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Classical Conditioning of Shock-Elicited Fighting Behavior in Paired Rats

by

Jerry T. Treadway

Thesis

Submitted in partial fulfillment of the requirements for the degree of Masters of Science in Psychology at Kansas State College of Pittsburg

1968

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ACKNOWLEDGEMENTS

I wish to express my debt of gratitude to Dr. Doris M. Sindt who helped direct the research contained in this thesis and to Dr. H. P. Rumford and Dr. C. J. Dellasega who served with her on the thesis committee. In addition, Dr. Bernat Herskovets is gratefully acknowledged for his help in the initial planning of this project.

I would like to thank Dr. Joseph Spradlin, Associate Director, Dr. John Hollis, Research Associate, and Dean L. Fixsen, Research Assistant, of the Bureau of Child Research, The University of Kansas for their advice and support during this research. I would also like to thank Mrs. Cheryl Hurt who typed the manuscript.

I would especially like to thank my wife, Debbie, for her patience, encouragement, and understanding throughout the course of this thesis.

ABSTRACT

The present experiment investigated the effectiveness of two methods of stimuli presentation in classically conditioning shock elicited fighting behavior in paired rats.

The results indicated that fighting responses occurred to the unconditioned stimulus (shock), however, at no time did a fighting response occur to any of the tone-alone test trials.

Therefore, it was concluded from the data in the present study that shock-elicited fighting in paired rats did not appear to be a behavior which could be classically conditioned using either a simultaneous or a random method of stimuli presentation.

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CHAPTER I
INTRODUCTION

Aggression or fighting behavior has been noted in a great variety of complex forms, both in man and in lower animals (Kimble, 1967). Fighting behavior itself, varies with the species involved and the conditions under which it occurs. For the purpose of this study it refers to any striking and/or biting movements made by one organism upon another in a controlled laboratory setting.

The early studies of fighting behavior were of animals fighting in their natural habitat. An observer hidden by a blind or some other obstruction would watch from afar and attempt to determine the variables which related to the particular behavior in question (Kimble, 1967). In the case of fighting behavior, it was noted that territorial encroachment, limited space, and direct attack from predators were environmental factors related to fighting (Scott, 1958). Naturalistic observations such as these are of great importance in providing information which relates to causes and control of fighting behavior. However, the large number of uncontrolled variables existing in a natural setting often make definite statements of causality very difficult. Therefore, a more exact laboratory analysis of fighting behavior and those conditions under which it may be obtained is warranted.

One variable which has been shown to be an effective elicitor of fighting behavior in some species and easily subject to experimental control is electric shock (Richter, 1922; O'Kelly and Steckle, 1939; Daniel,

1943; Ulrich and Azrin, 1962; Azrin, et al., 1964; Ulrich, et al., 1964, Ulrich and Craine, 1964; and Ulrich and Vernon, 1966).

The studies cited above, primarily studied the parameters of shock in eliciting fighting behavior. It was found that intensity, duration and frequency bore a direct relationship to the probability of fighting behavior occurring in response to shock.

One study, in particular, successfully conditioned shock elicited fighting to occur in the presence of a tone stimulus after having been paired with electric shock (Ulrich and Vernon, 1966). However, these authors utilized only one method of conditioning the response, namely, that of preceding the onset of the electric shock with the onset of a tone stimulus both of which terminated together. This method of stimulus presentation is known as forward conditioning, or overlapped stimuli presentation (see Appendix A, Figure 1). Ulrich and Vernon (1966) having used only one method of stimuli presentation opened many questions concerning how crucial the method of stimuli presentation is in successfully conditioning the fighting response. Also, the Ulrich and Vernon (1966) study lacked a random stimuli presentation group to control for pseudoconditioning.

The present study is an attempt to test the effects of a different method of stimuli presentation in conditioning the fighting response.

Statement of the problem. The problem was to determine if the fighting response could become conditioned to occur in the presence of a tone stimulus when a simultaneous stimuli presentation method was employed with paired rats.

Need for the study. It has been the aim of previous investigators to examine many variables related to shock elicited fighting. However, very few studies have been concerned with classically conditioned fighting behavior in paired rats. A recent study, reported by Ulrich and Vernon (1966), successfully conditioned the fighting response in rats using a forward conditioning procedure (see Appendix A, Figure 1). However, the Ulrich and Vernon (1966) study gives rise to the question of whether the method of stimuli presentation is a crucial variable.

It was to this question that the present research was directed. A random stimuli presentation group was included in the present study to control for pseudoconditioning, a control not present in the Ulrich and Vernon (1966) study.

Hypotheses of the problem. There were two hypotheses tested in the present study.

Hypothesis I. The hypothesis in the present study was that there would be no statistically significant differences in the frequency of fighting responses occurring to a tone stimulus between Group I (simultaneous stimuli presentation) and Group II (random stimuli presentation).

Hypothesis II. The hypothesis in the present study was that there would be no statistically significant differences in the frequency of fighting responses occurring to a tone stimulus within Group I or Group II.

Limitations. This study was limited in the following ways:

(1) All the subjects in this experiment were Sprague-Dawley rats of the Holtzman strain which were known to be more docile than rats of other strains (Azrin, et al., 1964).

(2) All the rats were raised and maintained in a laboratory setting extending from birth through the experiment.

(3) The rats used in this experiment were all female rats.

(4) The number of rats used in the experiment may have been a limiting factor in that a larger amount of rats may have yielded more statistically significant results.

(5) The dimensions of the experimental chamber was a limiting factor in that limited space has been shown to be a crucial variable in the probability of eliciting fighting responses (Azrin, et al., 1964).

(6) The study of fighting behavior in a laboratory setting was a limiting factor in that such behavior may differ from that brought about by conditions existing in the rats "natural" environment.

(7) The use of human observers in recording aggressive or fighting responses was also a limiting factor in that some responses may have been arbitrarily designated as aggressive.

(8) The physiological condition of the rats were not ascertained as to disease or brain damage.

Definition of terms. This section contains a list of definitions of the most important terms used in the problem. For the most part, however, an attempt was made to define the terms as they occurred in the text.

(1) Fighting responses. For the purpose of this study, a fighting response was defined as any striking or biting movement of either or both animals toward the other while in the experimental chamber. A new response was recorded only for those striking movements which were separated from previous striking movements by approximately one second.

(2) Stereotyped fighting posture. This was defined as when one or both rats would suddenly face each other in an upright position, with head thrust forward and the mouth open (see Appendix A, Figure 2).

(3) Shock stimulus (unconditioned stimulus). Shock was defined as an electric shock developed by a 115 VAC scrambled electric shock source passed through a resistance of zero K ohms placed in series with the subjects. The result was a constant current shock with an output of 2.0 millamperes for a duration of .5 seconds (after Ulrich and Vernon, 1966).

(4) Tone stimulus or conditioned stimulus. This was defined as an electrically generated tone of 60 db at 1320 cycles per second (after Ulrich and Vernon, 1966).

(5) Pseudoconditioning. 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. It differs from conventional conditioning in that the response which is strengthened is appropriate to the conditioned stimulus, not to the unconditioned stimulus (Hilgard, 1961).

(6) Variable interval schedule of presentation (VI-10"). This was defined as a series of intervals of differing length with a mean of 10 seconds over each 30-minute session.

(7) Simultaneous stimuli presentation. This was defined as both tone and shock occuring together and terminating together.

(8) Overlapping stimuli presentation. This was defined as a varying temporal relationship existing between two stimuli.

(9) Unconditioned response. This was defined as the regular and measurable response to the unconditioned stimulus.

(10) Conditioned response. This was defined as a response which appears or is a modified consequence of the occurrence of a conditioned stimulus in proximity to reinforcement.

CHAPTER II

REVIEW OF THE LITERATURE

Several investigators have noted the relation of pain to aggression while pursuing other studies (O'Kelly and Steckle, 1939; Daniel, 1943; and Richter, 1922). In the study by O'Kelly and Steckle six rats were placed in an experimental chamber where periodic shocks were delivered through a floor grid. Although the rats had been docile prior to the delivery of shock, they immediately stood up, faced one another and struck vigorously once it was presented (Kimble, 1966).

