SCHEDULE-INDUCED AGGRESSION: THE EFFECTS OF CHANGES IN REINFORCEMENT ON FORCE OF RESPONDING IN COLLEGE STUDENTS

by

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ABSTRACT

The present investigation was an exploratory study with the purpose of examining new measures of Schedule-Induced Aggression (SIA), and determining the ideal procedural conditions to maximize the treatment effect, i.e., changes in response force resulting from both decreases and increases in reinforcement. Experiment 1 studied the effects of individual loss trials (a negative change in reinforcement) and win trials (a positive change in reinforcement), resulting from the outcome on a roulette wheel, on the force of an operant immediately preceding the outcome (R1), an operant immediately following the outcome (R2), and an escape response. The prediction was that response force would be greater following both loss and win outcomes relative to baseline trials in which neither losses nor wins occurred. Although some isolated incidences were suggestive of an effect, overall it was concluded that chance-based losses and wins on a trial-by-trial basis were not sufficient to consistently enhance response force following the outcome. However, five of six subjects increased force on R2 during the theoretically most aversive loss trials (i.e., after big losses, after three or more losses in a row) relative to all other loss trials. In Experiment 2, subjects played a

guessing game against a computer, the outcome of which was controlled by the experimenter. It was hypothesized that a string of losses (a Taking condition) after a series of wins and losses (a Reinforcement condition) would increase the aversiveness of the situation to the point that mean response force would be greater during Taking than during Reinforcement. The results of Method C--which was the accumulation of efforts to maximize the treatment effect--showed that mean response force was greater during Taking for seven of the eight subjects on R1, six of the subjects on R2, and six of the subjects on the escape response. These latter results are consistent with previous SIA studies with humans as well as response vigor studies with children. Methodological and theoretical considerations for future SIA experimentation with humans based upon problems encountered in the present investigation are discussed.

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DEDICATION

This thesis is dedicated to my mother and father,
the two halves of my whole.

INTRODUCTION

Prehistoric evidence of cracked skulls and crude stone weapons suggests that human aggression has been around as long as humankind itself. Although disciplines such as religion, philosophy, and even science have concerned themselves with this issue throughout history, today we still see haunting examples of human genocide and overkill nuclear arsenals. On a smaller individual scale, human aggression is even more apparent around us. It appears that even the most insignificant event can set off aggressive responding by an individual. A person stubs his toe and proceeds to punch the wall. Another person inserts coins into a confectionary machine, receives coffee minus a cup, and then kicks the machine. Perhaps by understanding individual instances of aggression, control of this consistent and increasingly dangerous problem can be managed on a grander scale.

The purpose of the present study is to examine some variables involved in the experimental study of human aggression triggered by changes in reinforcement. The relevant literature concerning an experimental analysis of aggression induced by antecedent events will be reviewed, and different theoretical explanations of this phenomenon will be discussed. Special attention will be given to human operant research, particularly a procedure developed by Kelly & Hake (1970). The pros and cons of this and

other designs will be examined, and the methodological rationale for the present investigation as well as the theoretical extension involved will be described.

The Behavioral Approach

Behaviorists have identified two principal classes of causes of aggression: "(a) the class of causal events which precede or are antecedent to instances of aggressive behavior and (b) the class of causal events which occur subsequent to aggression and which may influence the occurrence of future attack episodes" (Hutchinson, 1973, p.155). The present review will deal primarily with the antecedent causes of aggression which, in turn, can also be subdivided into two major types. The first class involves "the onset or increase of intense, noxious, painful, or negatively reinforcing-type stimuli, or previously neutral signals which have come to be paired with such events" (Hutchinson 1973, p.155)--this class will be referred to as Pain-Elicited Aggression (PEA). The person who stubbed his toe and proceded to punch the wall was displaying PEA. The second class of antecedant causes involves "the offset or decrease of pleasant, beneficial, biologically necessary, or positively reinforcing-type stimuli or other previously neutral stimuli which have come to be paired with one of these types of events" (Hutchinson, 1973, pp.155-156)--this class will be referred to as Schedule-Induced Aggression (SIA). The person who kicked the confectionary

machine after receiving coffee minus a cup was displaying SIA.

Before beginning the literature review, the following definitions are necessary. Aversive stimuli are "those events which an animal will work to avoid or escape or will suppress the responses upon which they are contingent" (Ulrich & Favell, 1970, p. 107). The word pain will be used interchangeably with this term.

For present purposes, aggression or attack will mean "the forceful seizure or contact with another object or creature such that physical injury, dismemberment, destruction, immobilization, or disarmament occurs" (Hutchinson, 1973, p. 157). Behaviorists have wrestled with the problem of operationally defining aggression in both PEA and SIA experimentation. In the initial animal research, human observers pressed microswitches for each striking or biting movement they observed (e.g., Ulrich & Azrin, 1962). Although within-laboratory reliability was high, between laboratory reliability was questionable. To circumvent this problem, target animals were restrained in gadgets that closed a switch when they were struck (e.g., Azrin, Hutchinson, & Hake, 1967). Another apparatus employed was an "inanimate victim" of aggression that could automatically record bites upon itself, the most common being a rubber tube attached to a pneumatic switch (e.g., Hutchinson, Azrin & Hake, 1966). Because of ethical

concerns, human research has primarily employed inanimate victims of aggression, e.g., a padded cushion (Kelly & Hake, 1970).

Literature Review

Pain-Elicited Aggression

The pioneer work in the experimental study of PEA was conducted by Azrin and his associates beginning in the early 1960's. Initially, their purpose was to use escape from foot shock as negative reinforcement for fighting behavior in laboratory rats (Azrin, 1967). What they found, however, was that the rats violently attacked each other as soon as the shock became painful and before the experimenter had time to terminate it. This finding lead to an abundance of research being conducted in the area of PEA. The basic paradigm entails delivering an aversive stimulus--usually foot shock--to a pair of organisms (or an organism alone) and subsequently measuring the resultant aggressive behavior between the two organisms (or against a designated target).

Animal Studies

PEA has been demonstrated in a number of animal species (Azrin, 1967) using a variety of noxious stimuli (Hutchinson, 1973). Pained animals will aggress against a conspecific (Ulrich & Azrin, 1962), a contraspecific (Azrin, 1967), and a diversity of inanimate objects

(Hutchinson, 1973), although not all inanimate targets are attacked (Ulrich & Azrin, 1962). Social learning enhances PEA but is not a prerequisite: rats isolated from birth will attack each other when paired and given foot shock (Hutchinson, Ulrich, & Azrin, 1965). PEA is not an "all or none" phenomenon, in that attack strength is directly and positively related to stimulus intensity, stimulus frequency, and stimulus duration (Hutchinson, 1973). Upon presentation of the painful stimulus, attack occurs immediately and at full strength and, subsequently, decreases over time (Hutchinson, 1973). PEA is extremely resistant to fatigue (Ulrich & Azrin, 1962). Across long-term trials of shock, either habituation to the aversive stimulus or facilitation of the aggressive response can occur, depending upon the stimulus parameters (Hutchinson, 1973). Neutral stimuli which are consistently associated with the receipt of pain can become conditioned aversive stimuli capable of eliciting aggression (Hutchinson, Renfrew, & Young, 1971; Ulrich, Hutchinson, & Azrin, 1965; Vernon and Ulrich, 1966). Punishment is effective in supressing PEA but only under certain conditions, one of which is consequating each attack episode with a brief shock of higher intensity than that of the eliciting shock (Ulrich & Symannek, 1969). Organisms with histories of unavoidable pain (Powell & Creer, 1969; Powell, Francis, Francis, & Schneiderman, 1972) or repeated

attacks by a more dominant animal (Powell et al.,1972) show little PEA, while PEA is enhanced when organisms have been negatively rewarded for the aggressive response in the past (Azrin et al., 1967; Knutson, Fordyce, & Anderson, 1980). Whether or not an organism will react to an aversive stimulus with escape-like or aggressive-like behavior is a complex issue and probably depends upon a number of factors including the organism's prior avoidance history (Azrin et al., 1967), counter-aggression from the target animal (Powell et al., 1972), and the topography of the escape-avoidance response (Sbordone, Garcia, & Gardner, 1977).

Both psychological and physiological evidence suggest that aggression in itself can be reinforcing to an animal when it is painfully stimulated. Azrin, Hutchinson, & McLaughlin (1965) reported that monkeys who received painful electric shock learned to pull a chain that delivered a canvas ball which they could then attack. Weiss, Pohorecky, Salman, & Gruenthal (1976) demonstrated that rats which were shocked in pairs and allowed to attack each other later had fewer gastric lesions than either rats which were shocked alone or rats which were shocked in pairs but not allowed to attack each other.

Human Studies

Little research has been conducted on PEA with humans because of the ethics involved in giving an individual

painful stimulation. Rachman (1965) reported that PEA is regarded as one of the main problems encountered by therapists during the administration of aversion therapy. Hutchinson, Pierce, Emley, Proni, & Sauer (1977) demonstrated that the temporal and intensive relationships between loud noise and jaw clenching in humans is the same as those found between other intense stimuli and biting attack in animals. Aversive stimuli which are not as physically painful as electric shock--such as the immersion of an individual's hand in uncomfortably cold water--have been shown to be capable of enhancing aggressive responding (Berkowitz & Frodi, 1977).

Schedule-Induced Aggression

The findings of PEA research raised many interesting questions. One in particular was advanced by Azrin (1967): "Is attack produced only by events which produce physical pain, or might `psychologically' painful experience have the same effect?" (p.32).

Animal Studies

The first study of SIA was conducted by Azrin, Hutchinson, & Hake (1966) in a classic series of experiments. Food-deprived pigeons were exposed to alternating periods of reinforcement and extinction. It was found that at the onset of extinction all subjects attacked a nearby restrained pigeon. This behavior was observed to occur over the entire duration of the

experiment (over three months for some birds). Other birds even attacked a stuffed model. Attack occurred whether or not a key peck was required for reinforcement and whether or not the extinction period was signalled. The duration of attack decreased as a function of the time since the last food reinforcement. Attack measures did not differ between pigeons raised in isolation and those which were socially raised. If the birds were satiated or if food reinforcement was inaccessible, then attack did not occur. Duration of attack was a direct function of the number of food deliveries prior to extinction. From these extensive findings, the authors concluded that "the transition from continuous reinforcement to extinction may be considered an aversive event" (p. 203).

Reinforcement schedules. Attack behavior has been observed under a variety of reinforcement schedules. The following is a brief summary.

Extinction is defined as the cessation of reinforcement for a specified behavior or a chain of behaviors. Aggressive behavior occurs at the onset of extinction following both continuous reinforcement (Azrin et al., 1966) and intermittent reinforcement (Hutchinson, Azrin, & Hunt, 1968). Generally, attack occurs immediately after the withdrawal of reinforcement and declines thereafter (Looney & Cohen, 1982). There are conflicting reports as to the persistence of attack across alternating

reinforcement-extinction periods: Azrin et al. (1966) reported that extinction-induced aggression remained constant across numerous extinction periods, while Thompson & Bloom (1966) found that fighting had nearly returned to baseline levels by the fifth extinction period.

A _ratio schedule_ of reinforcement is one in which reinforcement is contingent upon a specified number of responses since the last reinforcement. During a _fixed-ratio_ (_FR_) schedule, a fixed number of responses per reinforcement are required; for example, to receive reinforcement under a FR10 schedule an organism must respond 10 times. During a _variable-ratio_ (_VR_) schedule, response requirement varies from one reinforcement to the next, with the designated VR value being the average number of responses required for reinforcement. Aggressive behavior has been observed under a variety of ratio schedules for both FR (Cohen & Looney, 1973) and VR (Webbe, DeWeese, & Malagodi, 1974) schedules. The relationship between the FR value and aggression appears to be an inverted U function, with peak aggression ranging from FR60 (Knutson, 1970) to FR75 (Cohen & Looney, 1973). Generally, FR schedules induce attack primarily during the postreinforcement pause and in the early part of the ratio run (Cherek & Pickens, 1970; Gentry, 1968; Hutchinson et al., 1968).

An _interval schedule_ of reinforcement is one in which

reinforcement is contingent upon the first response after a specified period of time between reinforcements. Responses during the interval are of not reinforced. As with ratio schedules, there are _fixed-interval_ (_FI_) and _variable-interval_ (_VI_) schedules. A variety of interval values of both FI (Cherek, Thompson, & Heistad,1973) and VI (Dove, Rachotte, & Katz, 1974) schedules are capable of inducing attack behavior. Cherek et al. (1973) found that aggression was an inverted U function of the FI value, peaking at FI120 sec or FI180 sec. _Fixed-time_ (_FT_) schedules--FI schedules in which reinforcement is not response contingent--are also capable of inducing aggression (Cherek et al., 1973; Flory, 1969). Generally, both FI (Cherek & Heistad, 1971; Cherek et al., 1973) and FT (Flory, 1969) schedules induce attack primarily during the postreinforcement pause.

Aggression has been induced by two other schedules of reinforcement. A _differential-reinforcement-of-low-rate_ (_DRL_) schedule is one in which reinforcement occurs after the first response following a period of no operant responding. With a 20 sec inter-response requirement, pigeons attacked throughout the interval (Knutson & Kleinknecht, 1970). A _differential-reinforcement-of-other-behavior_ (_DRO_) schedule is one in which reinforcement occurs after a period of no occurrences of a designated behavior. A DRO schedule which programmed

food delivery when attack had not occurred for 30 sec produced aggression even though it delayed reinforcement (Flory, Smith, & Ellis, 1977).

Other Variables. SIA has been demonstrated with a number of animal species, pigeons being the most commonly used subjects (Looney & Cohen, 1982). Both animate and inanimate objects are the victims of SIA, although the latter are attacked less frequently (Looney & Cohen, 1982). Specific features of a target are more sensitive to aggression than others (Cohen, Yoburn, Pennington, & Ball, 1979; Looney & Cohen, 1974). Initial exposure to a target under schedules of reinforcement which do not typically generate attack can reduce subsequent attack probability under schedules which do typically induce attack (Looney, Cohen, & Yoburn, 1976). Introducing a target after extended exposure to a low probablity of reinforcement schedule initially enhances probability of attack relative to an earlier target introduction (Looney & Dove, 1978). SIA can become conditioned to stimuli which signal low probability of reinforcement and result in "preservation of attack" to the conditioned stimuli (Cole & Litchfield, 1969).

Under certain low probability of reinforcement schedules, organisms will learn an operant response to gain access to a target which is then attacked (Azrin, cited in Ulrich et al., 1965; Cherek et al., 1973). As with similar

PEA findings, these SIA results suggest that aggression is reinforcing for organisms exposed to aversive conditions, assuming that low probability of reinforcement schedules are aversive.

Human Studies

Reinforcement schedules. Humans have been observed to aggress under a number of reinforcement schedules. The following is a brief summary.

During an extinction period following a FR200 schedule, human subjects increased the rate (Kelly & Hake, 1970) and magnitude (Harrell, 1972; 1973) of cushion punching. Young children hit a Bobo doll during extinction periods, but not during continuous reinforcement or baseline periods (Frederiksen & Peterson, 1974). Ulrich, Dulaney, Arnett, & Mueller (1973) reported that college students were more likely to deliver foot shock to a laboratory rat during termination of either positive or negative reinforcement. With regards to the temporal character of attack during extinction, Kelly & Hake (1970) found that the majority of aggressive responses occurred in the first quarter of the FR200 ratio requirement. Nation and Cooney (1982) specifically studied the time course of aggression during extinction and found that peak aggression occurred earlier following continuous reinforcement than following a VR2 schedule, and earlier following extended continuous reinforcement than following abbreviated continuous

reinforcement.

Frederiksen and Peterson (cited in Frederiksen and Peterson, 1977) varied FR schedules of monetary reinforcement (FR1, FR10, FR20, FR40, and FR80) with college students and found that the rate of aversive noise delivery to a human target was greatest during the FR40 schedule. Another study found that increases in non-functional jaw clenching were correlated with high FR schedules (Hutchinson et al., 1977). Harrell & Ross (1974) reported higher rates of pad striking during a FR200 schedule than during a FR1 schedule even though the average amount of reinforcement per operant response was identical. Other research has demonstrated that in addition to the FR value currently in effect, the preceding FR value has a strong influence on aggressive behavior. Subjects delivered more aversive noise to a human target when the preceding FR value was lower than when the preceding FR value was higher (Frederiksen & Peterson, cited in Frederiksen & Peterson, 1977). Peterson (cited in Frederiksen & Peterson, 1977) found that when an FR schedule was gradually increased from continuous reinforcement to FR50, less doll punching occurred than if the schedule change was rapid.

Frederiksen (cited in Frederiksen & Peterson, 1977) reported human aggression during both FI60 sec and FT60 sec schedules, although it was unclear whether all subjects

could accurately discriminate which schedule was in effect. During a FT90 sec schedule, non-functional jaw clenching was inversely related to the amount of pay (Hutchinson et al., 1977).

<u>Other variables</u>. Subject variables have received little attention in SIA studies with humans. When sex was employed as an independent variable, no differences were discovered in the amount or intensity of doll punching by children during extinction (Frederiksen & Peterson, 1974). Although age has never been employed as an independent variable, SIA has been demonstrated with nursery school children (Frederiksen & Peterson, 1974), juveniles (Kelly & Hake, 1970), and college students (Nation & Cooney, 1982). SIA studies have noted a wide range of aggressive behaviors including: punching a Bobo doll (Frederiksen & Peterson, 1974); punching a cushion (Kelly & Hake, 1970); slamming books (Hutchinson et al., 1977); defacing the apparatus, i.e., pounding, stabbing with knives and pencils (Kelly & Hake, 1970); delivering shocks to rats (Ulrich et al., 1973); delivering aversive noise to a human target (Frederiksen & Peterson, cited in Frederiksen & Peterson, 1977); and increasing the intensity and frequency of non-functional jaw contractions (Hutchinson et al., 1977).

Theoretical Interpretations of SIA

A number of hypotheses have been put forward to explain SIA. The following is a short description and

critique of a few of the more prevalent ones.

SIA Interpretations

The Direct Linkage Hypothesis. Azrin et al. (1966) proposed that extinction-induced aggression is directly linked to the aversive properties of intermittent positive reinforcement and, in part, to the transition from reinforcement to extinction. This hypothesis is consistent with the previously discussed PEA findings which showed that aggression is a direct result of aversive stimulation. To assess this hypothesis, Looney & Cohen (1982) compared SIA behavior with schedule-induced escape behavior. It was reasoned that since escape behaviors are directly related to the aversiveness of schedules of reinforcement, then attack behaviors should be similarly under the control of these same schedules. The authors concluded:

> In summary, the precise relationship between schedule-induced attack and escape remains uncertain. The direct linkage version of the aversiveness hypothesis remains a viable qualitative explanation of attack in view of its success in integrating observations of such attack with schedule-induced escape and pain-elicited attack. The lack, however, of a consistent and qualitative relationship between various measures of attack and escape, both within and between subjects, is problematic for the direct linkage

> hypothesis. If there is a direct linkage between attack and schedule aversiveness, it is a complex and partial one, subject to subtle differences in experimental procedure and design. (p. 31)

The Indirect Linkage Hypothesis. Falk (1971) described adjunctive behavior as

> behavior maintained at high probability by stimuli whose reinforcing properties in the situation are derived primarily as a function of schedule parameters governing the availability of another class of reinforcers. (p.586)

He proposed that adjunctive behaviors are indirectly linked to the aversive properties of intermittent positive reinforcement through a process of behavioral conflict. Adjunctive behaviors are mediated by the behavioral conflict stemming from appetitive behaviors that maintain the organism in the vicinity of the reinforcement, and the conflicting and negatively reinforcing behaviors that remove the organism from the site. The adjunctive behavior which is to be engaged in is "to a large extent a function of the environmental opportunities provided" (p. 583). Thus, aggression is only one form of adjunctive behavior. The problem, however, with the adjunctive behavior explanation is that although there are many similarities between SIA and other adjunctive behaviors such as schedule-induced polydipsia, there are also many

differences (see Looney & Cohen, 1982). Furthermore, as Frederiksen & Peterson (1977) note, the adjunctive behavior interpretation "is primarily descriptive rather than explanatory" (p.59).

The Arousal Hypothesis. Another explanation of SIA focuses on the relation of aggressive behaviors to a non-specific behavior arousal. Wayner (1970) proposed:

> Reinforcement during intermittent schedules not only increases the probability of the preceding response upon which the reinforcement is contingent but also increases momentarily the probability of all potential responses which might follow the reinforcement; that is, evoked by the available environmental stimuli. (p. 321)

SIA is viewed as an amplified form of aggressive behavior that might normally occur in the experimental setting. This is consistent with both animal studies (Looney et al., 1976) and human studies (Harrell, 1972) which have noted that the initial aggressive reaction against a target, i.e., before the experimental manipulation, is a good indicator of the subsequent levels of SIA. However, as the differences between experimentally-produced aggression and other adjunctive behaviors become more apparent through laboratory testing, proponents of the arousal hypothesis have recently doubted whether aggression is, in fact, an adjunctive behavior (e.g., Wallace & Singer, 1976). Also,

as with the indirect linkage hypothesis, the arousal hypothesis is too broadly conceived to make specific predictions (c.f., Looney & Cohen, 1982).

The three aforementioned interpretations of SIA offer little in terms of differential predictions, though they differ to some degree in their assumptions regarding the relation between SIA and other schedule-induced behaviors. While the latter two interpretations view SIA as only one of many alternative schedule-induced behaviors (depending on the environmental conditions provided), the direct linkage hypothesis views only aggression and/or escape behavior as the direct result of schedule aversiveness. Looney & Cohen (1982) summarize these three explanations of SIA:

> It still appears... that, across species, schedule-induced attack is in some way related to the aversive properties of intermittent positive reinforcement. The details of this relationship remain elusive. Preliminary work...suggests that adjunctive attack, like displacement activities..., is most likely to occur under conditions of behavioral competition or conflict. This hypothesis is appealing, since it is consistent with other observations that adjunctive attack is related to the aversive properties of

> intermittent positive reinforcement, and also because it puts schedule-induced attack (and perhaps other adjunctive behaviors) in a broader biological context...Eventually this hypothesis must be reconciled with other evidence that the temporal organization of adjunctive attack mimics that of general behavioral activation... (pp. 33-34)

The Frustration-Aggression Hypothesis

The finding that "psychologically" painful experiences induce aggression is, in many ways, consistent with the Frustration-Aggression Hypothesis which "assumes a universal causation between frustration and aggression" (Dollard, Doob, Miller, Mowrer, & Sears, 1939, p. 10). In other words, "aggression is always a consequence of frustration", and "the existence of frustration always leads to some form of aggression" (Dollard et al., 1939, p. 1). This theory is largely a restatement of the basic SIA relationship but in the form of a stronger, more universal statement, provided that "frustration" is operationally defined as extinction or other related low probabilty of reinforcement schedules. It is clear, however, the assumption that frustration is a necessary and sufficient condition for aggression is an overstatement. Aggression can be controlled by operant conditioning and does not require that an organism be frustrated (e.g., Reynolds, Catania, & Skinner, 1963). The mafia hitman

kills for money, not due to some prior thwarting. Also, because of previous learning experience, some people have learned to respond non-aggressively to frustration. Society frowns upon "poor losers", while in many athletic competitions "sportsmanlike" prizes are awarded. These kinds of contingencies are sufficient to keep the frustrated loser of such events from displaying aggressive behavior.

