of classical conditioning without the possibility of contamination by sensitization. These data taken in conjunction with previously reported studies exploring the effects of auditory stimuli in eliciting aggression (Ulrich and Azrin, 1962; Creer, et al, 1966) and the occurrence of spontaneous aggression (Vernon and Ulrich, 1966) provides a clear demonstration of classical conditioning of pain-elicited aggression, with little possibility of non-associative factors contributing to the measurement of conditioned responses.

The results of Experiments I and II suggest that a combination of longer ITI and CS periods facilitate conditioning. It is apparent from the data of pair #4 that the success of the 16-16 paradigm is not merely a reflection of increased opportunity to respond due to the longer CS, but that a combination of CS with ITI lengths is necessary.

The "warm-up" phenomenon found in this study, characterized by a between session decrement and a within session improvement, has not been previously noted in classical conditioning of aggression literature. Hoffman (1966) reports a very similar warm-up phenomenon in discriminated avoidance behavior. He con-
cludes that:

"the decrement in performance at the start of each session represents a motivational phenomenon; apparently as shocks occur, their motivational after-effects persist and summate to create an emotional state which somehow facilitates avoidance. When, however, the S was removed from the apparatus, this motivational state dissipated and was not reinstated until the S again made contact with aversive stimulation on subsequent sessions."

Hoffman was able to reduce warm-up by the delivery of un-signal ed and inescapable "free-shocks" prior to each session. This shock apparently increased the Ss emotional state to the point at which avoidance was facilitated.

The fact that in the present study warm-up was attenuated by the delivery of free shocks at the 64 sec. interval only opposes a general emotionality interpretation of warm-up. Apparently, shock alone is not sufficient to eliminate warm-up in classical conditioning of aggression. Unfortunately, the present data are not sufficiently complete to supply an alternative interpretation.
REFERENCES


40.

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