Other investigators have shown that shock, elicited fighting behavior in rats both wild and domestic (Covain, 1949) as well as domestic mice (Tedeschi, et al., 1959). In each of these studies, however, the relation of pain to aggression was an incidental observation (Kimble, 1966).

An early example of the pain-aggression phenomena was reported by Ulrich and Azrin in 1962. In this experiment, paired rats were placed in an experimental chamber and observations were made of their behavior prior to the delivery of shock to the feet of the animals. At no time during this period did any fighting appear. Soon after shock was delivered, however, a drastic change took place in the rats' behavior. They would suddenly face each other in an upright position and, with mouths open, strike out at one another.

In the same experiment by Ulrich and Azrin, it was found that certain aspects of fighting between rats occurred as a nonmonotonic function of shock intensity (Ulrich & Azrin, 1962). These authors paired six rats and exposed them to various intensities of shock at a fixed frequency of 20 shocks per minute. Increasing the shock intensity from 0 to 2 milliamperes (ma) produced an increased frequency of fighting; at still higher intensities (3 to 5 ma) the rate of fighting was somewhat reduced. These authors argued that the reason the decrease in fighting behavior occurred at the highest intensity, that is 5 ma, appeared to be partly a consequence of the debilitating effects of the shock. Prolonged exposure to this intensity often resulted in a complete loss of fighting because of paralysis of one or both of the subjects. It was also noted that during the initial exposure to the very high intensity shock, fighting behavior appeared to be reduced by a tendency of the rats to engage in other shock-elicited behavior, such as biting the grids, jumping, running, or pushing on the walls of the experimental chamber. Thus, Ulrich and Azrin's results indicated the optimum current intensity for eliciting fighting was approximately 2 milliamperes.

Tedeschi, et al. (1959), in a similar study obtained results comparable to those found by Ulrich and Azrin in that he also found 2 to 3 milliamperes shock intensity to be optional for producing fighting between mice.

In addition to its relationship to shock intensity, the elicitation of the fighting reflex was also found to occur as a direct function of the

frequency of shock presentations. Ulrich and Azrin (1962) found that the more often the shock was presented, the more often the subjects fought. Shock frequencies in excess of six per minute produced fighting in response to 82-93% of the shocks. Shock frequencies of less than 1 per minute produced fighting to no more than 68% of the shocks. These authors noted that fighting responses were more likely to occur if the animals were facing each other at the moment when shock was delivered. Hence, at the lower frequencies the animals had sufficiently more time to slip out of the fighting posture and assume other positions. Thus, the probability of fighting appeared to be lower at the lower frequencies of shock presentations because of the increased likelihood for other behaviors incompatible with fighting to occur. When shocks were presented so frequent as to be continuous the fighting behavior decreased rapidly being replaced by what these authors described as "escape" behavior, i.e., attempts to escape from the experimental chamber. This "escape" behavior was also noted during the early part of the session when the subjects were first presented with shock. The optimum frequency of shock presentation for eliciting fighting behavior between rats appeared to be approximately 30 to 40 shocks per minute, but this frequency may be specific to rats (Ulrich, 1962). Lower frequencies have been found to be effective in species whose fighting tends to persist long after the shock has been presented (Azrin, Hutchinson, and Hake, 1963). Another study by Hutchinson (1965) also indicated the optimum frequency for shock-elicited fighting to be 30 to 40 shocks per minute.

In another study by Azrin (1964), fighting was found to be a direct function of the duration of the shock, the longer the duration of shock the greater the probability of fighting. The results of this study indicated that shock delivered for a duration of .075 seconds elicited fighting responses to about one-fourth of the shocks presented. At .5 seconds duration, 90% of the shocks elicited fighting. At 3.0 seconds, the longest duration used, fighting occurred after almost every shock. However, at the longest duration, the shocks elicited progressively less fighting responses after repeated presentations until percentage of fighing responses declined to a mere 40%. On the other hand, however, the briefer shock durations increased rather than decreased in effectiveness as a function of repeated deliveries. It was also observed that the longer durations gave ample opportunity for the rats to acquire postures and movements such as jumping, which reduced the receipt of shock. These escape attempts, as was noted earlier, appear to compete with the fighting reaction. The shorter shock durations did not appear to produce such attempts to escape. It was further noted that the longer shock durations may have indirectly reduced the likelihood of fighting by physically weakening the rats. Therefore, the optimal duration of shock for continued elicitation of fighting appears to be about .5 seconds duration (Azrin, et al., 1964).

In other studies the method of shock presentation has been found to be critical (Skinner, 1947). Failure to scramble the polarity of the electrified grids produced inconsistency in fighting. Many early investigators of shock elicited fighting used a type of shock circuit in which alternative bars on the floor grid were wired in parallel. Such a design permits the animal to avoid shocks by standing on bars of the same polarity and may account for the frequent failure of shock to elicit fighting behavior reported by other investigators (Miller, 1948; Richter, 1922).

Another form of aversive stimulation which has proved to be an effective elicitor of fighting is electrode shock. In a study by Ulrich, 1962, electrodes were implanted beneath a fold of skin on the back of a single rat. A harness and swivel arrangement allowed the animal complete freedom of movement. When a shock was delivered to a single rat a spasmodic movement of the rat resulted when no other rat was present. When the shock was delivered in the presence of a second rat, however, the stimulated animal usually assumed the stereotyped fighting posture and attacked the unstimulated rat. Upon being attacked, the unstimulated rat, in turn, often assumed the stereotyped posture and returned the attack (Ulrich, Wolff, and Azrin, 1964).

In addition to shock being an effective elicitor of fighting behavior, other conditions which elicit fighting have been investigated (Ulrich, 1962). In an experiment designed to ascertain the effectiveness

of intense heat as an elicitor of fighting behavior, a pair of rats was placed in an experimental chamber with a thin metal floor that could be heated from below by a heating coil. After the heating coil was energized, the metal floor became progressively hotter until the two rats were observed to jump about the floor and to lick their feet. No fighting was observed to occur under these conditions. However, when the same pair of animals was later placed on a preheated floor, fighting consistently resulted. These results were replicated using additional rats.

The failure of the gradual presentation of heat to produce fighting was attributed to the reinforcement of competing behavior, especially licking of the fore paws. The wetting of the paws may have been effective in cooling the animal at the initially lower temperature of the gradually heated floor but not at the high temperature of the preheated floor. Once fighting was elicited by a preheated floor, subsequent exposure to a gradually heated floor did elicit some fighting and the competing licking behaviors were reduced.

In view of the effectiveness of intense heat in eliciting fighting behavior, Ulrich, in the same study, investigated the effects of intense cold as a possible condition for producing fighting responses. However, no fighting was observed to occur when paired rats were placed on a sheet metal floor pre-cooled by dry ice. Ulrich reasoned that it was possible that the temperature induced by the dry ice was

not sufficiently aversive. Also, since the animals were consistently moving about, it was thought to be quite likely that the animals did not allow a given paw to remain in contact with the cold floor for a sufficient period of time (Ulrich, 1962).

Intense noise likewise was found to be ineffective in producing fighting behavior between paired rats. The noise was at an intensity of 135 decibals (re 0.0002 dyne/cm^2) and enclosed a band from 200-1500 cps. The delivery of noise was varied from brief bursts of less than one second to periods of more than one minute. No fighting resulted (Ulrich, 1962).

In a study by Azrin, Hake, and Hutchinson (1964), the delivery of a painful physical blow was found to be an effective elicitor of fighting behavior. Monkeys held tightly in restraining chairs were subjected to a blow on the tail. It was found that attack against a ball hanging just in front of the monkey occurred as a direct consequence of the blow.

The operant conditioning of fighting behavior has received little attention. However, Miller (1948) was able to condition fighting behavior in paired rats by making fighting contingent upon shock removal. However, these results may be confounded by the fact that shock is known to be an elicitor of fighting behavior regardless of the contingencies for its removal, hence fighting may have been produced whether the shock was terminated or not.