A Detailed Account of Human SIA Studies

The following is a detailed account of the most frequently cited evidence in support of SIA with human subjects.

In an experiment conducted by Ulrich & Favell (1970), four 10-year-old children were reinforced for stacking bottle stoppers on a table. The completion of this task was interrupted by experimentally programmed table vibrations. Each child was told that there was another child in another room doing the same task, and that a button press would shake the table of the other child. There was no explicit connection between the subject's own table vibrations and the behavior of the child in the other room. The results indicated that the button presses increased as a function of the disruptive vibrations, although variability between subjects was high. A subsequent experiment with two other 10-year-old subjects revealed that the number of button presses was greatest

after disruptive vibrations, followed in order by non-disruptive vibrations, reinforcement, and accidental failure. The authors suggested that it is possible to regard these results as reflecting aggression in response to an aversive event, similar to animal PEA research findings.

A series of experiments with college students was conducted by Ulrich et al. (1973). Subjects were placed on concurrent schedules of positive reinforcement and positive reinforcement plus avoidance of a time-out. The measure of aggression was the number of times a subject would shock a caged rat situated in front of him. Later in the procedure when either the positively reinforcing component or the negatively reinforcing component was discontinued (blamed on apparatus failure), subjects exhibited a greatly increased rate of rat shock. Furthermore, when the avoidance criterion was changed so that it was too high to meet, rat shock also increased, although not until the subject found himself unable to avoid the time-out.

In another similar study by Ulrich et al. (1973), subjects were exposed to a discrete trials avoidance schedule. During the presentation of a warning stimulus, the subject was required to emit a fixed number of responses to avoid losing five cents per trial from a fixed amount of money given at the beginning of each session. More rat shocks were evidenced by subjects exposed to a low

avoidance probability schedule (FR200) than those exposed to a high avoidance probability schedule (FR50). The shock responses occurred primarily when a subject found himself unable to avoid a time-out and in the first 10 sec beginning each new trial immediately after the counter recorded the loss.

Frederiksen & Peterson (1974) sought to explore aggressive behavior under conditions of high probability of reinforcement (continuous reinforcement) and low probability of reinforcement (extinction and baseline). Sixteen 5-year-old nursery school children served as subjects. The children learned to press a lever to receive a penny. The testing room was full of toys, one of which was a Bobo doll equipped to record the frequency and intensity of hits. The procedure began with a 2 min baseline whereby a stimulus light was darkened and the lever was inoperative. Subsequently, the stimulus light was illuminated, a 1 sec tone sounded, and each lever press delivered a penny on a continuous reinforcement schedule for 15 pennies. This condition was followed by a 2 min extinction period whereby the stimulus light remained illuminated but lever presses were not reinforced. Then, a 1 sec tone sounded to signify another reinforcement period. The order of conditions followed a ABCBCBCBCA sequence. The authors reported that no subject hit the doll during reinforcement, while hitting was relatively

frequent during baseline and extinction conditions for 12 of the 16 subjects. Three children who did not hit the doll cried. The intensity and frequency of hits were highest in the initial extinction period. There were no differences between signalled (baseline) and unsignalled (extinction) low probability of reinforcement schedules on either frequency or intensity measures. There were no sex differences between the eight males and the eight females.

A unique experiment was designed by Kelly & Hake (1970). Knob pulling responses were maintained on a schedule of monetary reinforcement. Concurrently, periodic occurences of a 2800 Hz, 68 db tone could be either escaped or avoided by one of two responses: a button press that required 1.5 lb (6.6N) of force (non-aggressive response); or a cushion punch that required 20 lb (88.96 N) of force (aggressive response). The authors designated the punch as the aggressive response "because the force of this response together with its topography appeared comparable to responses of humans that deface objects and produce escape or counter-aggression from other humans" (p.154). In the first phase of the experiment, nine male high school students were tested once daily and paid at the end of each session. After each 200 knob pulling responses, three stimulus lights turned off and the subject was required to insert a penny into a slot. Consequently, the stimulus lights illuminated red for 1 sec, the coin dispenser

clicked, and five cents was delivered to a coin tray. The tone, which could be avoided or escaped by either the button press or cushion punch response, was scheduled every 60 sec. The subjects were tested until there were five consecutive sessions in which the number of punches differed by fewer than five from the number of any of the other four sessions. Each session lasted until 40 nickels were earned or until the 45 pennies given to each subject at the beginning of each session were used, whichever came first. Three subsequent extinction sessions were then scheduled whereby only the first five knob-pulling ratios in each session were reinforced. If a subject left the chamber during one of the first two extinction sessions before all 45 pennies were used, then he was exposed to only two extinction sessions. The authors reported that seven of the nine subjects increased the number of punches during extinction. When six of these seven subjects were returned to the reinforcement condition for five more sessions, half returned to baseline punching rates, while the other half did not. This "persistence of aggression" had been noted in previous animal studies (e.g., Hutchinson et al., 1968). The three subjects who returned to baseline levels were exposed to reinforcement until 10 consecutive sessions met the baseline criteria before being reintroduced to three more extinction sessions. Again, punching rates increased, although they were not as high as

in the first extinction series. One of the three subjects discontinued participation during this second extinction series, while the other two subjects were returned to reinforcement for five more sessions, at which time they resumed their baseline punching rates. Overall, the probability of a punch given a tone was 0.02 during the reinforcement sessions and 0.2 during the extinction sessions. For the nine subjects, 95% of all escape-avoidance responses were button presses, and the rate of this response did not change across conditions. The discontinuing of monetary reinforcement had little effect on the rate of knob pulling, as this response never dropped below 75% of the average baseline rate.

The second phase of Kelly & Hake's (1970) experiment was conducted in order to answer the question: Would another non-preferred, concurrent, but non-aggressive escape-avoidance response also increase during extinction? When the cushion punch response was replaced by a knob twisting response, only one of five subjects showed an increase in knob twisting during extinction, and even in this instance it lasted only one session. Thus, the authors concluded that "the increase in punching observed during extinction cannot be attributed solely to the fact it was a concurrent response or non-preferred response; some other aspect of the aggressive response was essential" (p. 163).

A series of experiments by Harrell and his associates investigated the effects of a number of variables within the extinction-induced aggression paradigm developed by Kelly & Hake (1970). Undergraduate, male students were used as subjects. In the first of these reported experiments, Harrell (1972) examined whether or not high magnitude escape-avoidance punches (25 lb or more) were different in number during extinction than those of a low magnitude (20-24 lb) on the same manipulandum. Like Kelly & Hake (1970), the tone (2800 Hz, 80 db) could be escaped or avoided by either a button press or a cushion punch, but now there was an additional measurement, that being cushion punch magnitude as defined by <u>high</u> and <u>low</u>. After 200 knob pulls, each subject was required to press a button which registered four cents on a counter. Concurrently, the tone sounded every 60 sec. The reinforcement condition was repeated until there was five consecutive 30 min segments in which the number of punches for any one segment differed by fewer than five from the number in any of the other four segments. This constituted the baseline. Each session lasted 90 min, and if the baseline criterion was reached in the middle of a session, then the condition was continued in effect for the full session. An extinction condition was then scheduled for the next session whereby reinforcement was discontinued after the first five knob pulling ratios. A reinforcement-extinction-reinforcement

sequence of sessions followed. The author reported that punching rates increased during the first extinction session for all six subjects; however, it was the variation in high magnitude punches which largely accounted for this difference--five of the six subjects increased only high magnitude aggression during this period. Rates of low magnitude punches tended to remain constant across all conditions. The author, like Kelly & Hake (1970), also reported high subject variability, greatest rates of aggression during the first extinction session for five of the six subjects, and persistence of aggression from extinction to reinforcement sessions for two of the six subjects. However, unlike Kelly & Hake, there was an inverse relationship between the rate of button pressing and the rate of punching during extinction; the subjects showed lower rates of aggression, i.e., fewer punches per hour, than did Kelly & Hake's subjects during extinction; and subjects were more apt to escape rather than avoid the tone.

Harrell & Giovine (1974) examined the effects of a taking condition. During the initial reinforcement sessions, four cents registered on a counter after every 200 knob pulls. Following a similar baseline procedure as outlined for Harrell (1972), a taking session was introduced whereby after earning one dollar, one cent was subtracted from the counter every 12 sec until only 20

cents were left. (It was impossible to make a profit at this rate.) Then, the subject was allowed to work his way back up to a dollar, whereupon the taking condition was reintroduced. This cycle was continued throughout the taking session. A reinforcement-taking-reinforcement series of sessions followed. The authors reported that rates of punching increased for all five subjects during the first taking session. Four of these subjects returned to baseline punching rates when returned to reinforcement. During the second session of taking, punching rates increased above baseline for all subjects and these rates were even higher than in the first taking session. Baseline rates of punching were again obtained for four of the five subjects during the third reinforcement session. Button pressing remained constant for four of the five subjects throughout the experiment. Taking tended to suppress the rate of knob pulling.

Harrell & Ross (1974) studied the effects of two FR schedules of reinforcement on human aggression. Seventeen subjects received one point after every knob pull and were told that these points could be exchanged for money at the end of the session, with one cent given for every 50 points (FR1). For another equal group of subjects, four points registered after every 200 knob pulls, each point worth one cent (FR200). The authors hypothesized that the delay of reinforcement in the latter condition would prove more

aversive and result in higher rates of aggression, even though the average pay per knob pull was identical for the two conditions. After a one hour session, there were no differences between the two groups in the amount of money earned; however, the FR200 group exhibited higher rates of escape-avoidance punching, as expected. When analyzed further, this difference was largely accounted for by high magnitude punching (see description of Harrell, 1972). The FR200 subjects also averaged fewer escape-avoidance button presses.

Another experiment examined the effects of an aggressive model within the extinction-induced aggression paradigm (Harrell, 1973). During two 90 min sessions, monetary reinforcement for FR200 knob pulling was discontinued after completion of the first five ratios. Ten experimental subjects worked alone during the first session, while during the second session a confederate was present who operated a similar apparatus under the same conditions. The confederate was told to hit the cushion every time he completed 200 knob pulls and was not paid, whether or not the tone sounded. Ten control subjects worked alone during both sessions to determine the effects of time on aggressive responding. The effect of the model was to increase the rate of high magnitude punching and slightly decrease the rate of low magnitude punching; the effect of time was to decrease the rate of high magnitude

punching while low magnitude punching remained constant (see description of Harrell, 1972). The experimental subjects also pressed the escape-avoidance button more often when the model was present than when he was absent. Another published study by Harrell & Schmitt (1973) demonstrated that the mere presence of a non-aggressive confederate was sufficient to enhance greater rates of high magnitude aggression within this paradigm.

Nation & Cooney (1982) used the Kelly & Hake (1970) paradigm to study the time course of aggressive responding during extinction following (1) continuous reinforcement (CRF) versus partial reinforcement (PRF), and (2) extended CRF versus abbreviated CRF. The subjects were male undergraduates. The operant response consisted of moving a shuttle manipulandum to the left. The auditory stimulus was a 3000 Hz, 90 db tone presented every 30 sec, and which could be terminated by either a button press or a cushion punch (25 lb or more). Tokens were given as reinforcement but were of informational value only; i.e., they were not exchangeable for money. In the first phase of the experiment, 12 subjects were exposed to a CRF schedule, while another 12 subjects were exposed to a VR2 schedule; in the former a token was given for every correct shuttle response, while in the latter reinforcement was given randomly on half of the trials with no more than three reinforcements in a row, except for the first five trials

which were all reinforced. After 30 reinforcement trials for both groups, 120 extinction trials commenced. It was reported that subjects in both the CRF and VR2 groups switched from the preferred mode of tone escape (button pressing) to the less preferred aggressive mode (cushion punching) from reinforcement to extinction. The time course of aggressive responding from the last reinforcement was an inverted U shaped function for both punching frequency and amplitude, which peaked earlier in both instances after CRF (peak = 25-30 trials) as opposed to the VR2 schedule (peak = 55-70 trials).

In the second phase of the experiment, 12 subjects were exposed to a CRF schedule for 10 trials (abbreviated), while another 12 subjects were exposed to the same schedule for 30 trials (extended), each followed by 60 extinction trials. Again, the authors noted that both groups shifted from the preferred mode of tone escape (button pressing) to the less preferred aggressive mode (cushion punching) from reinforcement to extinction. And again, the time course of aggressive responding since the last reinforcement was an inverted U shaped function for both punching frequency and amplitude, which peaked earlier in both instances after extended exposure (peak = 15-25 trials) relative to abbreviated exposure (peak = 25-30 trials).

The final phase of the experiment was conducted to determine whether pad striking was a schedule-induced

aggressive response or a schedule-induced response variation. The procedure was identical to the first phase, except that a non-aggressive knob turning response was substituted for pad striking. During extinction, CRF subjects made fewer preferred and more non-preferred escape responses than did their VR2 counterparts. However, because the pattern of these non-preferred escape responses differed from the previously described inverted U shaped functions of the aggressive response and because the VR2 subjects did not switch to the non-preferred escape response, the authors concluded the acts of aggression displayed by the subjects during extinction were not just response variations.

Response Vigor Studies

Kelly & Hake (1970) designated a cushion punch as an aggressive response "because the force of this response together with its topography appeared comparable to responses of humans that deface objects and produce counter-aggression from other humans" (p.154). With regards to response force, SIA reports have shown that high magnitude responding is characteristic of SIA (Harrell, 1972; 1973; Harrell & Ross, 1974; Nation & Cooney, 1982). There are other reports outside of the SIA literature which have also demonstrated that periods of nonreinforcement enhance response force. What follows is a review of these studies.

Olds (1953) trained 14 nursery school children to operate a crank-chip machine. During the training period, youngsters were required to turn the crank three times in order to obtain a poker chip which could later be used to purchase penny trinkets. Each daily session was completed after eight chips had been earned, and this procedure was conducted five days a week for four weeks. The children were then divided into four groups: Group A received a chip after an average of 12 cranks (varying from 3 to 36); Group B received a chip after an average of 7.5 cranks (varying from 3-18); Group C received a chip after 3 cranks; and Group D received a chip after 1 crank. All groups experienced three days of treatment. It was reported that Group A and Group B, both of whom experienced a delay in reinforcement, cranked the machine with greater force during the treatment condition. Group C and Group D, both of whom experienced no such delay, decreased the force in which they cranked the machine.

Haner & Brown (1955) employed 30 elementary school children as subjects in order to study the effects of task failure at varying distances from a goal on response force on a concurrent task. Children were required to fill 36 holes with marbles, the completion of which resulted in a reward. The instructions specified to each child that he/she would be given an unpredictable number of seconds on

each trial to complete the marble board filling task. The end of a trial was signalled by a buzzer which continued until the child pushed a plunger to stop it and begin another trial. Youngsters were frustrated at varying degrees of completion; i.e., by ending a trial after either 9, 18, 27, 32, or 36 holes were filled. Each subject had 12 trials and was allowed to succeed on the first and last trials, while on the other 10 trials he/she was blocked twice at each of the five different positions. The authors reported that the closer a subject was to successful responding when the buzzer sounded, the more pressure was exerted on the plunger as measured by the displacement of a pen.

Another study with 40 elementary school children examined the effects of an interference situation on ongoing response rate as measured by the rate of crank turning (Screven, 1954). Each subject learned to turn a crank continuously, causing a light to move downward through 12 panel positions. At the completion of this task, a marble was dispensed into a cup and when enough marbles were earned, each subject was entitled to a prize. During Session 1, all subjects were exposed to 11 non-interference trials; during Session 2, interference was introduced at two distances from task completion (interference = 30 sec delay in the movement of the light) on each of four trials following one non-interference

trial, a prize was awarded, and then this series was repeated a second time with another prize being awarded.. The subjects who were in a condition which required them to turn the crank during these delay periods demonstrated an "energizing" effect on the rate of crank turning. The energizing effects of interference were cumulative across trials. Interference at the two distances from the goal had no differential effect on the rate of crank turning. During Session 2, subjects swore, shouted, hit the apparatus, and increased vocal response intensity, all of which appeared to increase with successive interference trials. Such behavior was completely absent in the earlier session of non-interference.

Holton (1961) measured the amplitude of an instrumental response during extinction. The subjects were 45, 3-5 year-old children. A marble reinforcer was delivered each time a subject pushed the correct one of two windows. Subjects were given differential amount of pretraining: 4, 17, or 22 trials of reinforcement. Then, training commenced whereby a board with 11 holes was placed in front of the subject and he/she was told that the way to win a predetermined prize was to win enough additional marbles to fill the board. Subjects in the 4 trial and 17 trial pretraining groups were exposed to seven extinction trials after nine marbles had been earned during training. Subjects with 22 pretraining trials received the same

number of extinction trials after earning four marbles during training. All subjects were then reinforced for responses to the previously incorrect window until the marble board was filled. The mean force of responding, as measured by a utility scale, was compared for the first four trials prior to the first non-reward trial versus the first four non-reward trials following the first non-reward trial. The results indicated that subjects given relatively large numbers of reinforcements and then non-reward near the goal showed a greater increase in amplitude than either subjects given fewer reinforcements and non-rewarded near the end of the goal or subjects given a large number of reinforcements and non-reward far from the goal. Of the 45 subjects, 44 showed an increase in amplitude following omission of reward. There was a tendency for response amplitude to increase with successive non-reward trials, suggesting that the effect was cumulative.

Before ending this section, mention should be made of an area of research which tested Amsel's (1958) non-reward theory with children. These studies used a double lever analogue of a double runway whereby R1 is partially reinforced and R2 is always reinforced. In general, research in this area found that children responded faster on R2 following non-reward on R1 than following reward (Penny, 1960; Ryan, 1965; Watson & Ryan, 1966; Davidson &

Fitzgerald, 1970). A review by Ryan & Watson (1968) concluded that under massed trials, when speed is relatively fast, this _frustration effect_ can be detected provided the measure of R2 is taken as soon as possible following non-reward on R1; i.e., when the subject is maximally aroused. If _response latency_ is a valid measure of _response vigor_--which also includes _response force_ as a measure--then these studies can be viewed as evidence that restricting reinforcement increases general response vigor.

The response vigor studies demonstrated that periods of nonreinforcement enhance response vigor. In light of these studies, it may well be that SIA represents an extreme on the response vigor continuum; i.e., given sufficiently aversive periods of nonreinforcement, individuals enhance response vigor to the point that responding takes the form of aggression in terms of both response force and topography. Response force was employed as the dependent variable in the present investigation because: (1) the findings of the response vigor studies employing response force as a measure were robust [e.g., Holton (1960) reported that 44 of 45 subjects enhanced response force following the omission of reward]; (2) high response force is characteristic of many human aggressive acts, and consistent with the Kelly & Hake (1970) definition; and (3) it brings together two lines of research (i.e., SIA and response vigor) under the assumption that one (SIA) is an

extreme form of the other (schedule-induced response vigor).

A Synopsis of the Present Study

The present study was designed to (a) examine schedule effects upon force of responding using the single-subject type of design and adult population generally characteristic of the human SIA literature, but incorporating a continuous measure of response force, as characterizes some of the studies of response vigor in children; (b) attempt to examine response force on a trial-by trial basis across chance-based wins and losses in a gambling paradigm, rather than across phases of reinforcement and extinction under more contrived task conditions; and (c) extend the examination of response-force effects to those generated by _increases_ in reinforcement, in addition to _decreases_.

The game involved gambling with a roulette wheel. A tone sounded to begin a trial and continued throughout the trial. The subject could escape the tone for 7 sec at a time with a knee kick response. The first tone signalled the subject to push one of three buttons corresponding to one of three number range outcomes on the wheel. The subject was allowed to "change his/her mind" by pressing another button. To secure the final choice, the subject was required to push a button lever with a minimum

amount of force. At this point, the experimenter spun the wheel and announced the outcome. In response to this announcement, the subject pressed the button lever again to reveal his/her choice to the experimenter. The experimenter delivered the appropriate reinforcement and then the subject pressed the button lever a third time to end the trial. Both knee kick and button lever manipulanda comprised the apparatus on which responses of varying force could be applied and recorded.

A single-subject design was used; i.e., each subject's data were evaluated individually by means of comparisons across baseline and treatment conditions. During baseline trials, the procedure was identical to the outline above, except that no outcome was announced. During a reinforcement condition, a token was given to the subject for every correct choice; during a subsequent taking condition, a correct choice resulted in the loss of a token. Baseline trials were scheduled at the beginning of the session, between the reinforcement condition and the taking condition, and at the end of the session. At some point in both the reinforcement and taking conditions, the rules of the game were changed such that not only did correct number range choices result in one token wins or losses (depending upon the condition in effect) but also if the colour was correct (i.e., black as opposed to red), wins and losses were of a greater magnitude (10 tokens).

The information stored for data analysis included: (a) the force of all button lever responses; (b) the force of all knee kick responses; and (c) the number of times the subject "changed his/her mind".

Methodological Advantages

Procedurally, the present study includes a more in-depth analysis of both the operant and escape responses than previous adult human SIA studies. Harrell (1973) observed informally (i.e., no systematic measure), that subjects performed the operant response (i.e., knob pulling) with greater force during extinction. A provision was made in the present study to measure the force of the operant response. Furthermore, these measurements were made at the most experimentally opportune times throughout a trial; i.e., after the bet was made; after the wheel stopped and the outcome, therefore, was known; and after the appropriate reinforcement was delivered. Two operant responses were required after the outcome to examine whether the force measure was most sensitive immediately following the outcome (measured by the second response) or immediately following the actual delivery of reinforcement (measured by the third response), as these two events were temporally spaced.

The studies employing the Kelly & Hake (1970) design--excluding Nation & Cooney, (1982)--allowed subjects to either escape or avoid the tone. The present study

provided only an escape response for a number of reasons. First, data analysis was simplified, since all responses to the tone were of only one variety. Second, the avoidance response could have become a mechanically executed part of the task on any given trial; i.e., the subject might have avoided the tone only at set times during a trial, and thus a rate measure, which is the advantage of employing an avoidance response, would have been constant across trials. Related to this second point is the fact that trials were of relatively brief duration in the present study and, therefore, the range of the rate of avoidance responses per trial would have been limited, given the other tasks the subject had to perform. Third, escape responding ensured that the tone always sounded at regular intervals within a trial, with the advantage that exposure to the tone was generally constant within and across subjects. Finally, employing only escape responding simplified what was already a somewhat involved task for the subject.

The parameters of the escape response in the present study provided advantages over earlier research. First, in all the Kelly & Hake (1970) design studies, the escape-avoidance response was an "either-or" situation--either a button press or a cushion punch. By having only one escape response (i.e., the knee kick) the likelihood that a response of greater force was occurring due to

simple response variation was reduced. Also, by scheduling the tone frequently within a trial a more continuous measure of the effects of winning and losing on force of escape responding was made possible. This continuous measure was expected: (a) to be a more sensitive measure than previous SIA studies employed; (b) to be consistent with the possibility that the "aggression" demonstrated in the SIA studies with humans is a response class covering a broader continuum of more vigorous behavior; and (c) to make emission of an escape response with greater force less obvious to the subject and, therefore, perhaps less likely to be suppressed.