In a similar study by Ulrich (1963) water deprived rats were paired with non-deprived rats and placed in an experimental chamber in which the water deprived animal was given water whenever it approximated an attack response on the other animal. The results showed that fighting behavior can be operantly conditioned in rats through the use of water reinforcement.

Another study by Azrin (1964) obtained fighting behavior in the extinction of an operant response. In that study, a pigeon was conditioned to peck at a key by making food available immediately after the peck. After the response was well established, the food-deprived bird was placed on a schedule in which food reinforcement was given after each of 20 pecks. Following the 20 reinforced pecks the bird was placed on an extinction schedule in which none of the pecks resulted in food delivery. It was noted that when no other animal was present in the experimental chamber, the bird emitted a flurry of responses, which is typical following the initiation of extinction. However, when another pigeon was located nearby, the behavior changed and the hungry bird would instead rush over to the other pigeon and begin attacking its head. Thus, from these results it appears that situations which involve no physical painful stimulation will produce fighting behavior upon the termination of a favorable schedule of continuous reinforcement.

Azrin, Hutchinson and Hake (1966), in a similar study with pigeons obtained results comparable to the earlier study. These

authors suggested on the basis of their results that schedules of reinforcement may produce fighting behavior as a by-product that is not apparent when the individual subject is studied in isolation.

Still another condition that was found to produce fighting behavior was intermittent reinforcement of a concurrent operant response. Hutchinson, Azrin, and Hunt (1968) trained squirrel monkeys to press a lever for food pellets delivered on various fixed-ratio schedule. Biting attacks on a rubber hose could be recorded simultaneously during each of the different schedules. Occasionally, subjects were exposed to extinction. The results indicated extinction after intermittent reinforcement produced recurring attack episodes lasting hours and weeks. This finding extends the results reported earlier by Azrin, et al. (1966), demonstrating that the effect occurs in primates as well.

There are several variables that play a part in the elicitation of pain-aggression as well as some that do not. Those variables in the latter category are; sex of the subject, whether more than two animals are subjected to painful stimulation, previous experience of the animals, and number of presentations of aversive stimuli.

Fighting elicited by painful shock to the feet occurs in and among rats of both sexes. Moreover, sexual behavior tends to be completely displaced by fighting under these circumstances. Unlike

"natural" fighting behavior, reflexive fighting behavior does not appear to be appreciably affected by sexual differences (Ulrich and Azrin, 1962). Similarly, shock elicited fighting occurs when more than two rats are shocked simultaneously. The usual stereotyped fighting response was found to occur although two or more rats sometimes attacked a single rat (Ulrich and Azrin, 1962; Antal and Kemeny, 1964).

Previous experience was not found to appreciably effect the elicitation of fighting through foot-shock (Ulrich and Azrin, 1962). On the other hand, nonreflexive fighting behavior has been found to be affected by previous familiarity (Seward, 1945).

Ulrich and Azrin (1962) in the same study, found that increasing numbers of aversive stimuli have little or no effect upon the rate of fighting. Frequent shocks were delivered to pairs of rats for an uninterrupted period of 7.5 hours. Over 10,000 fighting responses occurred without a noticeable reduction in rate.

The amount of fighting between rats in response to shock was found to depend upon the amount of floor space available. With only a very small amount of floor space (6 by 6 inches) the fighting response was elicited by approximately 90% of the shocks. At the larger floor areas, the number of fighting responses decreased; with the largest floor space (24 by 24 inches), only 2% of the shocks elicited fighting. The amount of fighting between rats in response to shock appears to depend critically upon the amount of floor space in the fighting chamber.

It was observed that when the rats were only a few inches apart, the shock was likely to cause them to turn and lunge at each other. At the larger distances, the rats largely ignored each other (Ulrich and Azrin, 1962).

Another variable related to shock-elicited fighting was time since shock. The temporal course of a given aggressive display was determined in a study by Azrin (1964). In this study, it was shown that the probability of attack gradually diminished immediately after shock until it reached zero some moments later. Thus, it was determined that there was an inverse relationship between the time elapsed following the painful stimulus and the probability of an attack response.

Ulrich and Azrin (1962) also investigated the differential effects shock might have when presented to different strains of rats. Four strains of rats were studied in addition to the Holtzman Sprague-Dawley rats. Those studied were; Long-Evans hooded, Wistar, General Biological hooded, and Charles River Sprague-Dawley rats. The results indicated that the same stereotyped fighting reaction occurred following the presentations of shock. However, it was noted that less than 50% of the shocks produced fighting between rats of the Wistar strain, whereas over 70% of the shocks produced fighting between rats in each of the other strains.

In the same study (1962) by Ulrich and Azrin, different species of animals were studied to determine if the shock-fighting phenomena

could be obtained with guinea pigs, and hamsters. These subjects were exposed to the same experimental conditions under which the rats had been exposed. Delivery of shock to a pair of hamsters produced a similar type of stereotyped fighting posture and attack as was seen with rats. However, it was found that the fighting response could be consistently elicited at lower intensities of shock (0.75 ma) than was required with the rats. Also, the hamsters were observed to persist longer in their fighting. In contrast, the paired guinea pigs were never observed to display the fighting posture or any fighting behavior in response to the shock. Variations in shock intensity and frequency did not alter this failure to fight. When a Sprague-Dawley rat was paired with a hamster, shock produced the same fighting reaction by both animals. However, when a rat was paired with a guinea pig, all of the attacking was done by the rat. The guinea pig was observed to react only by withdrawing from the rats biting attack following the delivery of shock.

In addition to the species of animals previously mentioned the fighting reflex has also been found to occur in paired snakes, turtles, chickens, raccoons, and opossums (Ulrich and Azrin, 1962; Azrin and Hutchinson, 1963; Azrin, Hutchinson and Hake, 1963; Ulrich, Wolff, and Azrin, 1964). It was noted that both monkeys and cats often fought until forcibly separated; unless precautions were taken they would frequently inflict serious injury to one another (Azrin, Hutchinson and Hake, 1963).

One final variable studied was the reaction of a shock stimulated rat when an inanimate object, a doll, was placed in the experimental chamber (Ulrich and Azrin, 1962). The results indicated that no attack was attempted. Similarly no attack movements were made toward either a conducting doll or a recently deceased rat. Dolls moved rapidly about the cage also failed to produce fighting. Fighting responses were elicited only when the dead rat was moved about.

Only a few studies have been found in the literature Brierton, Ulrich and Wolff (1964) which have attempted to classically condition the fighting response in rats. The results indicated that although the stereotyped fighting posture occurred quite frequently, only occasionally did the fighting response itself occur to the conditioned stimulus. Another study by Azrin (1964) attempted to classically condition the fighting response to occur in the presence of a buzzer alone. The subjects used were monkeys and chickens. The results were similar to the Brierton, et al. (1964) study. In contrast, Ulrich and Vernon (1966) successfully conditioned the fighting response to occur in the presence of a tone stimulus. These authors first established that the tone stimulus would not elicit any fighting responses prior to receiving a shock. Then the paired animals were given 2000 pairings of the tone with 2 milliamperes of shock. Duration of the tone hereafter referred to as the conditioned stimulus was 1.0 second. One-half second after onset of the conditioned stimulus this stimulus

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was joined by shock, hereafter referred to as the unconditioned stimulus, both terminating simultaneously after 0.5 second. This method of presentation is referred to as overlapping conditioned stimulus and unconditioned stimulus (Hilgard, 1961). The onset-to-onset interval between trials of the conditioned stimulus was 10 seconds. Each 11th presentation was the conditioned stimulus alone, this being a test for the development of the conditioned fighting response. Fighting responses were defined as any striking and/or biting movement made by either or both animals toward the other. Fighting responses were recorded by an observer who depressed a microswitch indicating that a response had been made. Usually, fighting responses were made from a stereotyped fighting posture on the hind legs, which the animals typically maintained through most of each session (See Figure 2). The findings of this study suggest that through the use of a Pavlovian conditioning procedure, a fighting response can be produced in paired rats as a response to a tone stimulus.

Pavlov (1927), on the basis of research conducted in his own laboratory, concluded that conditioned reflexes could be formed when the conditioned stimulus preceded the unconditioned stimulus by a short interval or was synchronous with it.