A gambling situation was chosen over other designs, such as that of kelly & Hake (1970) who used typical FR schedules of reinforcement followed by extinction, for two main reasons. First, the subject should have been less inclined to believe that the experimenter was somehow controlling the outcome, hopefully potentiating his/her reactions to wins and losses. This was accomplished in the present study by (a) placing the roulette wheel in full view of the subject, and (b) making the subject's choice unknown to the experimenter until after the wheel stopped. Second, a gambling situation is more analogous to real life than is pulling a knob on a FR200 schedule, and thus was expected to be more interesting and emotionally provocative for the subject. In the present study, the subject was

always actively involved in the outcome of a trial, as it was he/she making the choice. This was true even during the taking condition when the subject's objective was to avoid choosing correctly.

Employing a single subject design provided many advantages for the present study. One of the reasons for doing this research was to examine effects meaningful enough to be reliable across all subjects. If the expected effects were observed, then other new variables could have been investigated. Also, the present study represents a departure from most of the reviewed studies in that it relies on a more fine-grain, trial-by-trial analysis. A single subject design enabled the experimenter to modify variables from subject to subject in order to determine appropriate procedural conditions to maximize treatment effects.

Theoretical Extension

The literature review has focussed primarily on negative changes in reinforcement; i.e., changes from high density reinforcement to low density reinforcement. The present study broadens this focus and asks: Like extinction (or losing), will positive changes in reinforcement (or winning) also increase general response vigor? Anecdotal evidence suggestive of such an effort is the successful game show contestant who wins a big prize and procedes to jump up and down, hug the announcer, and

engage in a host of other energetic activities.

Two lines of research are consistent with the idea that positive changes in reinforcement enhance general vigor of responding. Positive incentive contrast effects are defined "when an increase in the amount of reward results in performance that rises significantly above the level of a high reward control group" (Weinstein, 1970, p.65). Weinstein (1970) explored positive incentive contrast with humans. Thirty undergraduate students were required to work at 20 multiplication problems. Subjects were told that they would receive 0-40 points after each answer, depending upon the speed and accuracy with which they answered. In the preshift condition, there were three experimental groups who received either 5 points, 10 points, or 20 points on predetermined trials, while a control group received 40 points. After solving 15 problems, the postshift condition commenced whereby all subjects received 40 points on predetermined trials for the last five trials. In the preshift condition, the control subjects took less time to answer than any other group, and response latency appeared to be inversely related to reward magnitude for the experimental groups. In the postshift condition, subjects in the 5 point and 10 point groups abruptly decreased mean latency of responding to a level below the control subjects, while subjects in the 20 point group reached the latency level of the control subjects.

Thus, positive incentive contrast effects in this study were a monotonic function of the amount of reward increment. Other similar studies have also reported positive incentive contrast effects with humans (Weinstein, 1971; 1980; 1982). These studies demonstrate that positive changes in reinforcement can increase response vigor as defined by response latency. Furthermore, it appears that the greater the positive change, the greater the increase in vigor.

A second line of research has demonstrated attack behavior in pigeons with no transition in reinforcer probability (Yoburn, Cohen, & Campagnoni, 1981). Although 100% of the birds on a FT90 sec schedule (reinforcement probability is zero immediately following reinforcement) showed post-food attack against a two-dimensional target, 50% of the birds on a RT90 sec schedule (reinforcement probability is constant) also attacked during postreinforcement. Thus, the aversive time-out period following reinforcement is not a necessary condition for inducing aggression. Perhaps reinforcement *per se* increases general response vigor which may be manifested in many ways (aggression being only one alternative), while reinforcement followed by an aversive reduction in reinforcer probability increases the likelihood that aggression is the vigorous behavior elicited. Regardless of the explanation of this phenomenon, this study clearly

shows that reinforcement per se can increase response vigor and, if winning during gambling with humans is similar to reinforcement on intermittent schedules with pigeons, then it is expected that winning will increase response vigor in the present study, although perhaps not as consistently as aversive losing.

Predictions

The general prediction of the present study is that response force on both the operant and escape manipulanda will increase immediately following either taking of reinforcement (a loss trial) or delivery of reinforcement (a win trial) relative to when reinforcement is neither taken nor delivered (a baseline trial). From the previous PEA and SIA research, losses are hypothesized to be aversive and, therefore, to enhance magnitude of responding. Wins are hypothesized to be invigorating to the extent that research has shown that positive changes in reinforcement, and even reinforcement per se, can increase response vigor. The magnitude of the increase in response force is expected to be directly related to the magnitude of a loss or a win.

Trials in which neither wins (non-win trials) nor losses (non-loss trials) occurred were not considered for analysis because of the ambiguity of these trials. A non-win trial was similar to a loss trial in that reinforcement did not occur, but dissimilar in that a

reinforcer was not taken. If both win and loss trials did indeed increase response force, then a comparison between win and non-win trials would have, in effect, been a comparison between a win trial and an ambiguous loss trial, a comparison which would have yielded little information regarding the response force enhancing effects of winning relative to baseline in which neither winning nor losing occurred. The same reasoning can be applied to non-loss trials since they were similar to wins in that reinforcement was not taken, but dissimilar in that reinforcement did not occur. Thus, a comparison between loss and non-loss trials would have also provided little information regarding the response force enhancing effects of losing relative to baseline in which neither winning nor losing occurred. Nonetheless, the inclusion of these trials was necessary to separate win trials and loss trials into two different conditions, thus controlling for the potential carry-over effect from a win trial to a loss trial (and vice versa).

The present thesis was an exploratory study. In the course of the investigation, it was necessary to change the procedure many times. The format of the presentation was designed so that the reader can follow the logic of each change as it is introduced. Each new method was designed with the purpose of determining the appropriate procedural

conditions to maximize treatment effects; i.e., changes in response force resulting from both decreases and increases in reinforcement.

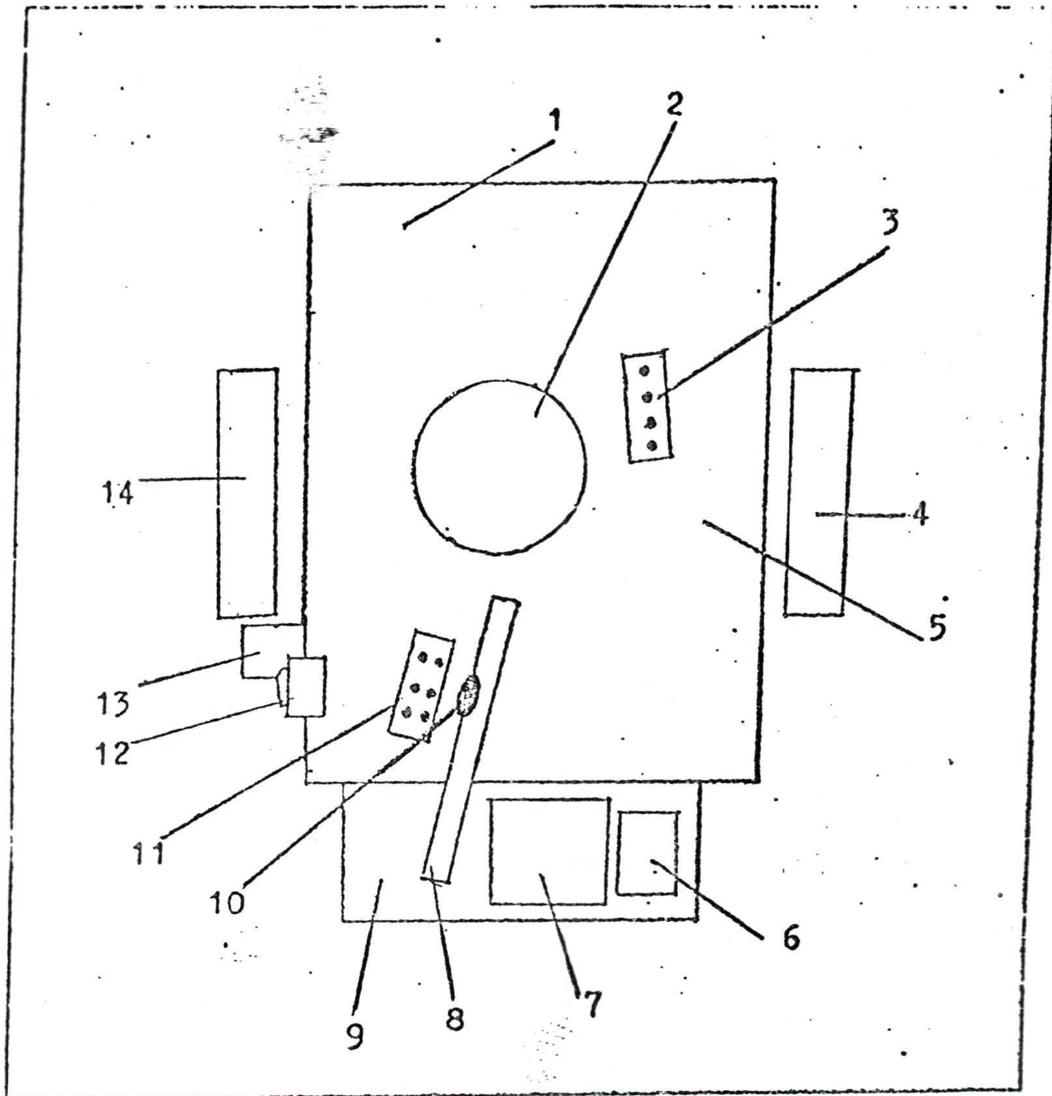
Experiment 1

Method A

The subjects were one female graduate student (S1) and one male undergraduate student (S2). Neither subject was experimentally naive; i.e., both had previously participated in psychology experiments.

Apparatus. The testing room was located in the Psychology Department at the University of Victoria. Figure 1 diagrams the setup of the experiment. A desk, which served as a table, measured .75 m in width X 1.12 m in length X .75 m in height, the width of which separated the experimenter and the subject. A roulette wheel was situated in the middle of the desk. To the subject's right and within easy reach was a panel (7 cm X 24 cm) consisting of three small buttons and three corresponding LED's (Panel 1). A cardboard box hid this panel from the experimenter. A second similar panel (Panel 2) was visible to both the subject and the experimenter in the middle of the desk and contained three LED's corresponding to those on Panel 1, as well as a fourth LED which signalled the appropriate time for the experimenter to spin the wheel.

Also to the subject's right and clamped to the desk was a hinged, box-like manipulandum covered with cloth. This manipulandum was levered in a way that an outstretched forward motion with the right hand against a round white button at the end of the lever closed a switch. Another



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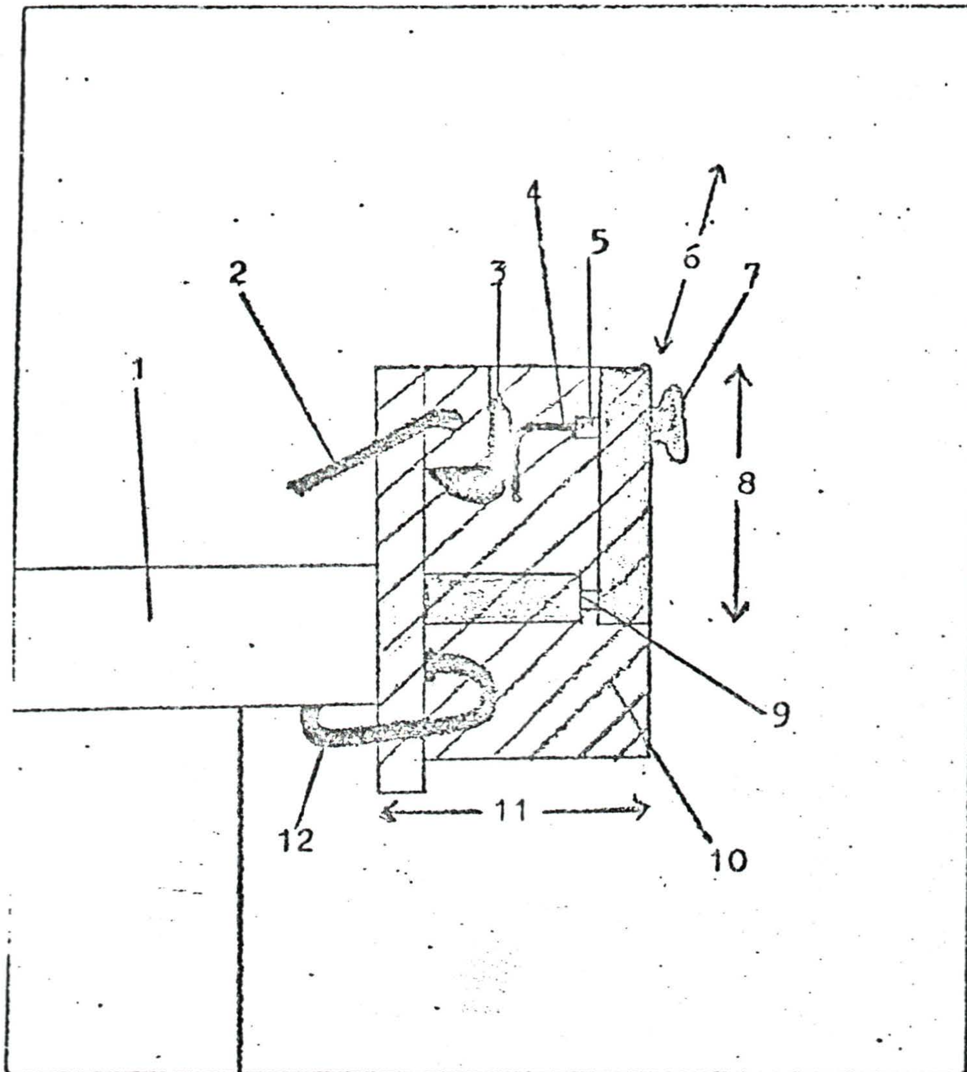
1. AREA OF DESK FOR SUBJECT'S TOKENS
2. ROULETTE WHEEL
3. PANEL 2
4. CHAIR FOR EXPERIMENTER
5. AREA OF DESK FOR EXPERIMENTER'S TOKENS
6. SPHYGMOMANOMETER
7. COMPUTER
8. PARTITION
9. SMALL TABLE
10. SONALERT SIGNAL (TONE)
11. PANEL 1
12. BUTTON LEVER MANIPULANDUM
13. ESCAPE MANIPULANDUM
14. CHAIR FOR SUBJECT

Figure 1. General setup of the apparatus in Experiment 1.

cloth covered manipulandum was clamped underneath the desk just above the subject's right knee. This lever was designed so that an upward motion with the knee against the lever was required to escape from a tone by turning it off. For further reference, the former will be referred to as the button lever response, while the latter will be called the escape or kick response. Figure 2 and Figure 3 illustrate each manipulandum in greater detail.

At the center of both the button lever and the escape lever and hidden by the cloth were rubber bulbs detached from anti-freeze testers. Each bulb provided a "cushion-like" effect in that it absorbed the impact of the response and caused each lever to spring back to its original position. The bulbs were attached via rubber tubing to a Sphygmomanometer Pre-Amplifier (Gross Instrument Company, Model 7P8B) which measured the pressure exerted on each bulb with a response on either lever. A Rockwell Aim 65 computer was circuited to the Sphygmomanometer so that it converted and recorded each press measurement in equal interval whole numbers from a range of 0-7. A 0 recording meant the subject depressed the lever with the minimal amount of force to register on the computer, and a press of any lesser magnitude was insufficient to achieve its purpose. Depressing a lever all the way against the bulb registered as a 7.

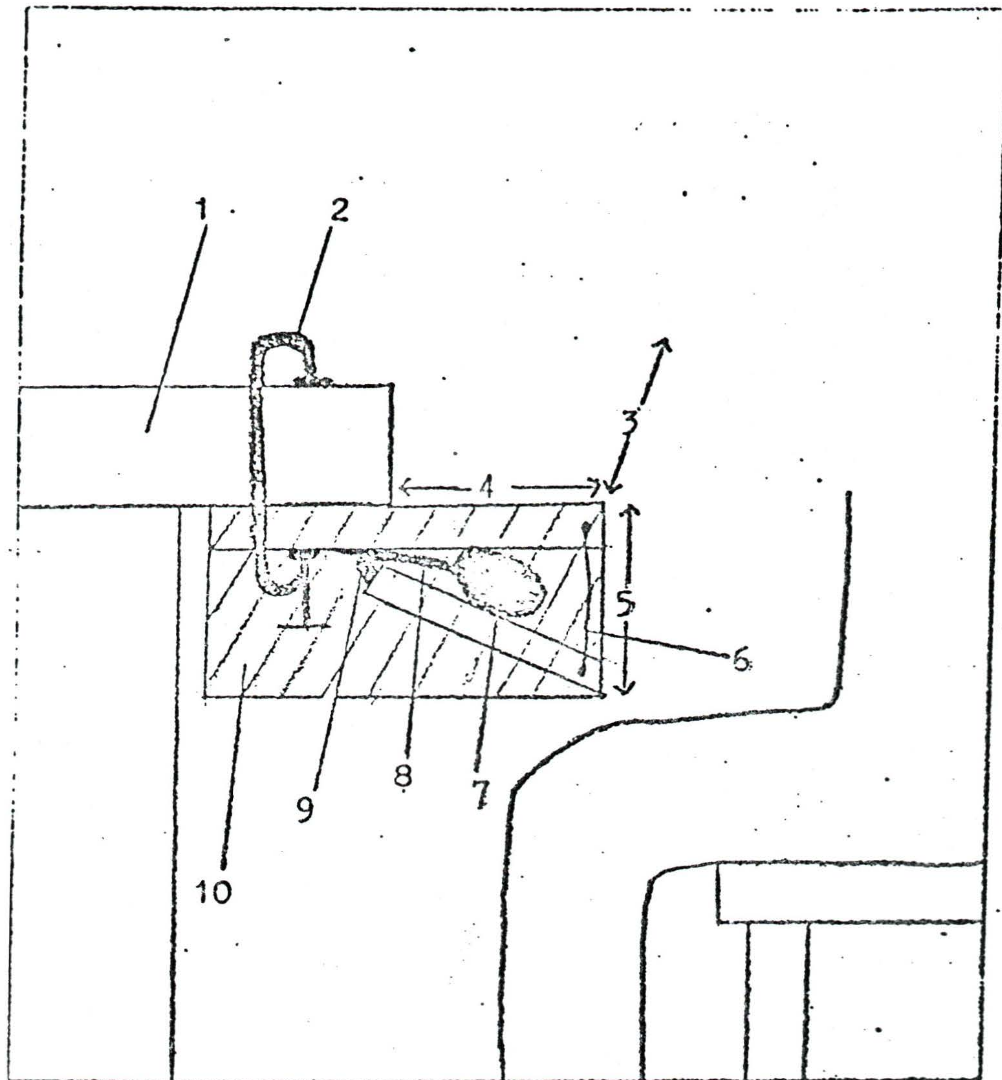
Both the sphygmomanometer and the computer were hidden



LEGEND: CODE

1. DESK
2. RUBBER TUBING
3. RUBBER BULB
4. BENT PIECE OF METAL RESTING AGIANST THE RUBBER BULB
5. SWITCH
6. 9 CM ACROSS
7. WHITE KNOB (DIAMETER = 5 CM)
8. 10 CM
9. HINGE
10. CLOTH COVERING THE ENTIRE MANIPULANDUM
11. 15 CM
12. CLAMP

Figure 2. Diagram of the button lever manipulandum.



LEGEND: CODE
1. DESK
2. CLAMP
3. 13 CM ACROSS
4. 15 CM
5. 10 CM
6. STRING JOINING THE TWO PIECES OF WOOD
7. RUBBER BULB
8. RUBBER TUBING
9. HINGE
10. CLOTH COVERING THE ENTIRE MANIPULANDUM

Figure 3. Diagram of the kick/escape manipulandum.

from the subject by a partition in the middle of a small table, on top of which both machines were located. Taped to the top of this partition facing the subject at approximately ear level was a 6-28 v DC Sonalert Signal (SC628) which sounded at a frequency of 2800 Hz and an intensity of 68 db.

Task. The task performed by each subject on any given trial was as follows. To begin a trial, the experimenter pressed a switch on the computer keyboard which signalled the computer to (a) begin interval 1, and (b) alert the subject that the trial had begun by turning on the tone. The subject could escape the tone for 7 sec at a time throughout the trial by raising his/her knee with a minimal amount of force against the kick lever. Upon hearing the first tone, the subject pushed one of three buttons on Panel 1 corresponding to one of three outcome possibilities on the wheel. As there are 36 numbers on a roulette wheel (excluding 0), each button corresponded to a range of 12 numbers; i.e., Button A = #'s 1-12, Button B = #'s 13-24, and Button C = #'s 25-36. To bet correctly, the subject had to choose the range in which the winning number on the wheel fell. The subject was allowed to change his/her bet. When the choice was final, the subject secured the bet by pressing the button lever (R1) which closed a switch and signalled the computer to: (a) begin interval 2; (b)

illuminate the LED on panel 1 which matched the final button press, serving as a reminder for the subject for the remainder of the trial of the final bet; and (c) flash the fourth LED on Panel 2, alerting the experimenter to spin the wheel. After the wheel stopped, the experimenter pressed the switch on the computer keyboard to signal the computer to start interval 3, and then he announced the outcome. The subject pressed the button lever again (R2), closing a switch which (a) revealed the final bet to the experimenter by illuminating one of the three other LED's on Panel 2, and (b) signalled the computer to begin interval 4. The experimenter manually delivered or took away tokens, or waited a few seconds and did nothing, depending upon the condition and the outcome. Finally, the subject pressed the button lever a third time (R3) to end the trial. This final button press signalled the computer to: (a) end interval 4; (b) turn off the lights on both panels; (c) turn off the tone for the intertrial interval; and (d) print all relevant information. The information which was printed included: (i) all button press choices on Panel 1; (ii) the force of all three button lever responses; (iii) the force of all escape responses; and (iv) the interval during which each of the aforementioned responses occurred.

The task performed on each trial may be described as concurrent schedules in which one component consisted of a

chain of behaviors intermittently positively-reinforced on a VR3 schedule, while the other component consisted of a specific behavior (i.e., the kick response) continuously negatively-reinforced with escape from the tone.

Procedure. Before the experimental session began, the subject was seated across from the experimenter and informed that the purpose of the study was to examine betting strategies. The subject was acquainted with the apparatus and led through a number of practice trials. When the subject felt familiar with the procedure and no prompting was necessary from the experimenter, the experimental session began.