In a study by Wolfe (1930, 1932), finger retraction to a shock stimulus was most effectively conditioned when the conditioned stimulus preceded the unconditioned stimulus by approximately .5 seconds, however, when both stimuli occurred simultaneously there was relatively little conditioning.

In a similar study by Spooner and Kellogg (1947) forward conditioning was found to be far superior than the simultaneous and backward methods of stimuli presentation. However, some conditioning did occur using the simultaneous stimuli presentation method.

Bitterman (1964) investigated the relative ease of conditioning as a function of the conditioned stimulus and unconditioned stimulus interval. The subjects used in the study were goldfish which learned to swim over a hurdle when a light was presented in order to avoid receiving a shock. The results indicated that forward conditioning was the most effective, simultaneous presentation was somewhat effective and backward conditioning least effective. These results are consistent with the results obtained by the previously mentioned investigators.

Characteristic of the studies cited is the fact that most of them involve an unconditioned response which usually involved some relatively minor muscular movement (Wolfe, 1930; Spooner and Kellogg, 1947) or glandular secretions (Pavlov, 1927). These responses are quite different from the complex response(s) involved in the shock-elicited fighting phenomenon. As reported earlier, Ulrich and Vernon (1966) successfully conditioned the fighting response when using a forward (overlapping) stimuli presentation method. However, Ulrich and Vernon demonstrated only one classical conditioning procedure was effective in establishing the fighting response, that is the conditioned and unconditioned stimuli were presented in an overlap manner (forward conditioning).

The studies previously cited have investigated many of the parameters involved in the shock elicited fighting phenomenon as well as those variables involved in the conditioning phenomenon itself. However, the results obtained concerning classically conditioned fighting behavior must be interpreted as being somewhat inconclusive.

Thus far, there has been very little research reported concerning the variables underlying human aggression. Only one such study was found in the literature. Elbert and Ulrich (1966) conducted a study concerned with frustration produced aggression in children. The subjects in that study were four, 10-year old school children. Each subject was given the task of stacking 10 bottle stoppers into 2 stacks of 5 each. When the subjects completed this task successfully, a dime was delivered as reinforcement. At the beginning of the experiment the task was explained to each subject. In addition, the subjects were told that another hypothetical subject in another room was engaged in the same task. The hypothetical subject supposedly had in his room a button which he could push, causing the top of the subject's table to vibrate, upsetting his stack and depriving him of reinforcement. The actual subject also had a button which he could press, supposedly to shake the hypothetical subject's table. Presses on this button were recorded.

After the subject's stacking behavior was well established, the experimenters who observed the subject from behind a one-way mirror would occasionally introduce vibrations of the table.

Results indicated that in all cases aggressive responses increased after the vibrations were introduced. However, a wide variation from subject to subject in button pressing rate both before and after the vibrations was noted. Also, some of the children indicated, in interviews conducted after the session, that they had not pushed the button as much as they would have liked, since they had been taught that such behavior was wrong (Elbert and Ulrich, 1966).

CHAPTER III

METHOD

Subjects

Twelve female albino Sprague-Dawley rats of the Holtzman strain served as subjects in the experiment. Using a table of random numbers, the rats were chosen from a total population of 30, maintained by the Psychology Laboratory at Kansas State College of Pittsburg. All the subjects were experimentally naive at the beginning of the experiment. At the beginning of the experiment all the subjects were approximately 200 days old and weighed between 325 and 400 grams.

Apparatus

The experimental chamber consisted of plexiglas 1/4-inch thick measuring 10 by 4 by 12 inches high (inside dimensions). The "floor" consisted of 18 stainless steel rods (3/32-inch in diameter) and spaced 1/2-inch apart and placed across the 4-inch width of the chamber. The clear plexiglas sides of the chamber allowed viewing of the interior of the chamber. A shielded, 10-watt bulb at the top of the chamber provided illumination, and a speaker produced a "white" masking noise. The room temperature was maintained at about 75-degree Farenheit.

Stimulus Components

Tone Stimulus. The tone stimulus was an electrically generated tone of 60 decibals at 1320 cycles and programmed through a Foringer type relay rack.

Shock Stimulus. The shock was developed by a 115 VAC scrambled electric shock source passed through a resistance of five-hundred thousand ohms placed in series with the subjects. The result was a constant current shock with an output of 2 millamperes.

Recording Equipment. The subjects' responses were recorded by two observers who depressed a microswitch, indicating on a Gerbrands Cumulative Recorder, and a counter, that a fighting response had been made by the paired rats. This recording equipment also recorded onset of both stimulus components.

Programming Equipment. All time and stimulus programming was automatically controlled from a Foringer type relay rack consisting of an arrangement of relays, timers, counters, alternators and stepping devices.

Design

A two group design using randomly paired subjects was used in the present study. A Schematic of the design is shown in Appendix A, Figure 3. One group was given the syncronous stimuli presentations, hereafter referred to as Group I, while the remaining group was given random stimuli presentations, hereafter referred to as Group II.

Procedure

Prior to the first day of experimentation the 12 subjects were randomly divided into two groups. Then the six pairs of subjects were again randomly divided into three additional pairs using a table of random numbers (Edwards, 1964). There were three phases to which all pairs were exposed.

Baseline phase. During the baseline phase (2 experimental sessions) each pair of subjects was randomly taken from its respective home cage and placed in the experimental chamber. Each pair was in the chamber for thirty minutes with neither the shock nor the tone present. Two observers recorded any fighting responses that occurred during the session. This was done by depressing a microswitch which indicated the response on a cumulative recorder and a counter. Data obtained during the baseline phase served to indicate the frequency of fighting responses made by the paired subjects before any experimental variables were introduced.

Tone stimulus presentation phase. During the tone stimulus presentation phase of the experiment (2 experimental sessions), each pair of subjects was placed in the experimental chamber. During this phase the tone stimulus was introduced on a variable interval 10 second schedule of presentation. The data obtained during this phase was

taken by two observers using the same method outlined in the baseline phase of the experiment. The data during this phase of the experiment indicated any eliciting properties the tone stimulus might have prior to electric shock. This phase controlled for sensitization to the tone stimulus.

Conditioning phase. During this phase, the paired subjects in the experimental group were placed in the experimental chamber. The tone stimulus was presented simultaneously with the shock stimulus for .5seconds. This is simultaneous stimuli presentation (see Appendix A, Figure 1). Both stimuli were presented on a variable inter 10 second schedule of presentation. Each 11th presentation was the tone stimulus alone; this being a test for the development of the conditioned fighting response (after Ulrich and Vernon, 1966). The acquisition criterion was set at 70% occurrence of the response to the tone stimulus. In the event that acquisition criterion was not met, a limit of 2000 tone and shock presentations was set to terminate this phase (Ulrich and Vernon). Two observers recorded fighting responses as they occured during the session in the same manner as described above.

During this phase, the subjects in Group II were given identical conditions with the exception that the tone and shock stimuli were being presented independent of each other, that is, totally at random. This added control was applied because there was no such control in

the Ulrich and Vernon (1966) study. The data obtained during this phase from the control group served to indicate any pseudoconditioning that might have occurred. The data from this group was used for a direct comparison with the experimental group in which the stimuli presented were temporally related. Fighting responses were recorded in the manner described above. Acquisition criteria were the same for this group as the experimental group.

Extinction. Extinction criterion was set to equal the rate of responding observed during the Baseline Phase. This phase was employed when the data in the preceding phase surpassed the criterion set for acquisition. However, the data obtained during the preceding phase did not surpass the criterion hence implementation of extinction was not warranted.

CHAPTER IV

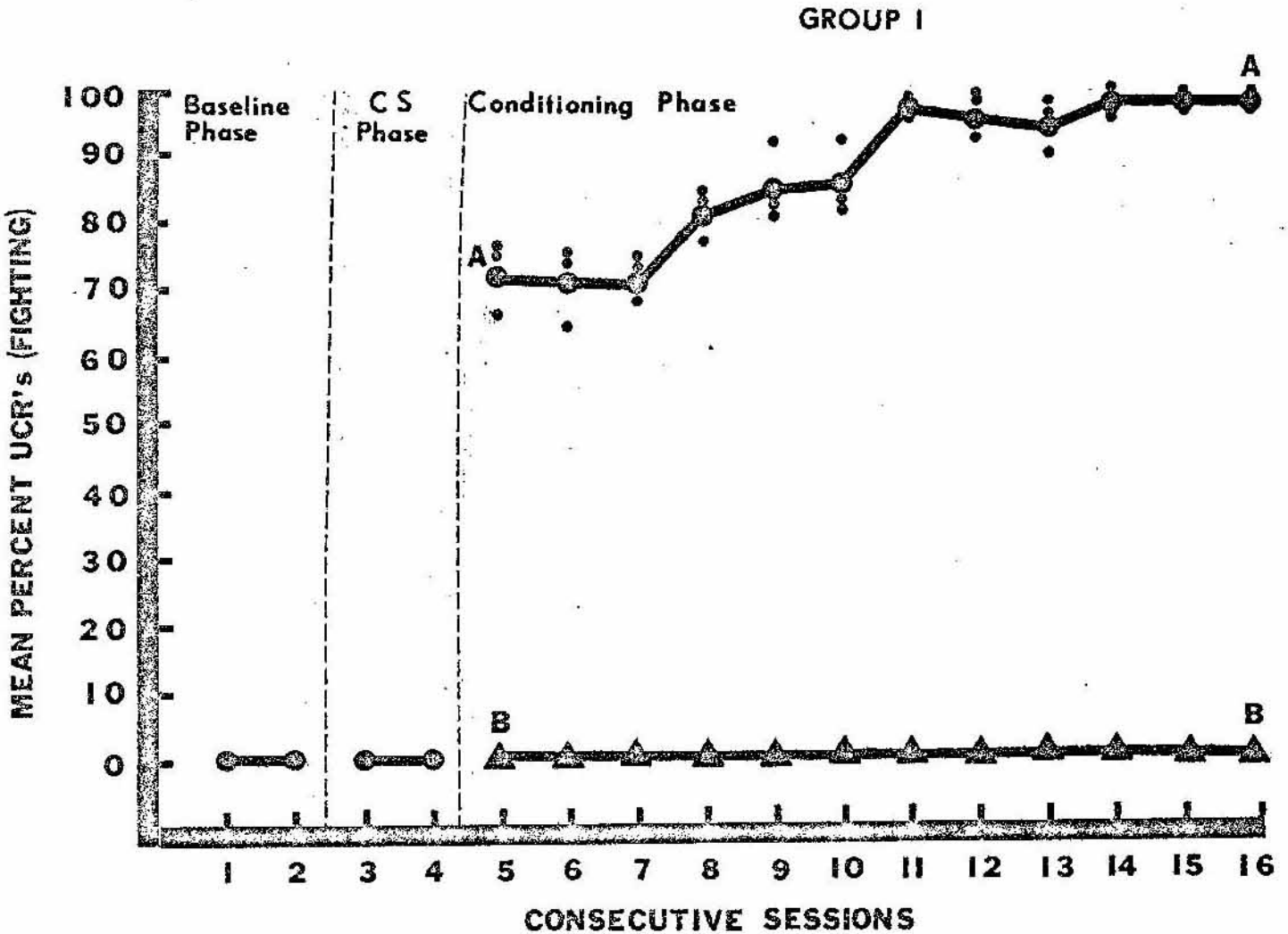
RESULTS AND DISCUSSION

A check on inter-observer reliability revealed that the number of fighting responses recorded by the two observers agreed an average of 98 per cent over the entire experiment with a range of 95 to 100 per cent extending over the 16 individual sessions. Individual and group mean percentages are presented in Appendix B, Tables 1 and 2.

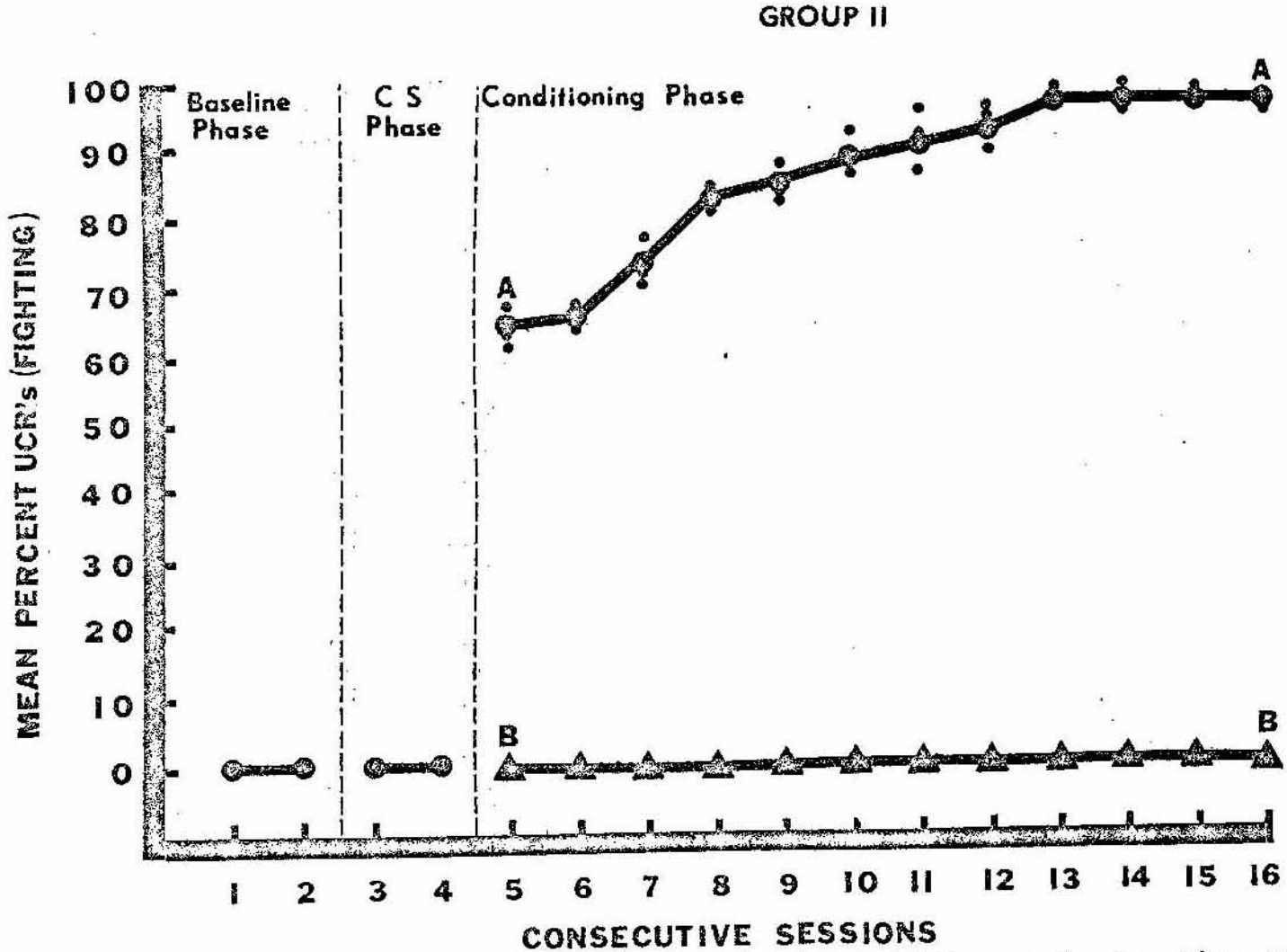
As shown in Graphs 1 and 2 the results obtained during the Baseline Phase indicated that at no time did a fighting response occur for any pair of subjects in either Group I or Group II. These data are consistent with those obtained by Azrin and Ulrich, 1962; and Ulrich and Vernon, 1966, which indicated that the fighting response for paired rats was a low probability behavior prior to the administration of an experimental treatment.