The session consisted of three conditions. The first condition, Baseline, included five trials such that all aspects of the task were identical to the task outline, except that when the subject was informed that the wheel had stopped, no outcome was announced. It was explained to the subject that the purpose of these trials was to analyze betting strategies independent of the outcome on the wheel. Baseline was scheduled at the beginning of the session, in-between the Reinforcement and Taking conditions, and at the end of the session. The second condition, Reinforcement, consisted of two phases. In the first phase, there were 15 trials whereby a correct bet resulted in the delivery of a token (win trial), while an incorrect bet was neither rewarded nor penalized (non-win

trial); in the second phase there were eight trials which were similar to the former in that each time a correct bet was made a token was delivered, but also if the bet was correct and the winning number on the wheel was black as opposed to red, then three tokens were delivered (big win trial). The third condition, Taking, also consisted of two phases. In the first phase, there were 15 trials whereby a correct bet resulted in the loss of a token (loss trial), while an incorrect bet was neither penalized nor rewarded (non-loss trial); in the second phase, there were eight trials which were similar in every way to the big-win trials, except that three tokens were taken instead of delivered when the winning number on the wheel was black (big loss trial).

The session lasted approximately 45 min. At the end, each subject was told the actual purpose of the experiment. Also, each subject was asked to communicate any feelings or emotions which had been present during the session and if he/she had any afterthoughts about the experiment in general.

Each subject began with a pile of 15 tokens and could add or subtract from this total depending upon the outcome on any given trial. Although the object was to win as many of these tokens as possible, they were not exchangeable for money or prizes.

Results and Discussion. S1 maximally depressed the

button lever on every trial. Because of this ceiling effect, results for S1 are reported for the escape data only. Table 1 shows mean escape response magnitudes on the last response before the outcome and the first response after the outcome during baseline, win, and loss trials. Escape response force immediately following the outcome was nearly double that of baseline during win trials; during loss trials, it was slightly greater than baseline. Table 1 also reveals that S1 increased magnitude of responding from the escape response immediately preceding the outcome to escape response immediately following the outcome on both win and loss trials, the effect being most pronounced in the former. However, the same trend was shown, although to a lesser degree, on baseline trials. A Chi-Square analysis was used to calculate if there was any difference in the proportion of trials in which escape response magnitude increased from the response immediately before the outcome to the response immediately following the outcome for (a) loss trials versus baseline trials, and (b) win trials versus baseline trials. Neither comparison was significant.

S2 kicked with minimum force (i.e., 0-magnitude) to escape the tone on the first few trials and thereafter no longer performed this response, choosing instead to leave the tone always on. Table 2 (see p. 68) shows the magnitudes of the three button lever responses during

Table 1

Force Means for the Last Escape Response before the Outcome (E1) and the First Escape Response after the Outcome (E2) during Baseline, Loss, and Win Trials for S1

	Escape Response	
Condition	E1	E2
Baseline	1.79(.70)	2.00(.47)
	(n = 14)	(n = 10)
Win	2.57(.53)	3.83(1.60)
	(n = 7)	(n = 6)
Loss	2.00(.51)	2.50(1.00)
	(n = 4)	(n = 4)

Note. Parentheses beside magnitudes denote standard deviations.

baseline, and all win and loss trials (including big-win and big-loss trials). No noteworthy trends in the means of the three button lever magnitudes for any of the conditions are shown for S2.

Both subjects reported that the game was not very exciting and this was confirmed by observation. When asked what would make the game more exciting, both subjects commented that money should have been used as reinforcement.

Method B

All aspects of Method A were repeated with one exception: quarters were used in place of tokens as reinforcement, and whatever was left over could be kept.

The subject (S3) was one experimentally naive male undergraduate student; i.e., he had never previously participated in a psychology experiment.

Results and Discussion. Only 13 of the 148 escape responses were greater than 0-magnitude. It is interesting to note, however, that every one of the greater than 0-magnitude kicks was after a non-win during Reinforcement or after a loss during Taking. Furthermore, during a period when three consecutive losses occurred, S3 emitted three kicks greater than 0-magnitude coupled with loud negative verbal responses. Table 2 reveals no significant trends in the means of the three button lever magnitudes for any of the conditions. However, closer scrutiny of the

data showed that button lever magnitude on all three responses generally increased across all trials within the session. This latter finding takes on increased significance considering the fact that no wins were recorded after the first phase of Reinforcement, and thus all the subject was exposed to for the remainder of the session were baseline trials, non-win trials, non-loss trials, and loss trials. Overall, S3 appeared disinterested in the outcome on any given trial. He was easily distracted and later called the game "not very exciting".

Method C

At this point in the investigation, it was hypothesized that the lack of consistent findings resulted because (1) subjects were not actively enough involved in the task, and (2) the previous procedures had too many phases and, therefore, not enough losses and wins to generate reliable results. A new procedure was devised to rectify these shortcomings. All apparatus, computer circuitry, and parameters were the same as in the other two methods except where otherwise noted.

The subject (S4) was one experimentally naive male undergraduate student; i.e., he had never previously participated in a psychology experiment.

Procedure. On a roulette wheel there are 36 numbers excluding zero. Each number is either red or black. A mat

containing these numbers was situated between the subject and the experimenter on the desk such that the subject could easily reach over and place a nickel on a number. If the winning number on the wheel was the same colour as the number that the subject bet on, then this constituted a _win_; a _loss_ occurred when the colours were dissimilar. The subject controlled the magnitude of each bet by pressing one of the three buttons on Panel 1 at the beginning of the trial which signalled a bet of either 5 cents, 10 cents, or 15 cents. If the subject also bet on the correct number, then a 50 cent bonus was added (_big win_). The subject was given 25 nickels at the start of the session, and was informed that he could keep whatever was left at the end of the experiment.

When the tone sounded to begin a trial, the subject placed a nickel on 1 of the 36 numbers on the mat. In an animated voice, which attempted to emulate the dealer in a casino, the experimenter cued the subject to choose the magnitude of the bet. The subject picked the magnitude by pressing one of the three buttons on Panel 1. The experimenter then asked the subject to secure his bet, which was accomplished by pressing the button lever (_R1_). Then, the subject spun the wheel and, subsequently, announced the winning number and colour. Immediately following the outcome, the subject pressed the button lever a second time (_R2_) to reveal the magnitude of the bet to

the experimenter by illuminating one of the LED's on Panel 2. The experimenter delivered or took away the appropriate amount of nickels depending on whether or not the bet was correct. Finally, the subject pressed the button lever a third time (R3) to end the trial.

S4 was a pilot subject in the sense that the setup was changed a number of times within the 77 trial session. For consistency, results are reported only for the 34th to the 77th trial. Trials 51-55 and 73-77 were baseline trials. Escape data are not reported, as response topography requirement was unsuccessfully varied throughout the session to alleviate the problem of 0-magnitude responses deomstrated by two of the three previous subjects.

Results and Discussion. Table 2 shows that S4 increased mean force from R1 to R2 on both loss and win trials, although the extent of this increase is unknown because of a ceiling effect on the magnitude of R2. Observation was in accord with this suggestion of a ceiling effect, for on some occasions, particularly during loss trials, S4 punched the lever extremely hard. It should be noted, however, that the increase in mean force from R1 to R2 was also evidenced during baseline trials, and it may be that all trials were affected by a ceiling effect. Observation also revealed that S4 hit the table and swore after some loss outcomes. Because of the success of Method C in eliciting these behaviors, this procedure was extended

into Method D.

Method D

The procedure was similar to Method C with the following changes. First, the kick response was again reemployed as the only escape response topography for consistency across subjects, although the possibility of 0-magnitude kicks was anticipated. Second, the result of a 0 outcome on the wheel resulted in a 50 cent bonus loss (big loss). And third, the subjects were video recorded. This latter change in procedure was added to aid the experimenter in a more detailed observation of subjects' behaviors. One observation of special interest noted in Method C was variation in the topography of the button lever response; i.e., sometimes the subject pressed, other times he punched the lever.

The two subjects (S5 and S6) were male undergraduate students, and only the former was experimentally naive; i.e., S6 had previously participated in psychology experiments, while S5 had no such experience. S5 was exposed to 121 trials, and baseline was composed of Trials 1-5, 61-65, and 117- 121. For S6, there were 60 trials, the first and last five of which were baseline trials.

Results and Discussion Again, uniformly 0-magnitude kick responses were observed and, therefore, no escape data are presented for either subject. Results for S6 are reported for only Trials 28-60 because of apparatus

failure.

Table 2 shows that S5 decreased mean force from R1 to R2 on both loss and win trials, while S6 increased mean force. This same pattern was shown by each subject during baseline. (It should be noted that S6's baseline data are based on only the last five trials of the session, and these came after a string of losses.) Thus, it appeared that variables other than the loss and win outcomes *per se*, apparently present during all trials including baseline, were responsible for the suppression of R2 magnitude for S5 and the enhancement of R2 magnitude for S6.

Each subject's emotional responses coincided with the R1-R2 response force trend shown after losing and winning. S5 exhibited little emotion in response to a loss or a win outcome. S6 was extremely animated and swore when he lost and expressed pleasure when he won. Each subject reported that he did feel like hitting or punching the button lever at certain moments during session, but he did not in fear of breaking the apparatus.

Method E

Because each of the last two subjects reported that he inhibited forceful responding, it was decided that subjects in the new procedure would be told to express their emotions on both response levers. The major advantage of this approach was that inhibitions would be minimized and relatively stable across subjects in comparison to the

previous methods whereby some subjects expressed themselves and others did not. Although the kick response yielded minimal variability thus far, it was kept as part of the task in case this response was also previously being inhibited.

The subjects (S7, S8, S9) were three experimentally naive male undergraduate students; i.e., none had previously participated in a psychology experiment. All were exposed to 5 baseline trials, followed by 50 win-loss trials, and then 5 more baseline trials.

Results and Discussion. Escape data are not specifically reported for any subject because the vast majority of kick responses were of 0-magnitude. S8 emitted no escape responses.

Table 2 reveals no significant trends in button lever response magnitude for S7. S8 suppressed average button lever response magnitude after an outcome, as evidenced by: (a) there was no R1-R2 difference in magnitude on baseline trials; (b) magnitude decreased from R1 to R2 on both win and loss trials; and (c) R2 magnitude was greater on baseline trials than on either win or loss trials. S9 showed a slight increase in magnitude from R1 to R2 on baseline trials, a larger increase on win trials, and a still larger increase on loss trials. R2 magnitude for S9 was distinctly greater on loss trials than on baseline trials.

Two noteworthy findings were observed for S9. Of the 11 escape responses greater than 0-magnitude, 10 of these were emitted in the period immediately following a loss outcome. Also, of the five button lever responses of maximum force (magnitude = 7), all were elicited on R2 immediately following a loss outcome.

Video recordings showed that S7 and S9 verbally expressed pleasure and displeasure after various outcomes, while S8 exhibited no emotion.

Group Results and Discussion

Table 2 shows the average button lever response magnitude for each of the three responses on baseline, loss (including big loss), and win (including big win) trials. Non-win and non-loss trials for S's 1-3 are not reported because of the ambiguity of these trials (see Predictions).

Mean force on R2, which immediately followed the outcome, was greater on loss trials than on baseline trials for five of the eight subjects, but this result was exaggerated since only one subject (S9) showed this effect to any great degree. (It should be noted that a ceiling effect may have obscured this comparison for S4.) Five of the eight subjects increased mean force on R2, which was immediately following the outcome, from R1, which was immediately before the outcome, on loss trials; however, this effect was pronounced for only three subjects (S4, S6, S9), and these subjects showed the same increase, although

Table 2

Force Means on the Three Button Lever Responses on Baseline, Loss, and Win Trials for Subjects in Experiment 1

Subject	Condition	Button Lever Response		
		R1	R2	R3
2	Baseline(15)	5.60(.63)	5.73(.46)	5.53(.64)
	Loss(7)	5.57(.53)	5.71(.49)	5.20(.84)
	Win(5)	6.00(0)	6.00(0)	6.00(0)
3	Baseline(10)	5.50(.53)	5.30(.48)	5.30(.67)
	Loss(7)	5.86(.38)	5.57(.53)	5.43(.79)
	Win(4)	4.25(1.50)	4.00(.82)	3.25(.96)
4	Baseline(10)	6.00(1.25)	6.67(.50)	6.50(.53)
	Loss(18)	5.72(.96)	6.94(.24)	6.67(.49)
	Win(13)	4.77(1.48)	6.92(.28)	6.77(.44)
5	Baseline(15)	1.00(1.00)	0.53(.64)	0.73(.70)
	Loss(50)	1.50(1.15)	0.76(.89)	1.32(.91)
	Win(56)	1.77(.99)	0.71(.87)	1.50(.71)
6	Baseline(5)	4.40(.55)	5.80(.45)	6.00(0)
	Loss(12)	3.92(1.44)	5.58(.51)	5.67(.49)
	Win(10)	4.10(1.10)	5.00(.94)	5.62(.74)
7	Baseline(10)	4.25(2.05)	4.12(1.81)	3.37(2.39)
	Loss(25)	4.16(1.55)	4.32(1.89)	4.48(2.08)
	Win(35)	4.09(1.82)	4.66(1.21)	4.23(1.77)
8	Baseline(10)	1.10(.87)	1.00(1.41)	0.30(.67)
	Loss(25)	1.84(1.52)	0.52(.71)	0.75(.94)
	Win(24)	1.95(1.43)	0.67(1.09)	0.87(1.26)
9	Baseline(10)	3.20(2.35)	3.60(1.71)	2.78(2.17)
	Loss(28)	2.36(1.64)	4.68(2.28)	1.93(2.11)
	Win(22)	2.73(1.35)	3.46(2.02)	0.50(1.06)

Note. Parentheses beside condition denote number of trials. Parentheses beside magnitudes denote standard deviations.

to a lesser extent, on baseline trials. The proportion of loss trials in which amplitude increased from R1 to R2 was compared to the proportion of baseline trials in which this effect occurred via _Chi-Square_ for each subject. Results showed significance for only one of the eight subjects (S4). These findings indicated that individual loss trials in Experiment 1 were unable to induce statistically significant more forceful responding on the button lever response immediately following the outcome.

The results were even less convincing for win trials. Although half of the eight subjects showed greater magnitude on R2 on win trials compared to baseline trials, in no instance was this difference pronounced. (Again, a ceiling effect may have obscured this comparison for S4.) Half of the eight subjects increased magnitude from R1 to R2, with this effect being pronounced for only two subjects (S4, S9); however, these two subjects demonstrated a similar increase during baseline trials. When the proportion of win trials in which magnitude increased from R1 to R2 was compared to the proportion of baseline trials in which this effect occurred, no significance was found for any subject. Thus, individual win trials in Experiment 1 were unable to induce statistically significant more forceful responding on the button lever response immediately following the outcome.

The results of Experiment 1 indicated that the effect

of schedule changes (i.e., individual loss and win trials) on the force of responding was minimal within the parameters employed. Alternatively, the response levers may have been insensitive measures in that responses on these manipulanda became so much a part of the task that subjects were discouraged from expressing emotion on them. Some subjects demonstrated overt emotional reactions following various outcomes (e.g., swearing, laughing), responses which did not necessarily register as high magnitude. Two arguments are offered against this conclusion. First, these overt emotional reactions were infrequent and, for the most part, subjects appeared disinterested throughout the session. Second, subjects were explicitly told to express their emotions on the levers in Method E, and still no effect was found. Thus, the small effects may have been due to ineffective loss and win conditions rather than the insensitivity of the response levers as measures of reactions to losing and winning.

It was expected that losing would increase force of responding based on the human SIA literature as well as studies on response vigor in children. That response force was not generally affected by losing (alternating with winning) on a trial-by-trial basis suggested that each loss trial *per se* was not aversive, at least not enough to enhance response magnitude. The human SIA studies employed

phases of reinforcement and extinction, and it was the extinction condition analyzed as a whole (i.e., consisting of a number of non-reinforced trials) which produced high magnitude responding (e.g., Harrell, 1972). In Experiment 1, each loss was small, taken from money (or tokens) already given to the subject, and interspersed with reinforcing win trials, all of which may have taken away from the aversiveness of an individual loss trial.

That conditions more aversive than individual loss trials were needed to enhance response force is in accord with the finding that the most explicit examples of emotional behavior (e.g., swearing) and aggressive response topography (e.g., slapping and punching the levers) came after a string of losses for S3, S4, S6, and S9. To further explore this hypothesis, response magnitudes during the theoretically most aversive conditions in Experiment 1 were considered for analysis; i.e., big losses and a string of losses. Table 3 compares mean force on R2 between (i) big losses and all other losses for each subject who experienced big losses, and (ii) loss trials following three or more losses in a row and all other losses for each subject who experienced three or more losses in a row. In both instances, response force immediately following the outcome was greater for five of the six subjects in the more aversive condition. Because of practical and ethical considerations, increasing the magnitude of a loss in

Table 3

Mean Force of R2 on the Theoretically Most Aversive Loss Trials Versus All Other Loss Trials

	a		b	
Subject	Big Loss	Other Losses	3 or More	Other Losses
S3	6.00(1)	5.50(6)	6.00(1)	5.50(6)
S4	----	----	7.00(2)	6.93(16)
S5	1.00(2)	0.75(48)	0.00(2)	0.79(48)
S6	5.33(3)	5.67(9)	6.00(3)	5.44(9)
S7	6.00(1)	4.25(24)	----	----
S8	1.25(4)	0.38(21)	0.80(5)	0.45(20)
S9	6.00(2)	4.58(26)	5.80(5)	4.44(23)

Note. Parentheses beside magnitudes denote number of trials.

Experiment 2 was not possible. Thus, Experiment 2 employed a condition of losses and wins followed by a condition of losses to: (a) enhance the aversiveness of the situation, specifically the loss phase; and (b) more closely emulate the extinction-induced aggression studies.

That individual win trials did not augment force of responding following the outcome implied that (1) winning does not increase response force, or (2) the saliency of a win in Experiment 1 was not sufficient to induce the desired behavior. The first alternative seems unlikely considering: (a) the frequency of common examples seen everyday, especially in the media, such as winning sports teams and game show contestants, and the vigorous behavior engaged in as a consequence; (b) the positive incentive contrast studies with humans, which demonstrated that increasing amount of reward results in decreased response latencies; and (c) the study by Yoburn et al. (1981) which suggested that reinforcement _per se_ induces aggressive behavior with pigeons. The magnitude of a win in Experiment 1 was small, and it was unlikely that it would have had as great an effect as the game show contestant winning a car or, as in the Yoburn et al. (1981) study, a food deprived pigeon receiving a grain. In other words, the saliency of reinforcement in Experiment 1 may not have been sufficient to have enhanced response force.

To test this hypothesis, the theoretically most salient

reinforcement conditions in Experiment 1 were considered for analysis; i.e., big wins, a string of wins. Table 4 compares mean force on R2 between (i) big wins and all other wins for each subject who experienced a big win, and (ii) win trials following three or more wins in a row and all other wins for subjects who experienced three or more wins in a row. Table 4 shows that mean force on R2 was greater for only two of five subjects on big win trials opposed to all other win trials. Futhermore, mean force on R2 was greater for only two of four subjects on win trials following three or more wins in a row relative to all other win trials. Thus, unlike loss trials, increasing the magnitude of a win or the number of win trials in a row had no consistent effect on R2 magnitude. Perhaps future observation of the invigorating effects of winning will have to be limited to observing the effects of a lucky person winning a one-in-a-million windfall, provided the observer is in the right place at the right time; it is obviously unethical to deprive an individual to the point that a nickel or a bite of food acquires extreme reinforcing value, and experimentally impractical to give away large prizes. Or perhaps, concerning the positive incentive contrast studies with humans, treatment effects require that reinforcement be contingent upon the subject's behavior. In these investigations, the subject was told that the amount of reinforcement depended upon the speed

Table 4

Mean Force of R2 on the Theoretically Most Salient Win Trials Versus All Other Win Trials

	a		b	
Subject	Big Win	Other Wins	3 or More	Other Wins
S4	7.00(2)	6.90(11)	----	----
S5	0.00(3)	0.75(53)	1.60(5)	0.62(51)
S6	6.00(1)	4.89(9)	4.00(1)	5.11(9)
S7	4.50(2)	4.67(33)	4.40(5)	4.70(30)
S8	0.40(2)	0.74(22)	----	----
S9	----	----	3.50(4)	3.45(18)

Note. Parentheses beside magnitudes denote number of trials.

and accuracy with which he/she answered; in Experiment 1, reinforcement depended upon chance.

Overall, it was concluded that high magnitude responses, when they occurred, were associated with loss trials more so than win trials based on the following considerations. (1) Some distinctly hard hits occurred, although infrequently, on loss trials immediately following the outcome, while on win trials these types of responses were absent. (2) By increasing (i) the magnitude of a loss trial, or (ii) the number of loss trials in a row, response force was enhanced immediately following the outcome relative to all other loss trials for five of six subjects; these changes in conditions produced similar effects for only a minority of subjects on win trials (see Tables 3-4).

In Experiment 1, losing and winning were the result of chance and, therfore, every subject was exposed to different schedule effects. The reasons for employing chance outcomes were: (a) to decrease subjects' suspicions that the experimenter was controlling the outcome, possibly leading to apathy and disinterest; and (b) to make the conditions of the experiment less contrived and more analogous to real life (e.g., a casino-like gambling setting). Although each subject knew that the wheel was not rigged (he/she was free to examine it), the gambling setting appeared to be artificial and far removed from a

true gambling situation, confirmed by both observation and reports from the subjects. A recent study by Anderson & Brown (1984) found that individuals showed a higher heart rate increase over baseline in a real casino compared to an artificial casino in the laboratory. This result was so pronounced that the authors doubted that laboratory gambling is a valid analogue of a real gambling situation. In view of the fact that the SIA studies were able to demonstrate high magnitude responding during aversive schedule conditions despite employing extremely contrived tasks, it would seem that the anticipated advantages of a gambling setting in which chance dictated the outcome were not realized. In Experiment 2, the experimenter controlled the outcome, making this procedure more similar to previous SIA research with humans. Moreover, experimenter control allowed the exposure of subjects to a Taking condition consisting of a string of losses.

Some other changes from Experiment 1 to Experiment 2 included a modification in the parameters of the escape response, as well as the exclusion of R3. The escape response appeared to be an insensitive measure of response force, considering that very few non-zero responses were observed for almost all subjects. Perhaps to deliver a hard kick when face to face with the experimenter was too outwardly an aggressive act and has met with social disapproval in the past. Experiment 2 attempted to control

for possible inhibitory effects of both the topography of the escape response as well as the subject's interpersonal contact with the experimenter by making the topography of the escape response identical to that of the more sensitive button lever response and by separating the subject and the experimenter with a partition.

Not only did few escape responses exceed 0-magnitude, but some subjects did not even kick to escape the tone at all, so that no escape data were available for these subjects. In Experiment 2, it was mandatory for each subject to escape the tone. To simplify the task, only one tone was scheduled at the beginning of each trial.

R3 provided little information in Experiment 1. It was included after the delivery or taking of the reinforcers in case it was this event and not the immediate reaction to the outcome (as measured R2) which triggered more forceful responding. Both observation and button lever response magnitude averages suggested that R2 was the temporally most sensitive measure of changes in response force resulting from a loss or win outcome; therefore, R3 was excluded in Experiment 2.

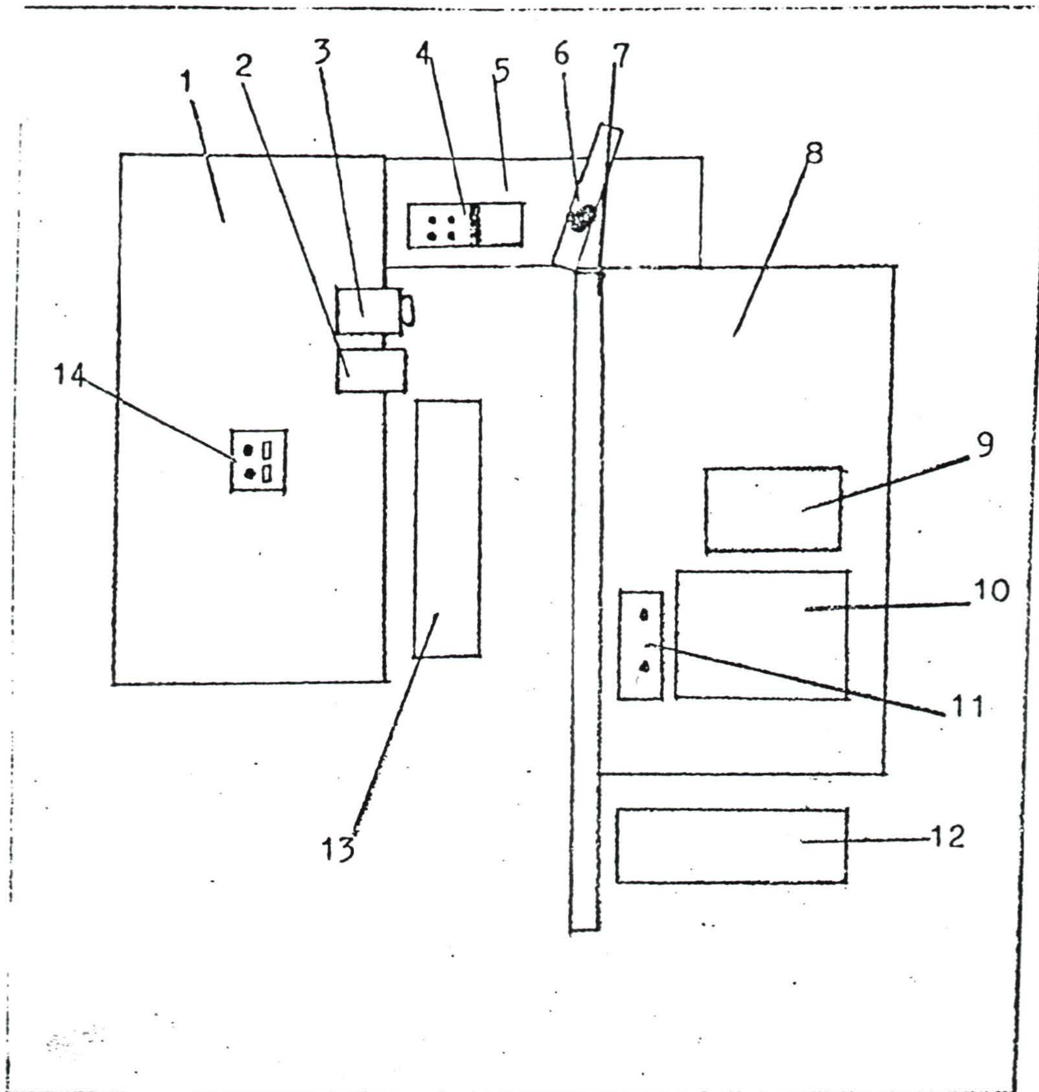
Experiment 2

Method A

The subjects (S10, S11) were two male undergraduate students. Neither subject was experimentally naive; i.e., both had previously participated in psychology experiments.

Apparatus. Figure 4 illustrates the setup of Experiment 2. The apparatus was similar to Experiment 1, except for the following changes. Both parties were seated at separate desks on opposite sides of a large partition. The escape response was redesigned to be similar to the button lever response. The two levers were both clamped to the table and situated within easy reach of the subject's right hand. Panel 1 was located on a small table to the subject's right. One button and its corresponding LED on Panel 1 were covered; the remaining two buttons and LED's were labelled either Heads or Tails. A 10 cm X 10 cm panel (Win/Loss Panel) was situated on the desk within easy sight of the subject. This panel contained two LED's, one labelled Win and the other labelled Loss. The experimenter controlled two switches which illuminated the LED's on the Win/Loss Panel. The computer and the sphygmomanometer were located on the experimenter's desk.

Task. The task performed by each subject on any given trial was as follows. The experimenter pressed a switch on the computer keyboard to sound the tone and begin the trial. This was the only tone which sounded during the



LEGEND: CODE

1. SUBJECT'S DESK
2. BUTTON LEVER MANIPULANDUM
3. ESCAPE MANIPULANDUM
4. PANEL 1
5. SMALL TABLE
6. SONALERT SIGNAL (TONE)
7. PARTITION
8. EXPERIMENTER'S DESK
9. SPHYGMOMANOMETER
10. COMPUTER
11. PANEL WITH SWITCHES FOR WIN/LOSS PANEL
12. CHAIR FOR EXPERIMENTER
13. CHAIR FOR SUBJECT
14. WIN/LOSS PANEL

Figure 4. General setup of the apparatus in Experiment 2.

trial and the subject was instructed to terminate it by pressing the escape lever before proceeding. Next, the subject pressed one of the two buttons on Panel 1 (i.e., Heads or Tails) to make his/her choice. Again, as in Experiment 1, the subject was allowed to change his/her choice, and the final choice was secured by pressing the button lever (R1). This press also signalled the experimenter via flashing a number on the small computer screen that the choice had been secured, and at this point the experimenter pressed one of the switches on his small panel to illuminate either the Win or the Loss LED on the Win/Loss Panel. After this outcome was revealed to the subject, he/she pressed the button lever a second time (R2) to end the trial. This series of events lasted approximately 10 sec.

During the intertrial interval, the computer printed: (i) all button press choices on Panel 1; (ii) the force of both button lever responses; and (iii) the force of the escape reponse. The intertrial interval took approximately 15 sec, during which time the subject was required to record wins and losses on a piece of paper by adding 20 cents for each win and subtracting 10 cents for each loss.

Procedure. When the subject entered the experimental room, he/she was seated and informed of the following. The subject was told that the purpose of the experiment was to test his/her ability in predicting a randon coin flip as

generated by a computer. The subject was instructed to keep track of his/her winnings (see Task), and was told that the final tally would be paid at the end of the session. After this explanation, the subject was acquainted with the apparatus and led through a number of practice trials. As in Experiment 1, when the subject felt comfortable with the procedure and no prompting was necessary from the experimenter, the experimental session began.

The session consisted of three conditions in succession. First, there was a Baseline condition with 10 trials whereby all aspects of the task were similar to the description above, the exception being that the labels on the Win/Loss Panel were covered. It was explained to the subject that the purpose of these trials was to examine choice strategies independent of win/loss feedback, since he/she did not know which LED signalled which outcome. Next, the cover was removed and there was a Reinforcement condition consisting of 60 win/loss trials. The order of wins and losses was generated by a random number table with the restriction that no more than three wins or losses could occur in a row (excluding a string of 11 wins which were programmed to occur from Trials 9-19). Finally, the subject was exposed to an unsignalled Taking condition with 20 losses in a row.

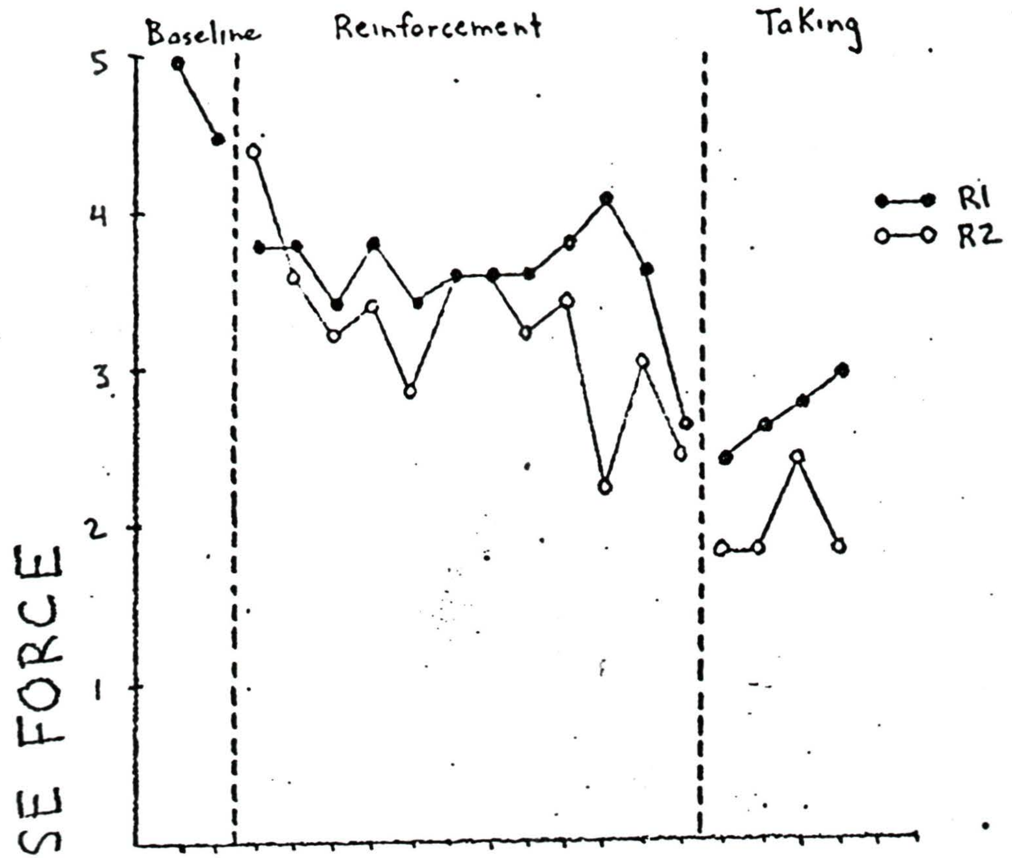
The session lasted approximately 45 minutes, and each

subject was paid three dollars at the end. Subjects were video recorded and these tapes were reviewed at a later time. When the experiment was over, each subject was told the actual purpose of the experiment. Subjects were asked to communicate any feelings or emotions that they remembered during the session, and also if they had any general afterthoughts about the experiment

Results and Discussion. Figures 5-6 are graphs of response force on both button lever responses and the escape response across all trials in five-trial blocks for S10 and S11, respectively. There were no baseline escape data for S10 because of apparatus failure. Figure 5 shows that magnitude on all three responses was generally lower during Taking relative to Reinforcement for S10. Since response force tended to decrease across successive trials within Reinforcement, there is some indication of a fatigue effect which could have carried over into Taking. Figure 6 reveals that magnitude on all three responses was relatively constant across trials and conditions for S11. Each subject reported that the game held little excitement as there was only a 50 per cent chance of winning on any trial despite whatever choice was made. Method B attempted to increase the challenge of the game for the subjects.

Method B

A challenging situation was arranged whereby the subject was informed that he was playing a game against the



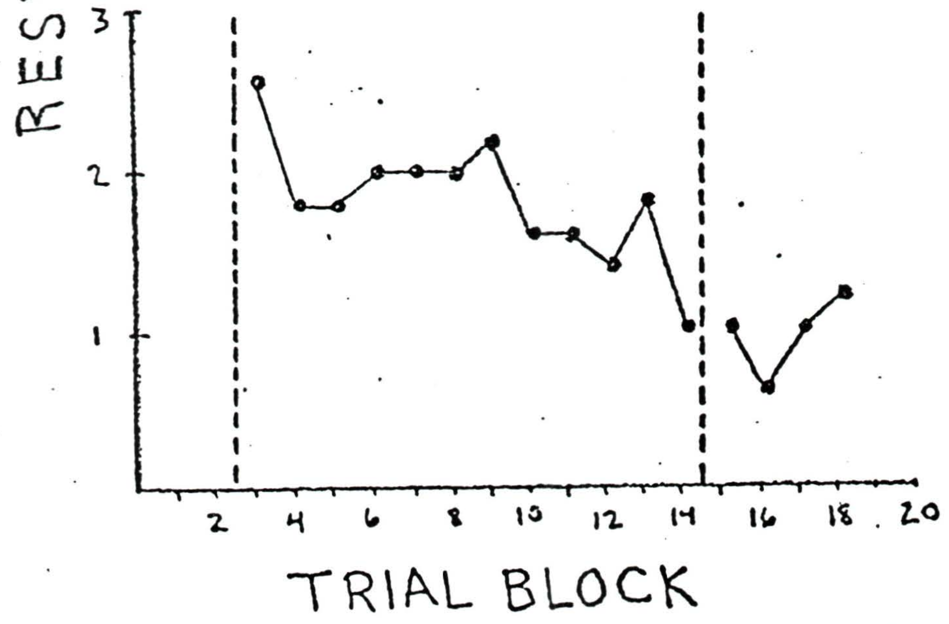


Figure 5. Force on all three responses across 5-trial blocks for S10.

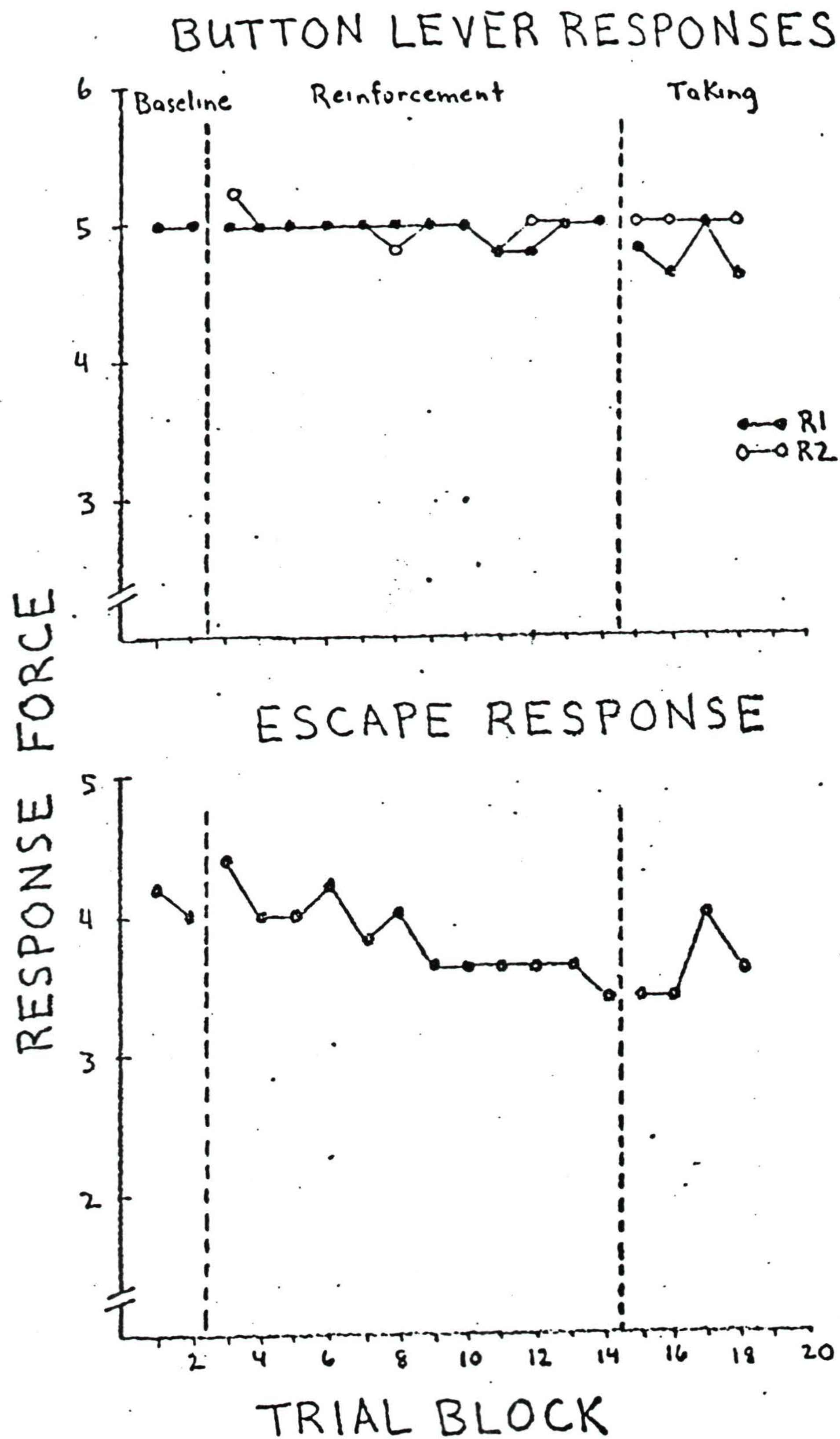
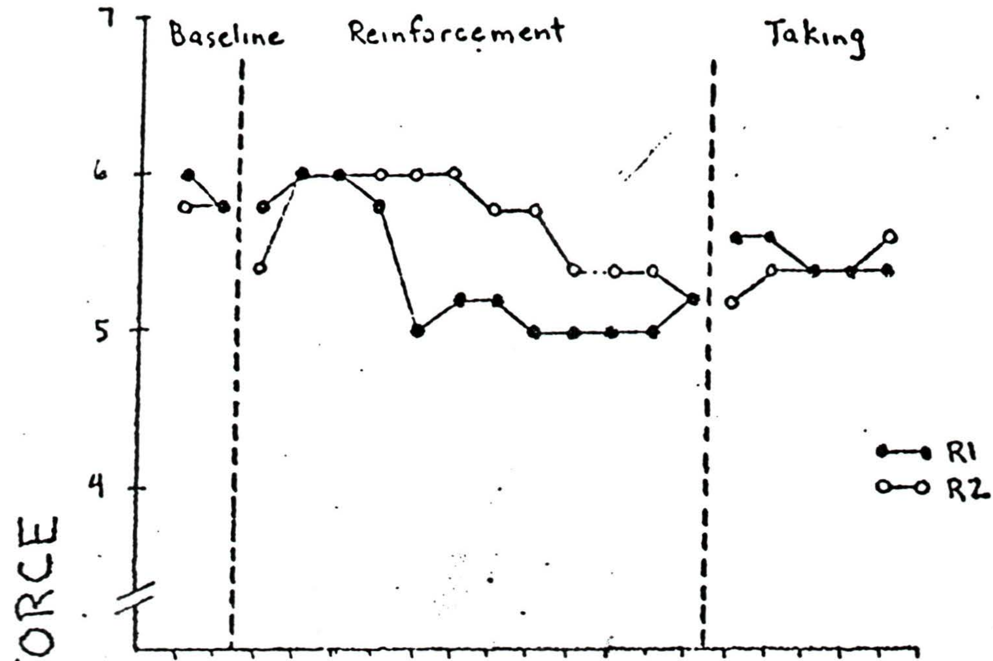


Figure 6. Force on all three responses across 5-trial blocks for S11.

computer. The subject was told that during the first 10 trials (identical to the baseline procedure for Method A), the computer was generating a pattern of his responding and that just before the first Reinforcement trial started, the computer would attempt to predict which response (Heads or Tails) he would choose based on this pattern. He was told that the computer's prediction for each subsequent trial was based on the pattern generated from all preceding trials and, therefore, the computer's ability to predict correctly would increase with time. It was explained that the object of the game was to outguess the computer, which would result in the Win LED flashing on the Win/Loss Panel; however, if the computer guessed which response he chose, the Loss LED would flash. All other parameters were identical to Method A.

The subjects (S12, S13) were two male undergraduate students. Neither subject was experimentally naive; i.e., both had previously participated in psychology experiments. All other parameters were identical to Method A, except that Taking was extended to 25 loss trials for both subjects.

<u>Results and Discussion</u>. The magnitudes of both button lever responses and the escape response across all trials in five-trial blocks are graphed for both S12 and S13 in Figures 7-8, respectively. Figure 7 shows that force on both button lever responses decreased slightly across



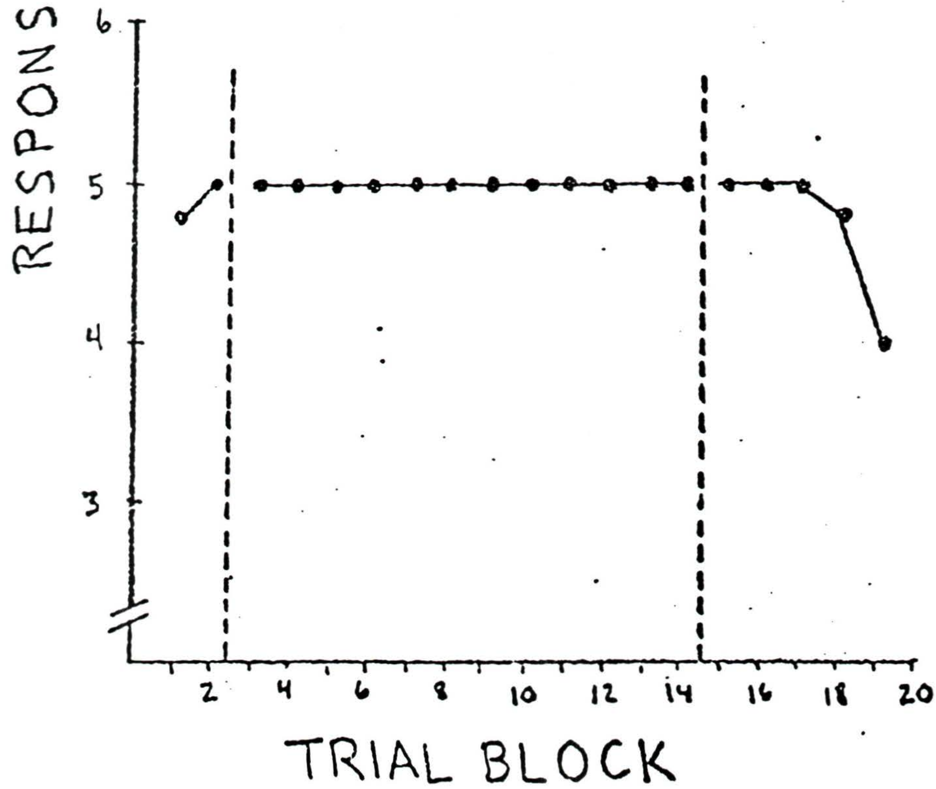
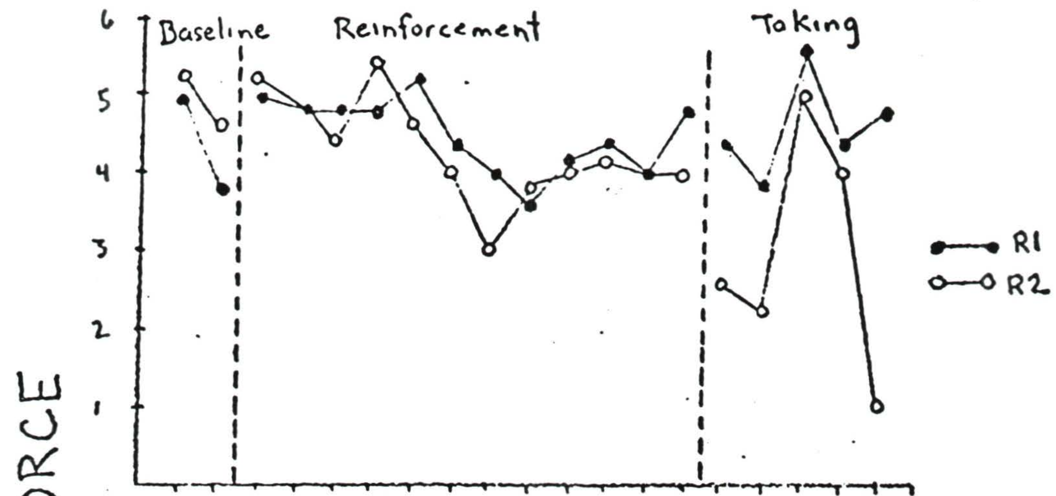


Figure 7. Force on all three responses across 5-trial blocks for S12.