Graphs 1 and 2 also show that the introduction of the tone stimulus (CS Phase) did not produce any fighting responses in any of the paired rats. These data too are consistent with those obtained by Ulrich and Vernon (1966).

Line A of Graphs 1 and 2 also show that the introduction of the unconditioned stimulus (shock) during the conditioning phase produced an obvious departure from the zero level of responding observed during the first two phases. Although there was some variability about the group means, approximately 70 per cent of the



GRAPH 1. After initial Baseline and CS Phases demonstrated that no fighting was developed by neither the experimental chamber nor the tone (CS) alone; tone(CS) plus shock(UCS) were instigated(Line A). Individual (small symbols) and mean (large symbols) are shown for each block of 162 shock (UCS) presentations. Triangles, (Line B) represent percentage of fighting responses (CR's) that occurred to the tone (CS) alone, in blocks of 18 presentations (test trials).



GRAPH 2. After initial Baseline and C S Phases demonstrated that no fighting was developed by neither the experimental chamber nor the (CS) alone; tone (CS) and shock (UCS) were instigated independent of each other (Line A). Individual (Small symbols) and mean (large symbols) are shown for each block of 162 shock (UCS) presentations. Triangles, (Line B) represent percentage of fighting responses (CR's) that occurred to the tone (CS) alone, in blocks of 18 presentations (test trials).

unconditioned stimuli presented during the first three sessions elicited an unconditioned fighting response (UCR) for both groups. Following these three sessions, an increasingly higher percentage of unconditioned responses were elicited by the unconditioned stimuli until the elicitation rate stabilized at near 96 per cent over the last four sessions for both groups.

These data replicate earlier studies (Azrin, et al., 1964; Ulrich and Azrin, 1962) that used similar parameters of shock, experimental space, and subjects. That is, these studies also obtained a gradual increase in elicitation rate over trials with a terminal rate over trials near 90 per cent.

Gross observation of the subjects during the course of the experiment revealed that the observed increase in elicitation rate may have been due to a corresponding decrease in the amount of other shock produced behavior (for example, jumping, clawing at the sides of the experimental chamber, etc.). The "other shock produced behaviors," however, were not quantitatively measured and are presented here only as a qualitative observation that may account for the observed increase in fighting behavior.

The data points on Line B of Graphs 1 and 2 show the percentage of fighting responses that occurred for Groups I and II during the tone stimulus test trials in which the UCS (shock) was not present.

As can be seen in these Graphs, absolutely no conditioned fighting response occurred during any of the test trials for either Group I (simultaneous) or Group II (random).

These data are consistent with those obtained by Brierton, et al., (1964) and Azrin (1964) which also showed a lack of conditioned responding. In contrast, however, these data are not consistent with those obtained by Ulrich and Vernon (1966). Since the present study was procedurally similar to the Ulrich and Vernon (1966) study, the inconsistency in the obtained results may be due to the different methods of stimuli presentation used in the two studies. Ulrich and Vernon used a forward conditioning paradigm in which the onset of the conditioned stimulus preceded the onset of the unconditioned stimulus by 0.5 seconds; (see Appendix A, Figure 1). The present study, however, used a simultaneous conditioning paradigm in which the conditioned and unconditioned stimuli appear and go off together (see Appendix A, Figure 1). The difference in obtained results, then may be explained in terms of the different conditioning paradigms used.

This explanation gains credibility when other studies using similar paradigms are considered. The results of a study by Wolfle (1930; 1932), shown in Figure 4 (Appendix A), clearly indicate the forward conditioning paradigm to be superior to the syncronous paradigm. Further

support is supplied by the results of a study by Spooner and Kellogg (1947), shown in Figure 5 (Appendix A). In this study too, forward conditioning was superior to synchronous conditioning. While the results obtained by Wolfle (1930; 1932) and Spooner and Kellogg (1947) show the superiority of forward conditioning, they also show at least some conditioning resulting from the simultaneous paradigm. In the present study, however, no conditioned responses occurred over a series of 216 test trials. The results obtained in the present study, then, lend support to the results obtained by Brierton, et al., (1964) and Azrin (1964) which also showed a lack of conditioned fighting responding.

General Discussion

While interspecies differences in pain (shock) elicited fighting have been found, it may be said that interspecies similarities are stronger (Ulrich, 1966). The fact that shock elicited fighting (aggressive behavior) has been observed to occur and to follow similar laws in such widely ranging species as rats, pigeons, and monkeys suggests that the interspecies generality of the phenomenon may extend even to humans (Ulrich, 1966). Thus, it is possible that pain may be a source of human aggression.

Recent research seems to confirm the hypothesis that pain may be a source of human aggression. As previously cited, Elbert and Ulrich (1966), conducted a study concerned with frustration produced aggression in children. The results indicated that in all cases aggressive responses increased after the frustration variable was introduced.

Studies such as this show that the objective study of complex human aggression is possible. Of course, the moral, ethical and practical difficulties in studying aggression in humans are great indeed. Yet, as knowledge of aggression in lower animals progress and as more feasible methods of studying aggression in humans are developed, it is entirely possible that some of the variables may become clear which initiate, maintain and eliminate aggression in humans.

CHAPTER V

SUMMARY, CONCLUSIONS, AND IMPLICATIONS FOR FURTHER RESEARCH

Summary. The present experiment investigated the effectiveness of two methods of stimuli presentation in classically conditioning shock elicited fighting behavior in paired rats. The subjects, 12 female albino rats, were divided into two groups. One group was given a simultaneous method of stimuli presentation while the other group was given a random method of stimuli presentation.

Data were obtained by two observers, who depressed a micro-switch which indicated on the recording equipment that a fighting response had been made by one or both of the paired animals.

The results obtained show that while fighting responses occurred quite frequently to the unconditioned stimulus (shock), at no time did a fighting response occur to any of the tone-alone test trials.

Hence, it was concluded from the data in the present study that shock elicited fighting in paired rats did not appear to be a behavior which could be classically conditioned using either a simultaneous or a random method of stimuli presentation.

These results were found to be in general agreement with the results obtained by other investigators.

Conclusion. Both Hypothesis I, which stated that there would be no statistically significant differences in the frequency of fighting responses occurring to a tone stimulus between groups, and Hypothesis II, which stated that there would be no statistically significant differences within groups, were retained. These results, then, permit the following conclusions:

(1) That classical conditioning of shock-elicited fighting behavior in paired rats did not occur as a function of using a simultaneous method of stimuli presentation.

(2) That classical conditioning of shock-elicited fighting behavior in paired rats did not occur as a function of using a random method of stimuli presentation.

Implications for Further Research. The interval or temporal contingency existing between the conditioned and unconditioned stimulus has been found by other investigators (Wolfle, 1930; 1932; Spooner and Kellogg, 1947; and Bitterman, 1964) to be a very crucial variable in classical conditioning. Thus far, only one study reported in the literature has been able to successfully condition the fighting response in paired rats (Ulrich and Vernon, 1966). Brierlon, et al. (1964) and Azrin (1964), like the present study, were unable to successfully condition the fighting response in paired rats. Therefore, a series of studies, attempting to condition the fighting response

using a variety of conditioning procedures would be warranted. Possibly the results of such experimentation would answer the still unanswered questions of what particular conditioning procedures are most effective and the more basic question of whether in fact the fighting response itself can be classically conditioned. The evidence to date does not provide data from which this question can be conclusively answered.

Furthermore, the effectiveness of using different stimuli as the conditioned stimulus has not been investigated. That is, would a tactill stimulus prove more effective as a conditioned stimulus than an auditory or visual one?

Finally, other parametric studies in the area of classical conditioning of shock elicited fighting, should be run to sample results that might have been obtained using different species of animals. As mentioned earlier, other animals, such as monkeys have shown more "sensitivity" to the shock-fighting phenomena. Hence, animals higher than rats on the phylogenetic scale may also be more sensitive to other variables.