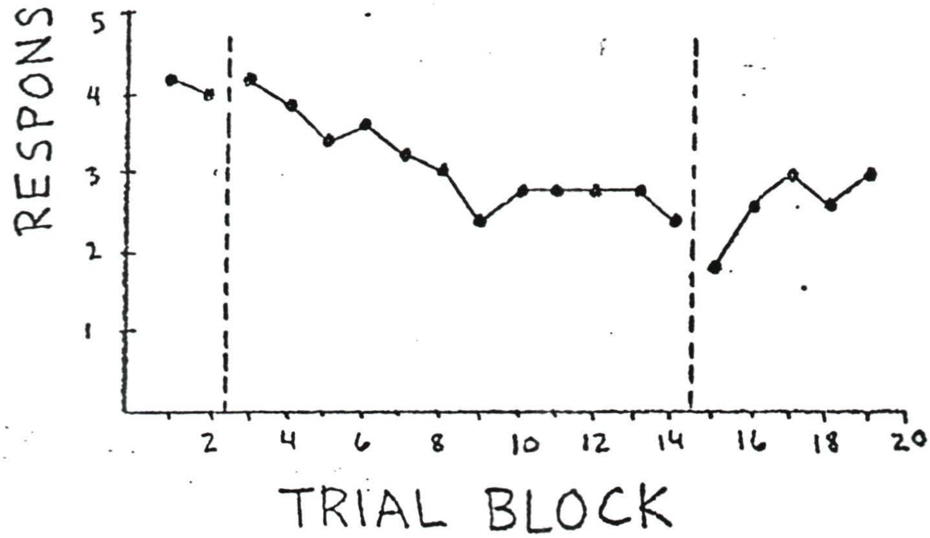


Figure 8. Force on all three responses across 5-trial blocks for S13.

Reinforcement for S12, stabilizing over the last 20 trials and across Taking. Escape response force was constant across the Reinforcement and the first 15 loss trials of Taking, tapering off over the last 10 loss trials. Figure 8 reveals that button lever response force was variable across Reinforcement, although overall it tended to decrease; during Taking, it dropped to a low level on the second trial block, and then peaked on the third trial block. Escape response force decreased across the session, reaching a low point on the first trial block during Taking, and then slowly climbed back to relatively moderate levels for the remainder of the trials.

A number of interesting behaviors were observed on the video recording of each subject, especially during Taking. Throughout the latter portion of Taking, S12 frequently delayed turning off the tone until he was told. Other behaviors observed only during Taking for S12 included hiding Panel 1, talking to the experimenter (e.g., "When is this going to be over?"), and laughing. S13 sighed, laughed, stabbed the button lever with his pen, prematurely pressed the choice button, conversed with the experimenter (e.g., "How many trials are left?"), changed his choice before securing it, punched the button lever a number of times to end one trial (after 15 losses in a row), and slapped or punched both levers; all but the latter behavior were observed during the Taking, and when slapping and

punching did occur during Reinforcement, it was usually after two or three losses in a row. For S13, these behaviors were most frequent during the third trial block during Taking which was also when peak response force occurred on all three responses from the latter half of Reinforcement to the end of the session.

The above results suggested that Taking in Experiment 2 was affecting the behavior of the subjects, although this effect was not as evident on response force magnitudes as it was on the video recordings. One explanation for the inability of the response levers to adequately show changes in response force across conditions could have been that subjects were initially responding at too high a response magnitude during Reinforcement to accomodate an increase during Taking; i.e., changes in response force may have been confounded by a ceiling effect. When the experimenter was explaining the task to the subject, the word *press* was used to describe the motion of both lever responses. Perhaps *press* was interpreted as a mandate for depressing each lever to its approximate maximum.

Method C

In this procedure, the subject was told to *tap* each lever and this motion was modelled a number of times by the experimenter to show the varying degrees with which the levers could be tapped. In this way, the subject knew the minimal amount of pressure needed to constitute a

response. It was hoped that this change in methodology would eliminate the ceiling effect by expanding the room for change in response force from Reinforcement to Taking. All other paramenters were identical to Method B, except that Taking was extended to 30 trials.

The subjects (S14, S15, S16, S17, S18, S19, S20, S21) were eight undergraduate students. Only S17 was female. All subjects were experimentally naive; i.e., none had previously participated in a psychology experiment.

Results and Discussion. Figures 9-16 are graphs illustrating response force for both button lever responses and the escape response across all trials in five-trial blocks for S's 14-21, respectively. Results are reported individually for each subject.

Figure 9 reveals that S14 increased magnitude on both button lever responses across Reinforcement, stabilizing at relatively high levels during Taking. Thus, it appears that time and/or the number of trials were responsible for enhancing button lever response magnitudes, and not the changeover from Reinforcement to Taking. Escape response force also increased across Reinforcement, although the graph shows that magnitude was suppressed during Taking relative to the last 15 trials of Reinforcement. The video recording revealed that the subject emitted new behaviors during Taking which were not present during the Win condition; i.e., taking a long time to make a choice,

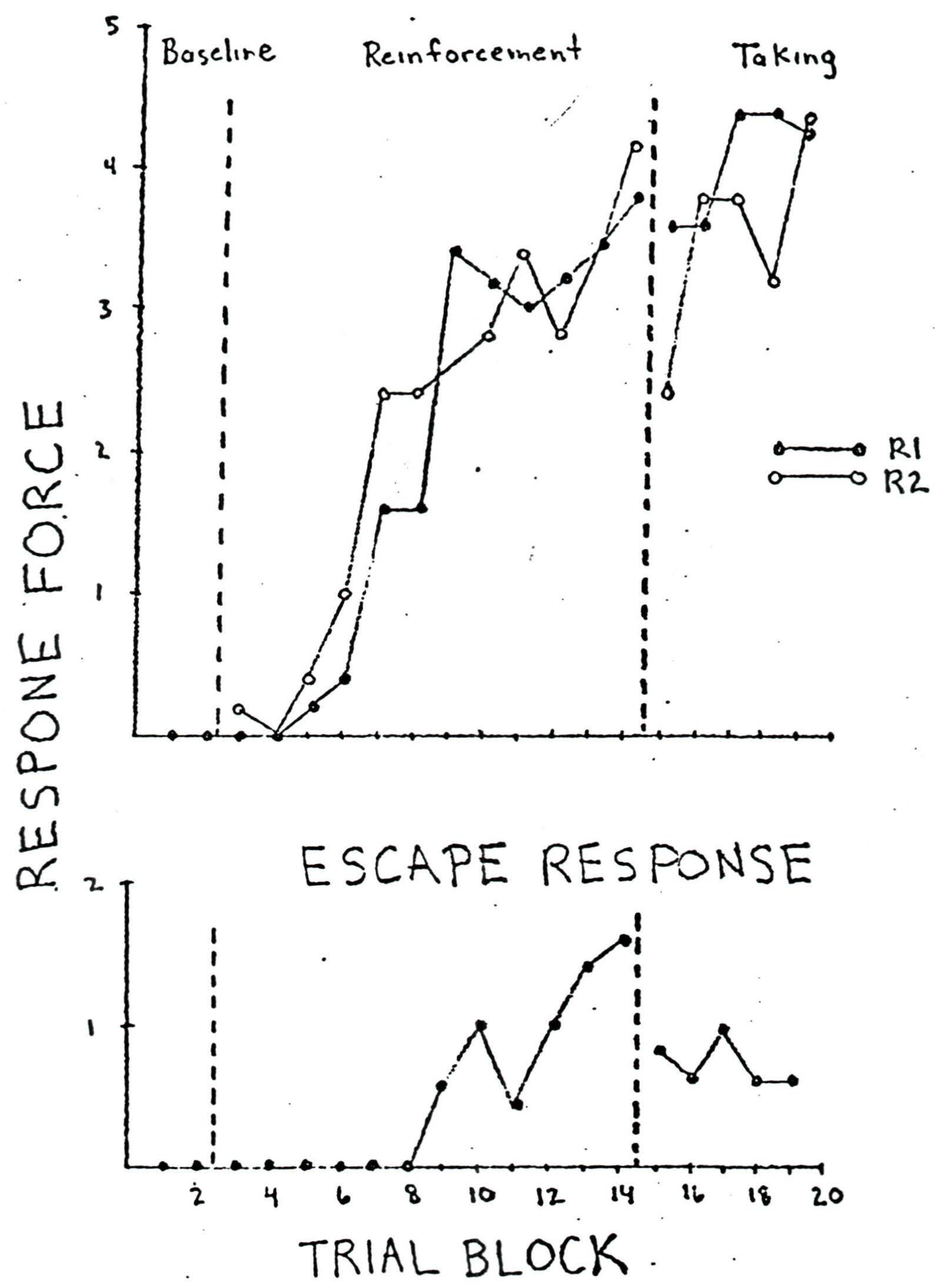


Figure 9. Force on all three responses across 5-trial blocks for S14.

becoming fidgety (e.g., wiggling a pencil, moving in chair), and switching response topography. In reference to the latter behavior, the subject changed from a preferred mode of responding (i.e., a finger push) to a more vigorous hitting motion with his palm.

According to Figure 10, S15 responded at near 0-magnitude levels throughout Reinforcement on both button lever responses; however, during Taking, response force sharply increased. The same effect was present, although not as exaggerated, for the escape response, except that response force peaked on the third trial block within Taking. After 23 losses in a row, the subject changed his choice four different times before securing it.

Figure 11 shows that S16 emitted slightly higher magnitudes on both button lever responses during Taking compared to Reinforcement. Escape response force remained relatively constant across the two conditions.

Figure 12 reveals that force on both button lever responses was slightly higher overall during Taking for S17. The magnitude of the escape response showed a similar, even slighter effect.

Figure 13 shows that force was extremely low across the session on both button lever responses and the escape response for S18. Almost all responses were of 0-magnitude. However, it is interesting to note that during the last 4 trials of the 11-trial winning streak

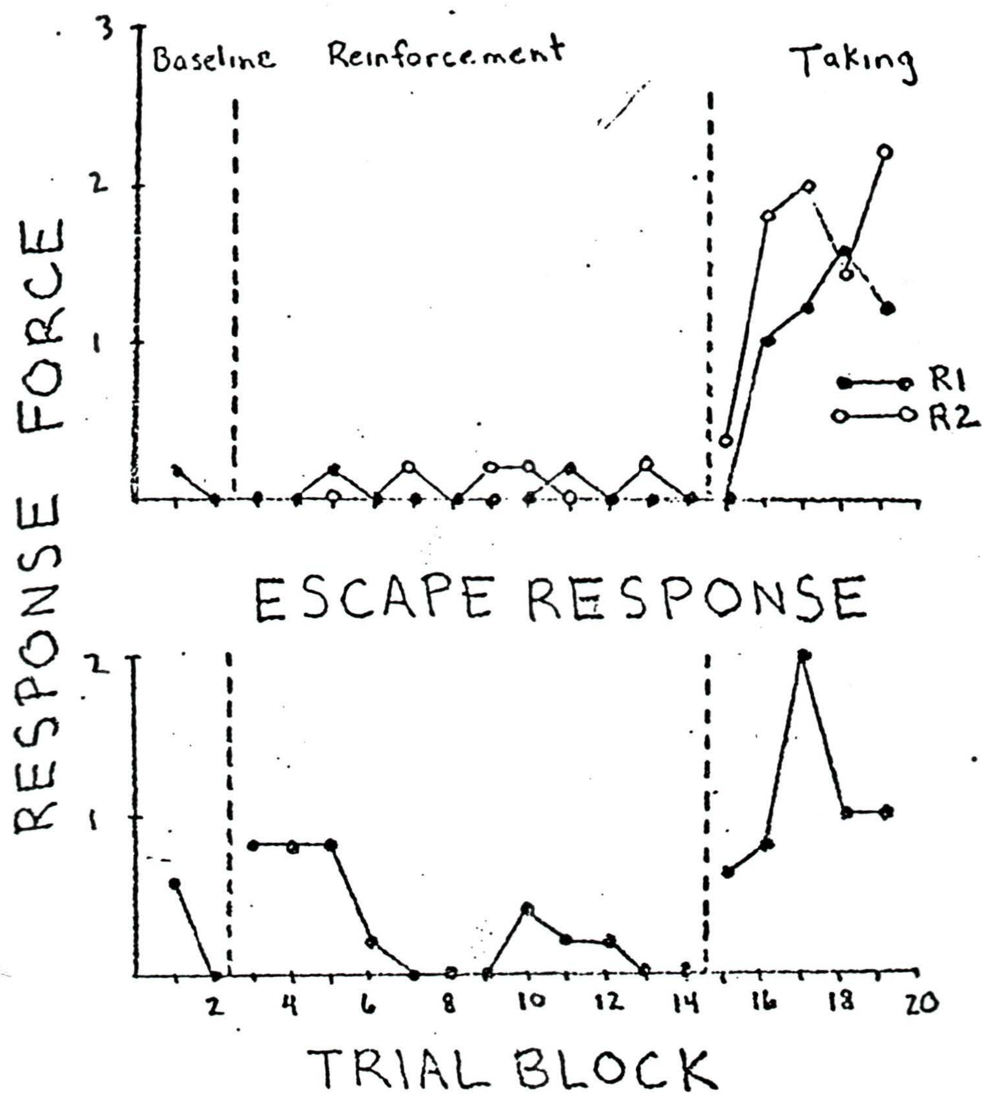
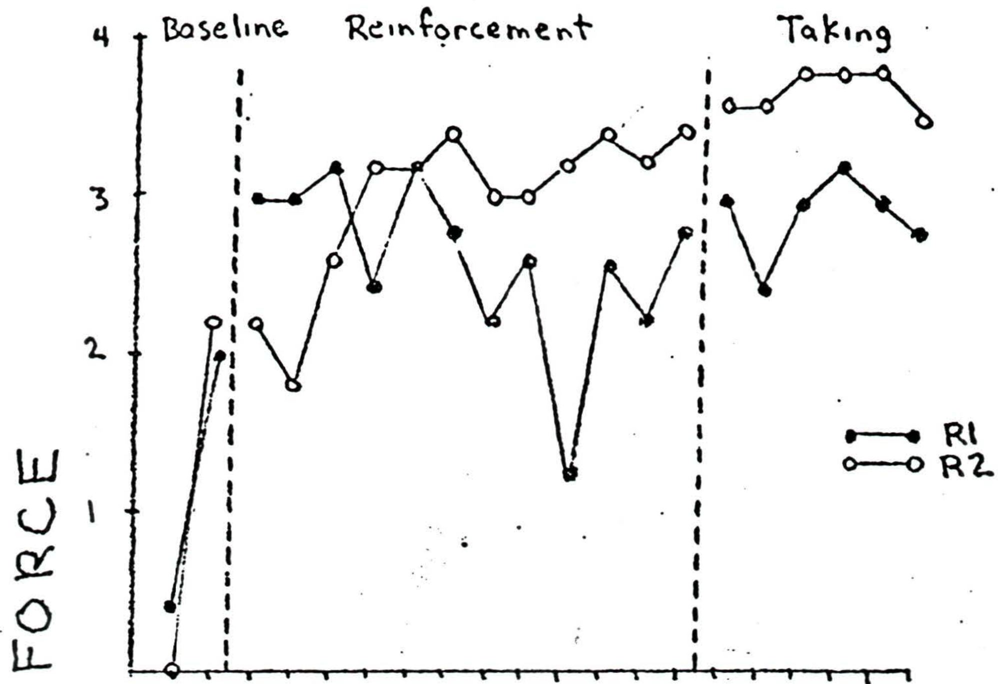


Figure 10. Force on all three responses across 5-trial blocks for S15.



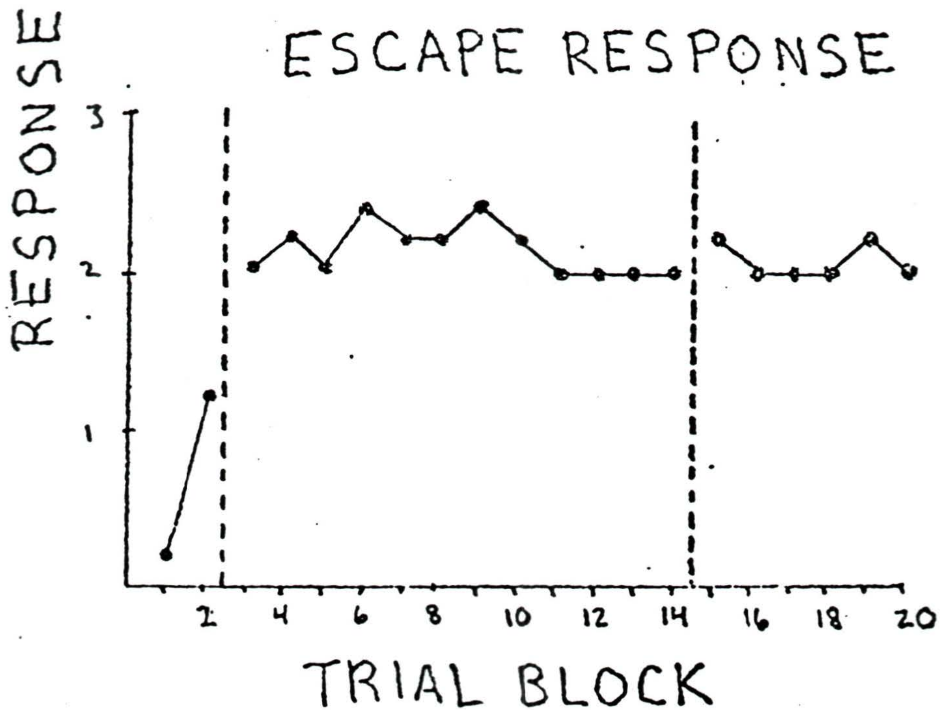
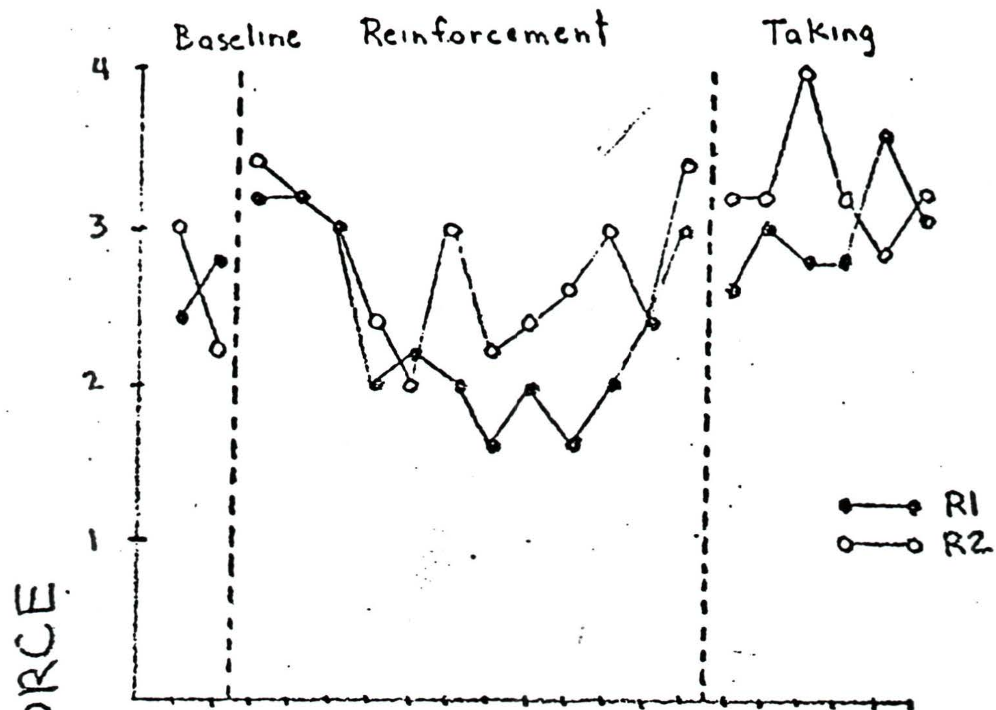


Figure 11. Force on all three responses across 5-trial blocks for S16.



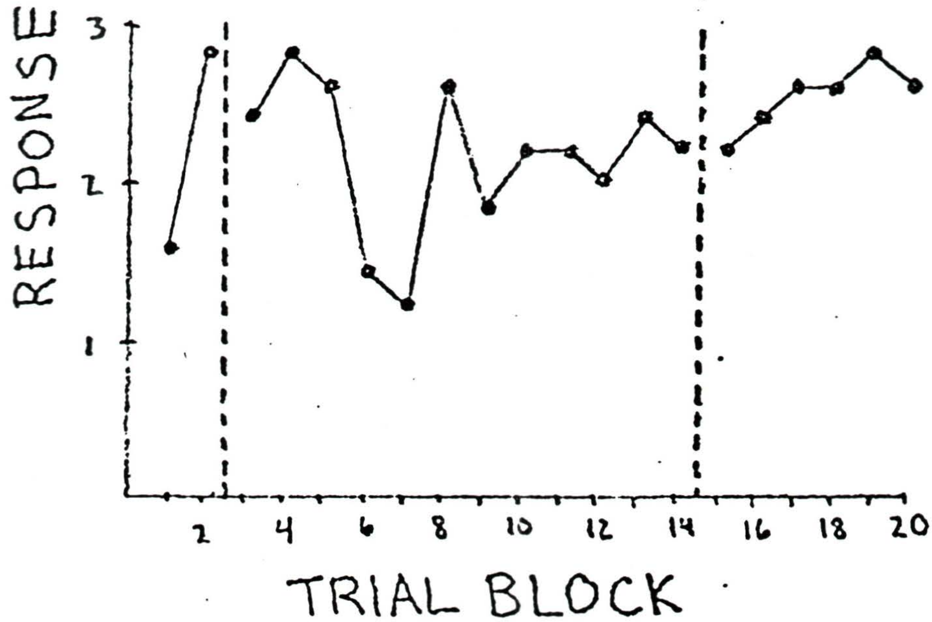


Figure 12. Force on all three responses across 5-trial blocks for S17.