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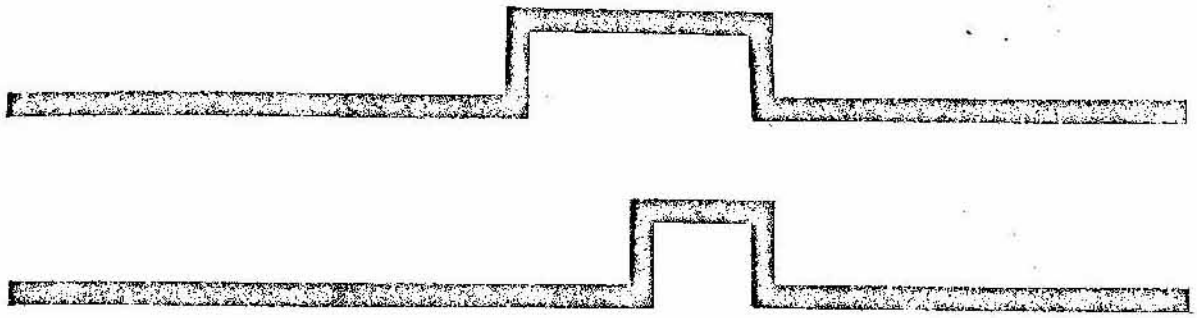
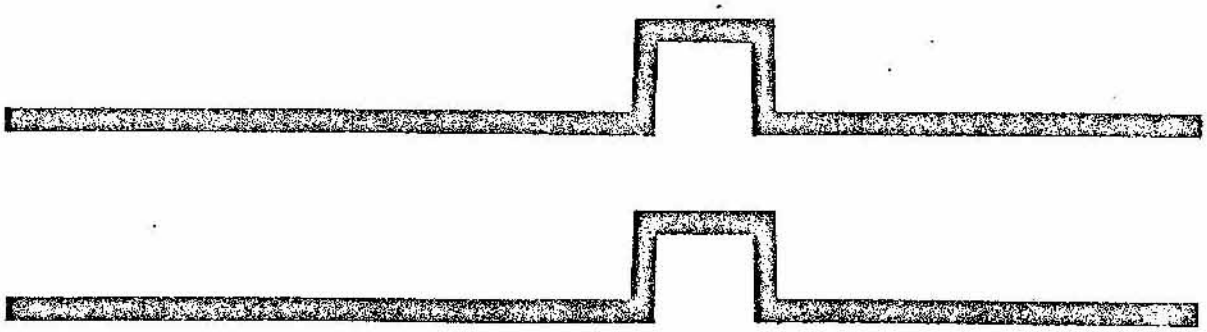
APPENDIX A



Overlap sequence (forward conditioning) of stimuli presentation (Ulrich and Vernon, 1966).



Simultaneous sequence of stimuli presentation (Hilgard and Marquis, 1961).

FIGURE 1. Example of two methods of stimuli presentation used in the Ulrich and Vernon (1966) study and in the present study.

Figure 2. Example of stereotyped fighting posture (Ulrich and Azrin, 1962).

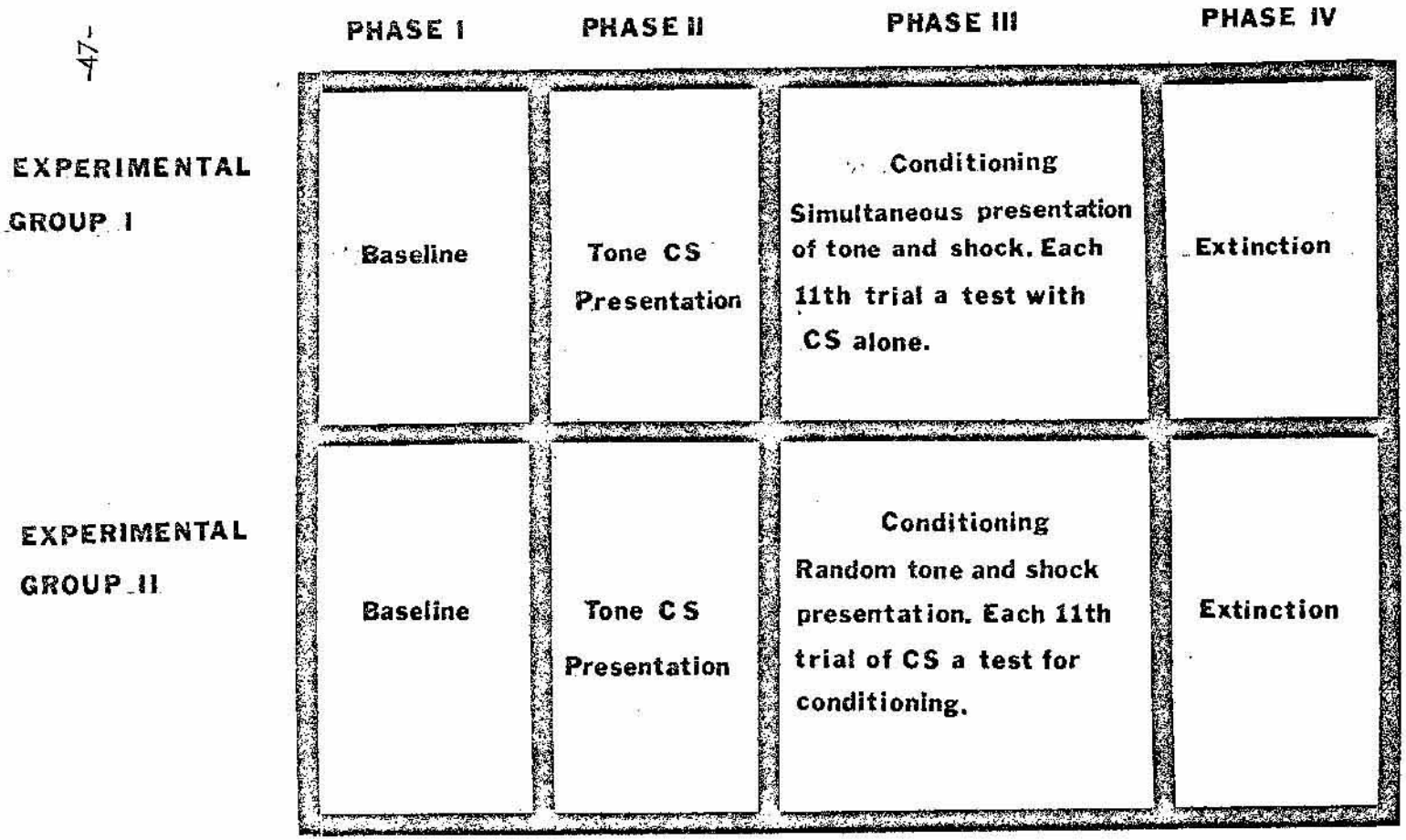


FIGURE 3. Schematic of the Design.

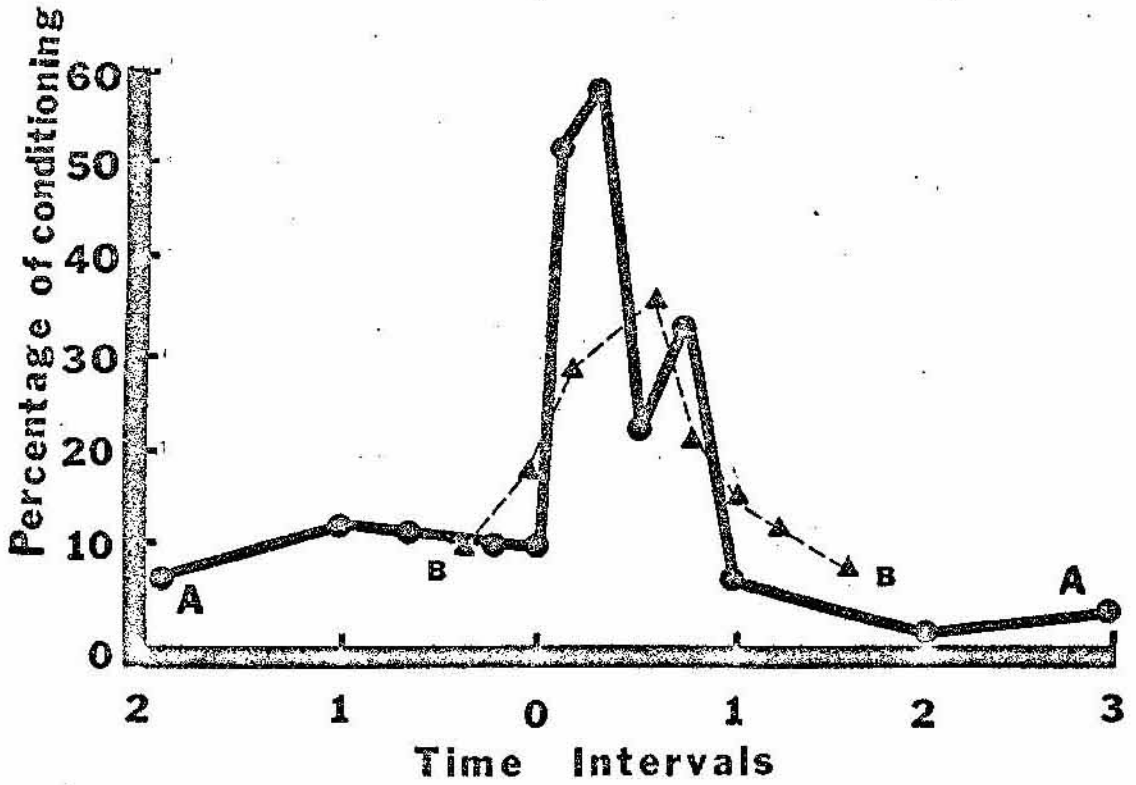


FIGURE 4. Data of two experiments in which the interval between CS and US is varied and ease of conditioning measured. At points to the left of 0 on the abscissa the US preceded the CS. H. M. Wolfle, in C. E. Osgood's Method and Theory in Experimental Psychology, Oxford University Press, New York, New York, 1961, p. 314.

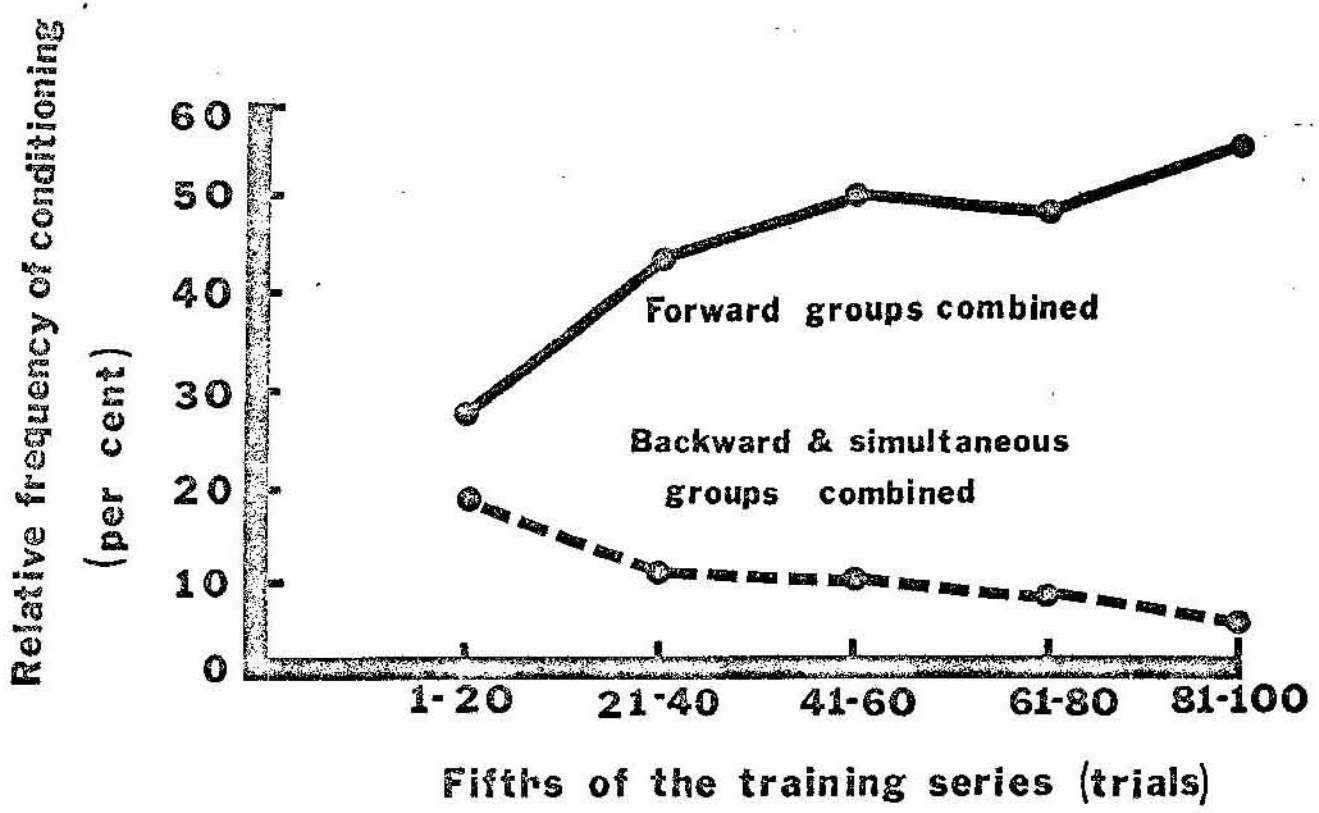


FIGURE 5. Performanance curves for forward conditioning and 'backward conditioning' groups. Spooner and Kellogg, in C. E. Osgood's, Method and Theory in Experimental Psychology, Oxford University Press, New York, New York, 1961, p. 314.

APPENDIX B

Group II

Consecutive Sessions	Pair 1			Pair 2			Pair 3			
	Ob. 1	Ob. 2	$\bar{x}$ %	Ob. 1	Ob. 2	$\bar{x}$ %	Ob. 1	Ob. 2	$\bar{x}$ %	Group $\bar{x}$ %
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	110	108	67	101	100	62	102	104	63	64
6	104	103	64	108	109	67	108	106	66	65
7	125	127	77	119	118	72	115	115	70	73
8	136	136	83	132	132	81	137	135	83	82
9	141	143	87	136	136	83	135	135	83	84
10	144	143	88	142	141	87	150	150	92	89
11	148	150	92	140	140	86	155	155	95	91
12	152	152	93	148	148	90	154	154	95	92
13	154	154	95	158	158	97	156	156	96	96
14	156	156	96	157	157	97	155	155	95	96
15	156	156	96	158	157	97	156	156	96	96
16	156	156	96	155	155	95	155	155	95	96

Table 2. Raw data obtained from Group II (random). Data represents frequency of unconditioned fighting responses for each pair of rats over 16 consecutive sessions as recorded by both observers. Mean percent for each pair of animals was found by taking a mean response rate recorded by both observers over the number of shocks (162) presented each session.

Group I

Consecutive Sessions	Pair 1			Pair 2			Pair 3			Group
	Ob. 1	Ob. 2	$\bar{x}$ %	Ob. 1	Ob. 2	$\bar{x}$ %	Ob. 1	Ob. 2	$\bar{x}$ %	$\bar{x}$ %
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	105	108	65	118	122	74	124	119	75	71
6	120	118	73	106	104	64	121	118	74	70
7	114	115	70	119	117	72	110	112	68	70
8	129	131	80	125	122	76	135	132	82	80
9	135	136	83	131	131	80	145	146	90	84
10	136	136	83	138	138	85	146	146	90	86
11	156	156	96	154	154	95	156	156	96	96
12	159	159	98	149	150	92	154	154	95	95
13	148	146	90	152	152	94	158	159	97	94
14	154	154	95	158	158	97	155	155	95	96
15	156/	156	96	158	158	97	155	155	95	96
16	155	155	95	155	155	95	156	156	96	96

Table 1. Raw data obtained from Group I (simultaneous). Data represents frequency of unconditioned fighting responses for each pair of rats over 16 consecutive sessions as recorded by both observers. Mean percent for each pair of animals was found by taking a mean response rate recorded by both observers over the number of shocks (162) presented each session.