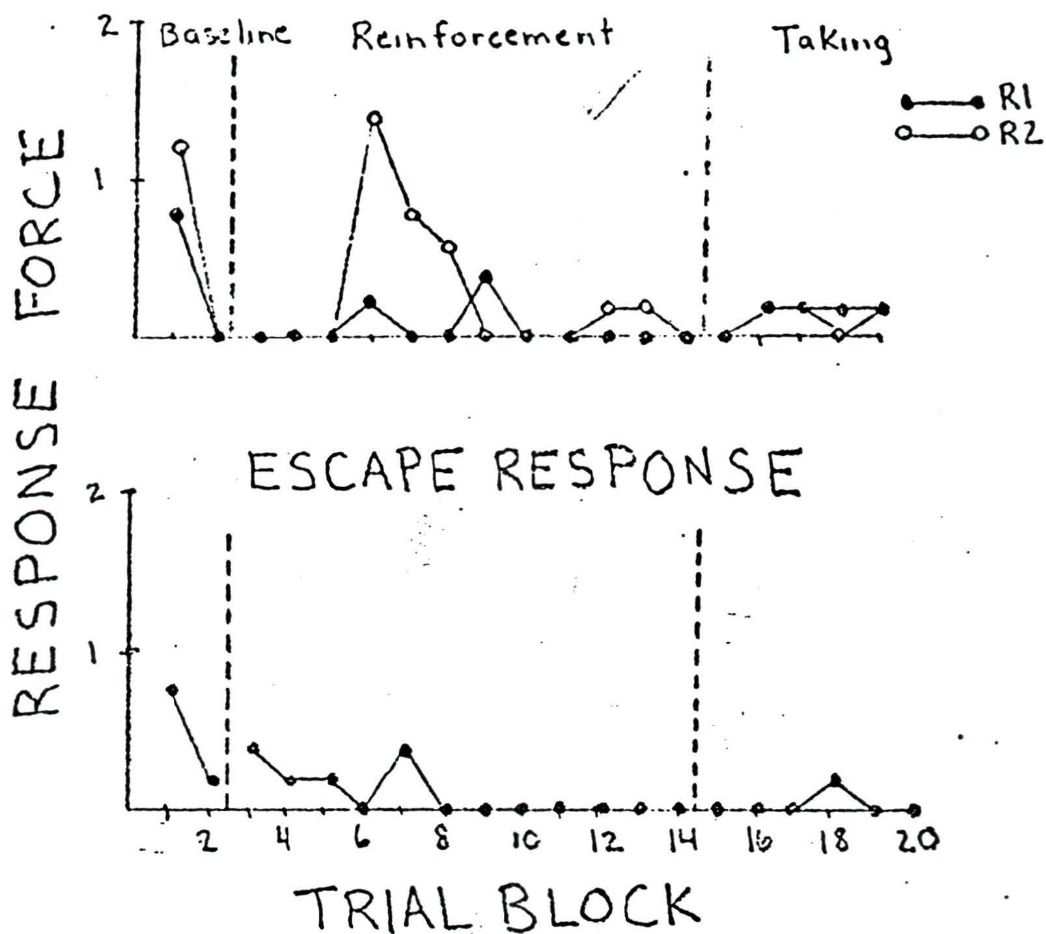
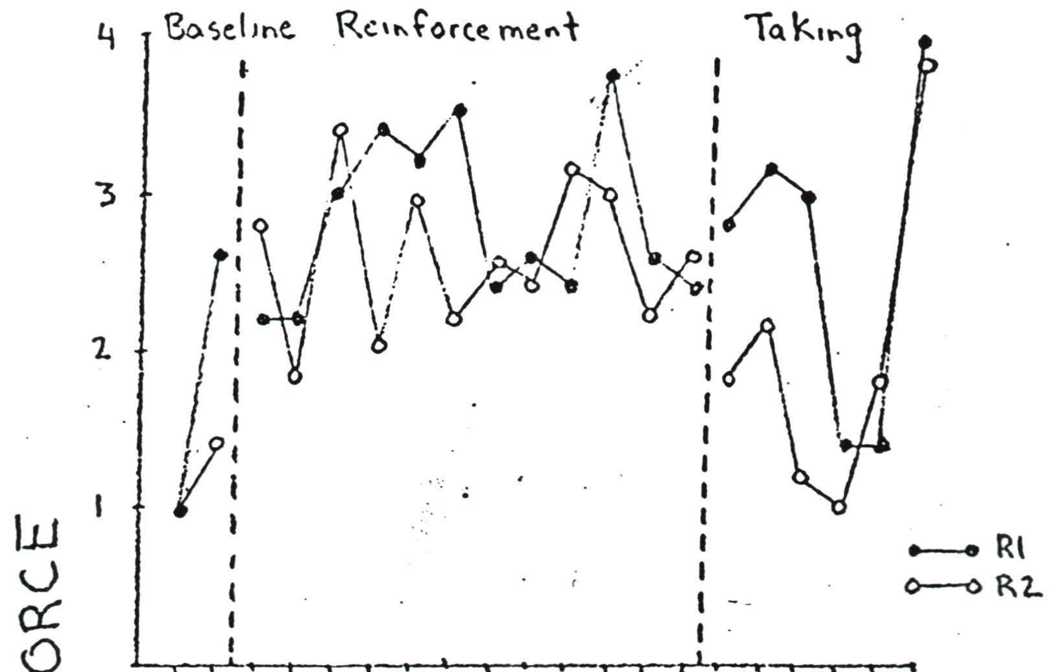


Figure 13. Force on all three responses across 5-trial blocks for S18.

(Trials 9-19) in Reinforcement, the subject responded above 0-magnitude on R2. Within Taking, the subject changed his choice before securing it on three different trials, a behavior which was absent within Reinforcement. The video recording revealed that response latency on all three responses generally decreased across trials in the Loss condition; for example, the subject had his hand already on the escape lever before the tone sounded, which made termination of the tone much quicker.

According to Figure 14, magnitude was highly erratic on both button lever responses throughout the session for S19. Peak response force occurred on the last trial block during Taking, and it would have been interesting to have had extended the number of trial blocks to examine whether or not button lever response magnitudes would have increased even more. Escape response force was also highly erratic throughout the session, although a comparison of the last six trial blocks of Reinforcement with Taking indicates that the latter was slightly higher. Video recordings showed that the subject exhibited a variety of behaviors during Taking which were not present during Reinforcement. These behaviors included: stabbing the levers with his pen; pressing the levers with his elbow; banging his pen on the desk; pressing the choice button without looking; pressing both choice buttons at the same time; whistling; sighing; swearing; and defacing the



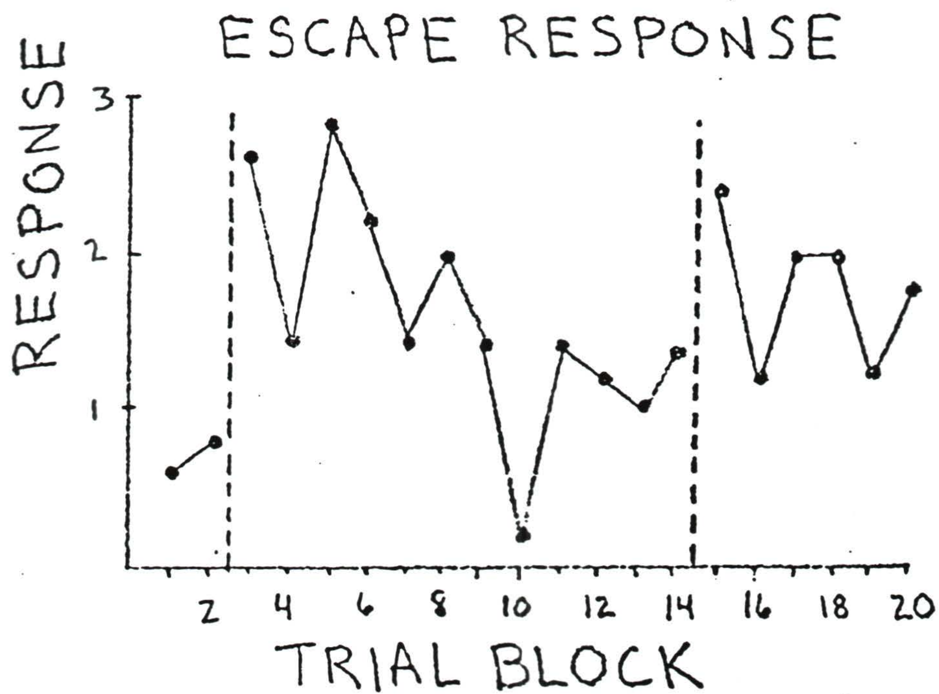


Figure 14. Force on all three responses across 5-trial blocks for S19.

apparatus by writing on the levers.

Figure 15 shows that S20 emitted a few button lever responses greater than 0-magnitude within the first four trial blocks of Reinforcement, but thereafter only one response reached this level. No escape response was greater than 0-magnitude for the last six trial blocks of Reinforcement; however, five responses were above 0-magnitude during Taking. There was one noteworthy observation for the subject: it appeared that choice presses were more forceful and more deliberate during Taking.

Figure 16 reveals that button lever response force was distinctly greater for both responses during Taking than during Reinforcement (excluding Trial Block 1 of the latter) for S21. Only one escape response was greater than 0-magnitude after the second trial block of Reinforcement. No baseline data are reported because of apparatus failure. S21 was scheduled to be returned to Reinforcement after Taking, but he prematurely terminated participation in the experiment.

Group Results and Discussion

An overview of the data from Figures 5-16 suggests that subjects responded most erratically during Baseline and the first half of Reinforcement, and then settled into a constant response magnitude pattern over the latter half. One factor which probably contributed to this irregular

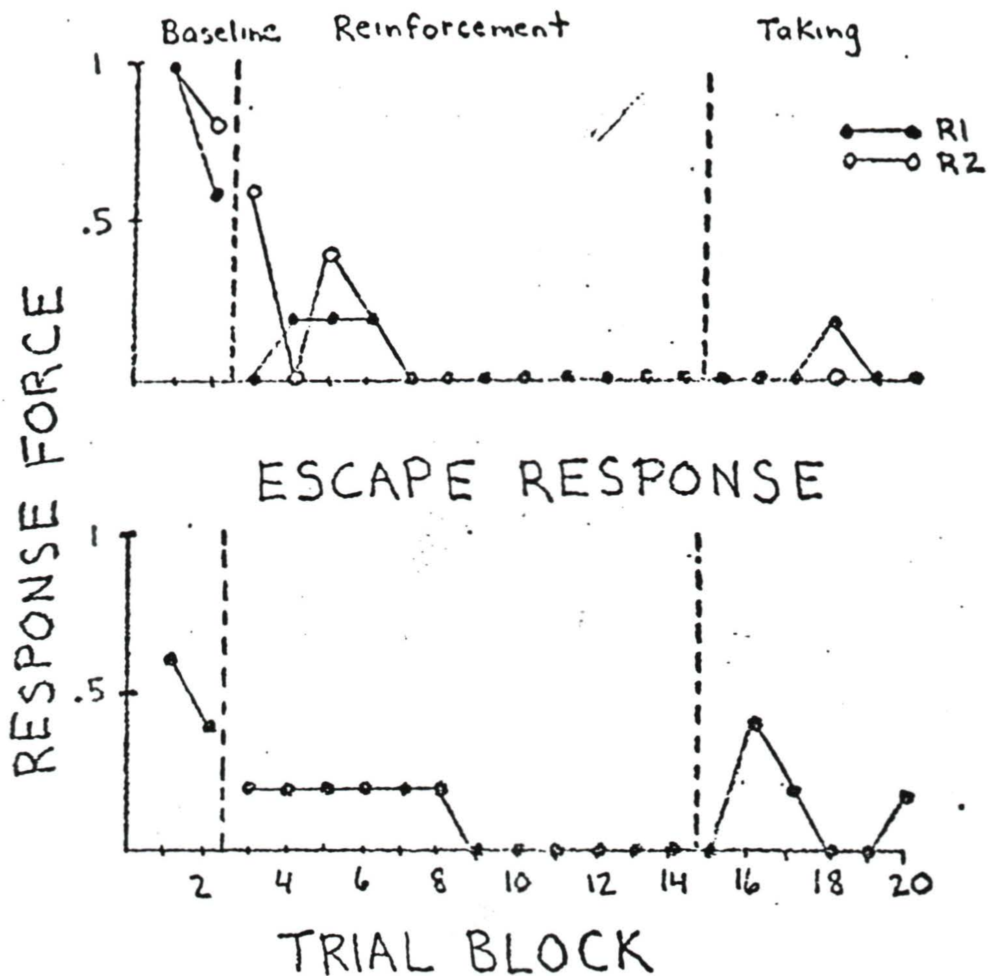
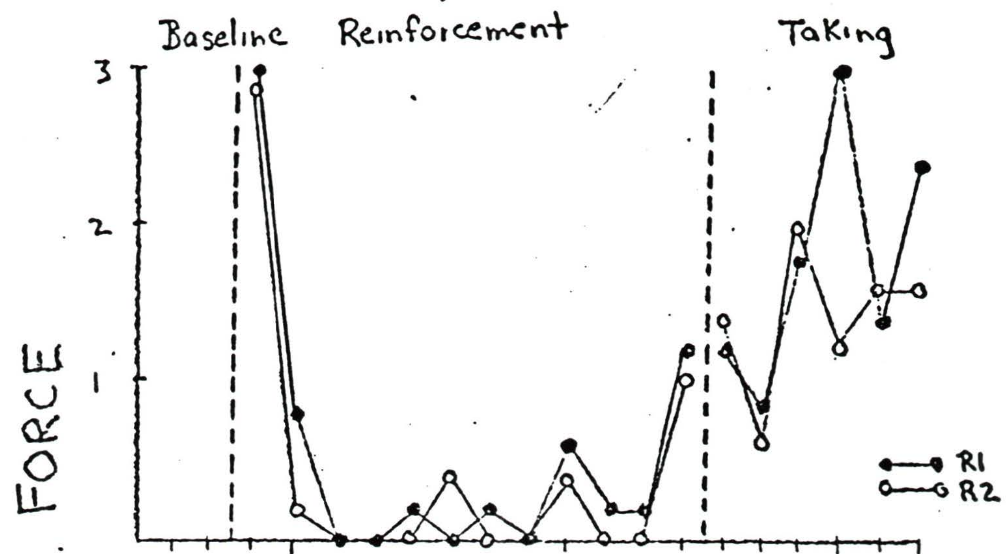


Figure 15. Force on all three responses across 5-trial blocks for S20.



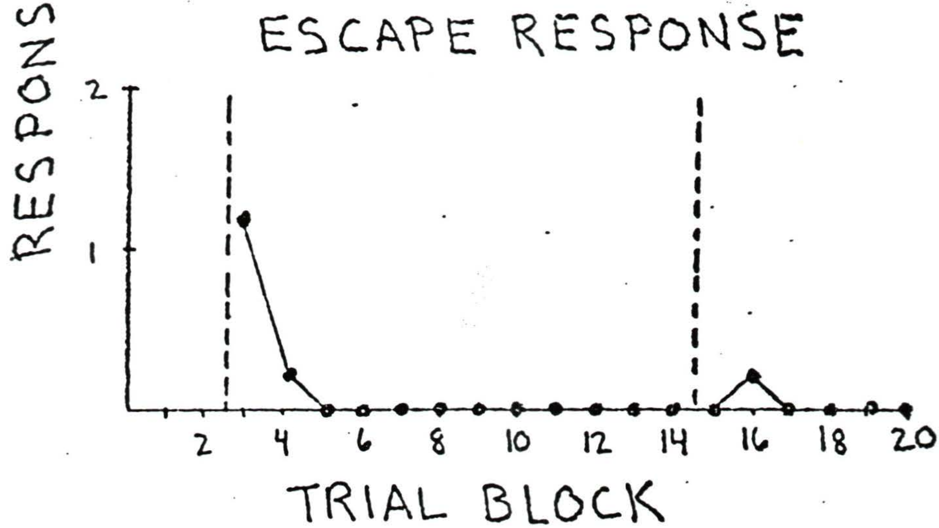


Figure 16. Force on all three responses across 5-trial blocks for S21.

pattern early in the session was that subjects had to be reminded to respond at various times during the task on some of the early trials. As these reminders became less frequent and as the subject became more comfortable and familiar with the task (evidenced by temporally shorter trials), response force became relatively more constant over the latter half of Reinforcement. As the present study was concerned with the effects of a string of losses (i.e., Taking) on a stable response force pattern during intermittent winning (i.e., Reinforcement), response force was compared between the latter portion of Reinforcement and the entirety of Taking. These results are reported in Table 5 which shows mean force of both button lever responses and the escape response during the latter portion of Reinforcement and for the whole of Taking. For convenience of comparison, an equal number of trials from the latter portion of Reinforcement was compared with the number of trials in Taking; for example, if a subject was exposed to 20 trials during Taking, then these trials were compared with the last 20 trials of Reinforcement.

Table 5 shows that mean force on R1 was higher for 9 of the 12 subjects during Taking. Two of the three subjects who did not show this effect were in Method A, where the game was less challenging. A two-tailed comparison of these means across subjects using the _Wilcoxan Matched Pairs, Signed Ranks Test_ yielded significance ($p < .05$). Thus,

Table 5

Force Means on the Two Button Lever Responses and the Escape Response during Reinforcement (Reinf) and Taking for Subjects in Experiment 2

Subject	Condition	Button Lever Response		Escape
		R1	R2	Response
10	Reinf(20)	3.30(.98)	2.75(1.02)	1.70(.57)
	Taking(20)	2.80(1.11)	2.00(1.02)	0.95(.51)
11	Reinf(20)	4.92(.28)	5.00(0)	3.56(.51)
	Taking(20)	4.65(.59)	5.00(0)	3.60(.50)
12	Reinf(25)	5.04(.20)	5.42(.50)	5.00(0)
	Taking(25)	5.48(.51)	5.40(.50)	4.64(.76)
13	Reinf(25)	4.20(.96)	4.00(.91)	2.72(.68)
	Taking(25)	4.60(.91)	2.76(1.92)	2.60(.71)
14	Reinf(25)	3.40(.91)	3.24(.72)	1.08(.81)
	Taking(25)	4.04(.93)	3.48(.92)	0.72(.79)
15	Reinf(25)	0.04(.20)	0.12(.33)	0.16(.37)
	Taking(25)	1.00(1.15)	1.60(1.26)	1.08(.76)
16	Reinf(30)	2.27(1.20)	3.13(.43)	2.10(.31)
	Taking(30)	2.90(.61)	3.60(.56)	2.10(.31)
17	Reinf(30)	2.13(.82)	2.47(.97)	2.14(.52)
	Taking(30)	2.97(.56)	3.27(.74)	2.56(.51)
18	Reinf(30)	0.07(.26)	0.07(.26)	0.00(0)
	Taking(30)	0.14(.35)	0.10(.31)	0.03(.18)
19	Reinf(30)	2.70(1.39)	2.60(1.40)	1.10(.86)
	Taking(30)	2.60(1.81)	1.97(1.50)	1.77(1.17)
20	Reinf(30)	0.00(0)	0.00(0)	0.00(0)
	Taking(30)	0.03(.18)	0.00(0)	0.17(.38)
21	Reinf(30)	0.40(.77)	0.23(.57)	0.00(0)
	Taking(30)	1.70(1.06)	1.40(1.33)	1.03(.18)

Note. Parentheses beside condition denote number of trials. Parentheses beside magnitudes denote standard deviations.

mean force on R1 was significantly greater during Taking than during the latter portion of Reinforcement across subjects in Experiment 2.

On R2, 6 of the 12 subjects showed higher mean force during Taking; four of the subjects who did not show this effect were those in Method A and Method B. On the escape response, 7 of the 12 subjects showed higher mean force during Taking; three of the subjects who did not show this effect were in either Method A or Method B. Neither of these two results was significant across the 12 subjects.

When mean response force during Taking was compared to mean response force during the latter portion of Reinforcement for subjects only in Method C, the results were unchanged: mean response force was significantly greater during Taking across subjects in the Loss condition on only R1.

Mention should be given to the 11-trial winning streak to which all subjects in Methods A-C were exposed during trials 9-19 of Reinforcement. In only one instance (S18) was there any indication of an effect of these trials on response force, and even with this subject the effect was minimal (see p. 93). Like Experiment 1, these results suggest that the possible invigorating effects of winning on response force may be specific to highly salient reinforcers rather than a small win in Experiment 1 or even a string of small wins in Experiment 2.

It was expected that subjects in Experiment 2 would increase the force of responding on all the responses required for the task during Taking, especially R2 which was temporally distributed immediately after the outcome. PEA research with animals and humans has demonstrated that upon presentation of a painful stimulus, attack occurs immediately and at full strength and, subsequently, decreases over time (Hutchinson, 1973). Even more relevant to the present discussion, Kelly & Hake (1970) reported that most of the aggressive responses during extinction occurred after the ratio requirement had been completed or early in the next ratio. That R1 (which was immediately before the outcome) yielded a significant effect, and not R2 (which was immediately following the outcome), is inconsistent with this previous evidence.

One SIA study, like Experiment 2, reported high rates of aggressive responding by humans immediately before an aversive outcome, although this study also found high rates immediately following the outcome (Hutchinson et al., 1977). The authors found high frequencies of jaw contractions by subjects exposed to a FT90 sec schedule both immediately before and after payment in a low pay condition relative to payment in an earlier higher paying condition. Payment in the low payment condition was considered to be an aversive event, perhaps similar to

individual loss trials during Taking in Experiment 2. Since R1 was immediately before the outcome, there may be some commonality between increased force of this press during Taking and increased frequency of jaw contractions immediately before payment during the low pay condition in the Hutchinson et al. (1977) study. Perhaps environmental and/or task cues (or even R1 itself in Experiment 2) acted as discriminatory stimuli signalling an oncoming aversive event. In Experiment 2, this aversive event could have been a loss outcome during Taking, while low payment during the low pay condition could have been the aversive event in the Hutchinson et al. (1977) study.

The above discussion offers a possible explanation as to why R1 increased in magnitude from Reinforcement to Taking, but it does not explain why R2 did not also increase. Two reasons are offered. First, response variability on R2 was extremely high during Taking. For example, subjects were observed to stab the lever with their pen; purposefully delay the response until told; swear, laugh, or address the experimenter in between a loss outcome and R2; switch hands (although instructed not to do so); and one subject even pressed the button lever with his elbow. All these behaviors were mostly specific to R2 during Taking, and all had the effect of decreasing response force. Second, a hard hit against the lever immediately following a loss outcome during Taking may have

been too blatant an aggressive or even vigorous act, one which may have met with social disapproval in the past. Perhaps the further temporally removed a response is from an aversive outcome, the less generalized it is to this punishment contingency and, therefore, it would be less likely to be suppressed. A few subjects reported being inhibited by the camera; thus, they may have suppressed response force, especially immediately following the outcome (R2) during Taking, and responded instead with more acceptable behaviors (e.g., talking to the experimenter).

Despite the significant finding for R1, it should be noted that the increase in response force from Reinforcement to Taking was not dramatic; i.e., subjects did not proceed from lightly tapping the button lever during Reinforcement to violently punching it during Taking, but rather response force change was hardly visible on the video recordings. Nonetheless, some increase in response force across conditions clearly occurred. Perhaps this increase was due to the passage of time and/or the number of trials. Method D was introduced in an attempt to test this hypothesis.

Method D

In this procedure, the number of trials in Reinforcement were varied, and some subjects were returned to Reinforcement after Taking. Except where otherwise

noted, all other aspects of the procedure were identical to Method C.

There were three experimentally naive subjects (S22, S23, S24); i.e., none had previously participated in a psychology experiment. The first two subjects were male undergraduate students, while the last was a female high school student.

S22 was exposed to 10 baseline trials, 30 Reinforcement trials, 30 Taking trials, 30 Reinforcement trials, and 30 Taking trials. The purpose was to explore: (a) if response force on R1 would increase during Taking after only 30 Reinforcement trials; (b) if response force would decrease to previous levels during the second Reinforcement condition (indicating a reversal effect), assuming it increased during the first Taking condition; and (c) the effects of a second Taking condition on response force.

S23 was exposed to 10 baseline trials, 90 Reinforcement trials, and 30 Taking trials. If the increase in force on R1 after 60 Reinforcement trials in Methods A-C was due to the changeover in conditions and not the passage of time and/or the number of trials, then response force should not change over the last 30 Reinforcement trials with this subject.

S24 was exposed to 10 baseline trials, 60 Reinforcement trials, 30 Taking trials, and 30 Reinforcement trials. As with S22, the purpose was to explore if response force on

R1 would decrease to previous levels during the second Reinforcement condition, assuming that it increased during the loss condition.

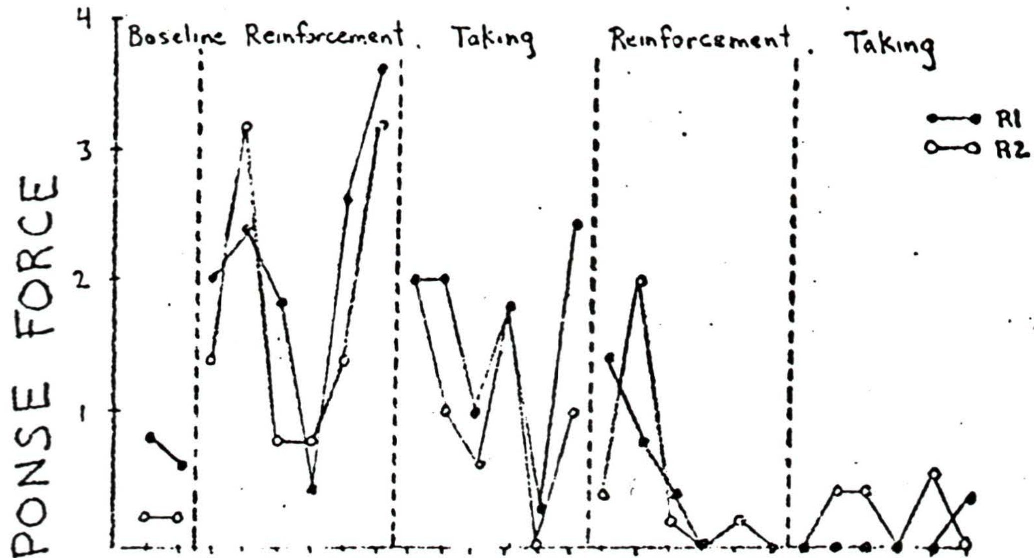
Results and Discussion. Response force on both button lever responses and the escape response across all trials in five-trial blocks are presented for S's 22-24 in Figures 17-19, respectively.

Figure 17 shows that force was erratic on both button lever responses across trials and conditions for S22, tending to decrease across the session. Escape response force was generally constant. There was, and could have been, no evidence of a reversal effect, as response force never increased during the first Taking condition. One variable which may have affected response magnitudes for the subject was the fact that he frequently switched hands when responding on the levers, even though he was instructed not to do so. Towards the end of the session, the subject threatened to leave, complaining that the session was too long.

According to Figure 18, force on both button lever responses increased across Reinforcement for S23, while during Taking it decreased somewhat and then remained stable. Escape response force showed no significant trends across Reinforcement; however, during Taking it tended to decrease.

Figure 19 is in contrast with the significant finding

BUTTON LEVER RESPONSES



RESPONSE FORCE

ESCAPE RESPONSE

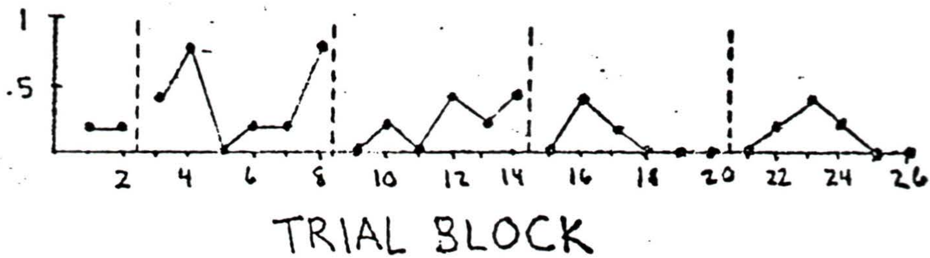
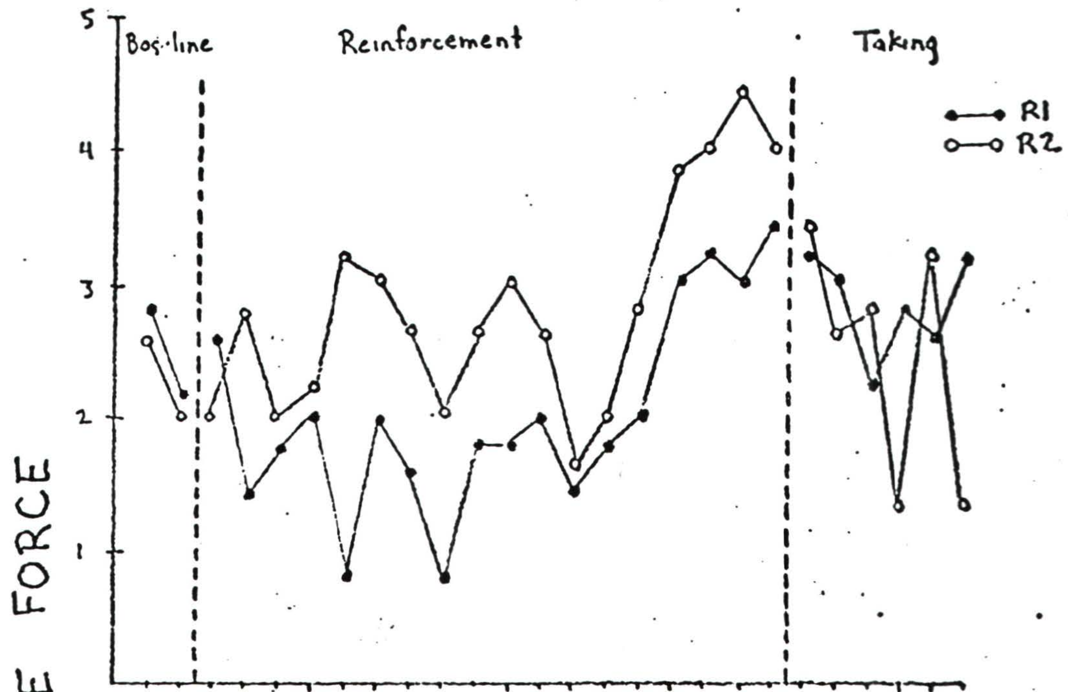


Figure 17. Force on all three responses across 5-trial blocks for S22.



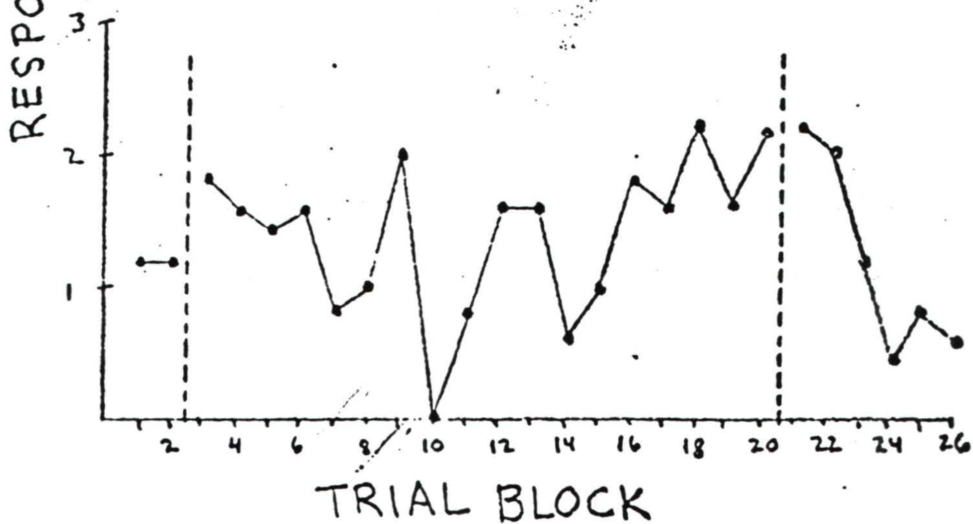


Figure 18. Force on all three responses across 5-trial blocks for S23.

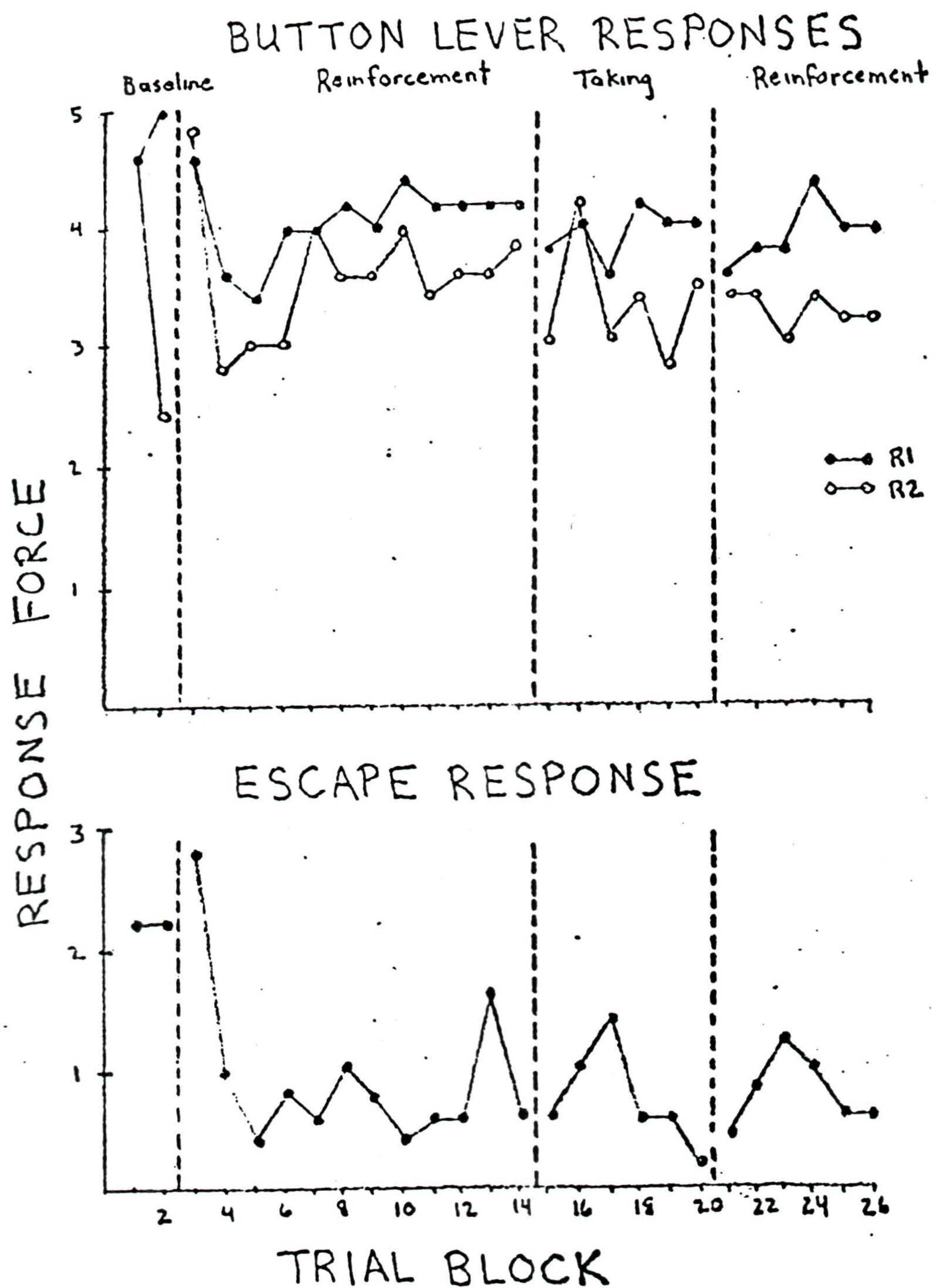


Figure 19. Force on all three responses across 5-trial blocks for S24.

reported previously across subjects in Method A-C: force on R1 did not increase during a 30-trial Taking condition after a 60-trial Reinforcement condition. Generally, magnitude remained constant across all conditions on all three responses. As with S22, there was no evidence of a reversal effect because response force did not increase during Taking.

The above data suggest that the phenomenon demonstrated in Method C, i.e., greater mean force on R1 during Taking relative to Reinforcement, was not general across subjects when the number of Reinforcement trials were varied: mean force on R1 did not increase during Taking following either a 30-trial Reinforcement condition for S22 or a 90-trial Reinforcement condition for S23. Even more damaging to the significant finding from Methods A-C was the fact that S24 did not show the effect even with an identical 60-trial Reinforcement condition. Admittedly, S24 was a high school student, but if this phenomenon was sensitive to such delicate changes in subject variables, then it is not as general as previously expected.

It is interesting to note that response force on both button levers increased over the last 30 trials in the 90-trial Reinforcement condition for S23. From these data alone, it would appear that higher mean force on R1 during Taking in Methods A-C was not the result of the changeover in conditions, but rather the result of a tendency to

respond harder on the lever due to time and/or the number of Reinforcement trials. This suggestion is rejected for several reasons. First, there was no consistent tendency for subjects in Methods A-C to increase button lever response force across a 60-trial Reinforcement condition. Second, it seemed improbable that almost all the subjects in Methods A-C would show a general increase in force at roughly the same point, which also happened to coincide with the change in conditions from Reinforcement to Taking. And finally, complaints about the length of the session by S23 began during the last three trial-blocks of Reinforcement, which was also when peak response force occurred for this subject. These initial complaints may have been manifested as high magnitude responses on both levers. Perhaps Taking was the aversive aspect of the experiment for subjects in Methods A-C, while the aversive aspect for S23 was "enduring" the long tedious experiment.

The results for S23 add merit to the suggestion that a control group should have been included to examine the effects of time on response force within a 90-trial Reinforcement condition. This procedure would have shown whether increased response force was due to the changeover from Reinforcement to Taking for subjects in Methods A-C or due to time and/or the number of Reinforcement trials regardless of the changeover in conditions. However, the present investigation was exploratory in nature, and to

have divided subjects into two large experimental and control groups would have defeated the intial purpose. If a stringent control procedure was implemented, then variables could not have been modified from subject to subject in order to maximize the treatment effect. Furthermore, there was no a priori reason to warrant speculation that time and/or the number of Reinforcement trials would enhance response force as there was no indication of this effect in Experiment 1.

At this point in the investigation, the next logical step was to extend Method D. The effects of a 90-trial Reinforcement condition should have been further explored to test if enhanced response force during the last 30 trials was an isolated incident for S23. The effects of reversal, especially on R1, should also have been further explored. In other words, will the enhanced response force evidenced by subjects during Taking following a first Reinforcement condition decrease to previous levels during a second Reinforcement condition following Taking? However, there was a flaw in the experimental design which prevented these further explorations. For subjects in Methods A-C, the 90-trial experimental session lasted approximately an hour. For the two subjects in Method D who were exposed to a 120-trial experimental session, the length of time of participation was extended another 15

min, and the effect of this extension lead to complaints by both subjects as to the length of the session. Interest of the subjects may have waned, resulting in "going through the motions" of responding towards the end of the session. This suggestion was confirmed by the post-experiment interview with both subjects. Since a further examination of the variables considered in Method D necessitated a longer experimental session than previous subjects who demonstrated an effect were exposed, and since the effects of a longer experimental session appeared to confound the effects of Taking on response force, the investigation was terminated.

General Discussion

Early in the introduction of the thesis, it was proposed that the general focus of this investigation was to examine variables involved in human aggression triggered by changes in reinforcement in the laboratory. The most relevant question to ask of the results is: Was aggressive behavior demonstrated by the subjects? Kelly & Hake (1970) designated a cushion punch as an aggressive response "because the force of this response together with its topography appeared comparable to responses of humans that deface objects or produce counter-aggression from other humans" (p. 154). Regarding the force aspect of aggression, Method C of Experiment 2--which was the accumulation of efforts in the present investigation to maximize the treatment effect--demonstrated that mean response force was greater during Taking than during Reinforcement for seven of the eight subjects on R1, six of the subjects on R2, and six of the subjects on the escape response. That the majority of subjects enhanced response force during a non-reinforcement period is in accord with the response vigor studies. However, although these increases were shown by most subjects, they were generally small; i.e., low magnitudes during Taking were relative to even lower levels during Reinforcement. Table 5 reveals that none of the resultant response force means during Taking approached maximum (i.e., magnitude = 7).

Examining these data on a trial-by-trial basis showed that no subject pressed either lever with maximum force, even though this level could be easily reached with an effortful response; e.g., S1 in Experiment 1 emitted maximal lever presses on every trial. Thus, in terms of aggression, response magnitudes during Taking in Experiment 2 were certainly not at the level "comparable to responses of humans that deface objects or produce counter-aggression from other humans" (Kelly & Hake, 1970, p. 154).

Aggressive response topographies were observed, although infrequently, in Experiment 1 when subjects slapped and punched at the levers, the most explicit examples occurring after two or three losses in a row. In Experiment 2, the majority of aggressive response topographies occurred during Taking; however, the frequency of these responses was extremely small compared to the number of opportunities available and the vast majority of non-aggressive response topographies that did occur. Thus, aversive schedule conditions in the present investigation did produce responses with aggressive topographies, but these instances were more the exception than the norm.

The results of Experiment 2, although consistent with the response vigor studies, seem to be inconsistent with previously published SIA reports with humans in terms of both response force and topography. However, closer inspection of the results reported by these studies

indicates that the discrepancies are not as great as they initially appear.

A reexamination of the data of Kelly & Hake (1970) reveals that only three of the nine subjects showed a marked increase in the number of punches per hour on the first extinction session following the reinforcement phase; for the remaining four subjects who demonstrated this effect, three extinction sessions (about 2 hrs!) were required. Furthermore, non-aggressive responding (button pressing) was still the largely preferred mode of escape/avoidance during the vast majority of extinction sessions across subjects. For example, given a tone, the probability of an aggressive cushion punch during reinforcement was 0.02, while during extinction the probability was still only 0.2. Thus, the aggressive response was not the norm nor even the preferred mode of escape, but rather it was the probability that this response would occur which increased during extinction relative to reinforcement. Similarly, slaps and punches on the levers were not the norm during Taking in Experiment 2, but the probability that these responses would occur increased from Reinforcement.

An even better example of how aggressive cushion punching was not the norm during extinction periods in the Kelly & Hake (1970) design studies is presented in the experiment by Harrell & Giovine (1974). The authors

reported that rates of aggression were higher when money was being taken from subjects working on a FR200 schedule than during sessions when taking was not in effect. However, a closer examination of the data reveals the following. (a) The number of cushion punch responses for the five subjects during the last 90 min of reinforcement before taking was introduced ranged from zero to two; during the first 90 min taking session, the frequencies increased to only three to eight. (b) The alternative mode of escape/avoidance remained constant across conditions for four subjects, ranging from 100 to 200 responses. (c) Despite this weak demonstration of SIA, the alternative hypothesis that any non-preferred mode of escape/avoidance would have also increased during taking was not explored.

Reexamining the data of the Kelly & Hake (1970) design studies in which data for the alternative non-aggressive escape/avoidance response were available (Harrell, 1972; Harrell & Giovine, 1974; Harrell & Ross, 1974; Kelly & Hake, 1970) indicates that although the frequency of aggressive cushion punching was greater during low as opposed to high density reinforcement periods, it was not the preferred mode of escape/avoidance; non-aggressive escape/avoidance was still vastly preferred during low density reinforcement periods. As just noted, a similar trend was noted for slaps and punches on the levers from Reinforcement to Taking in Experiment 2; i.e., these

aggressive response topographies, although relatively infrequent during Taking compared to non-aggressive response topographies, nonetheless were more likely to occur during Taking than during Reinforcement. Thus, the results of Experiment 2 are generally consistent with both the response vigor studies and the Kelly & Hake (1970) design studies.

Methodological Considerations for Future SIA Experimentation

Throughout the course of the present investigation, methodological weaknesses of the design became apparent. What follows is a descriptive list of some methodological considerations for future SIA experimentation.

Response Force. As was reported, aggressive response topographies (i.e., slapping and punching) were observed; however, somewhat contradictory was the fact that no response during Taking in Experiment 2 registered as maximum magnitude. Even more counter-intuitive was the fact that when some of these aggressive response topographies did occurr on the levers, a low response magnitude was recorded. The problem concerned the placement of the subject's hand immediately before a required response. If the subject's hand was away from the lever (e.g., at his/her side), then at the moment when the response was required, his/her hand was free to slap or punch at the lever, or to be placed on the lever so that it

could be pressed. If the subject's hand was already on the lever at the moment when a response was required, then the motion of his/her hand was restricted to pressing. Casual observation reveals that when many people slap or punch an object, the tendency is to pull back at the moment of contact. This explains how some slaps and punches recorded as low magnitude responses. If the force was somehow calculated earlier in the excursion of the slapping or punching motion than the point of contact, then undoubtedly the force level would have been recorded as extremely high. In retrospect, each subject should have been instructed to hold his/her hand on the lever before responding. By having only one response topography, the confounding effects of variable response topography on response force levels would have been minimized. This instruction may also have attenuated the noted tendency for some subjects to switch hands when they were responding, since instructions not to do so were insufficient. The purpose of not defining the response topography was to avoid demand characteristics inherent in most other SIA studies with humans. However, because the dependent variable in the present investigation was response force and because variable response topography confounded the treatment effect, avoiding response topography demands was detrimental rather than beneficial to the present investigation.

Response variation. In Experiment 2, new non-aggressive behaviors emerged during Taking. As previously discussed, response variation during nonreinforcement periods is consistent with the adjunctive behavior explanations of SIA. A problem with the Kelly & Hake (1970) design studies was that response variation during extinction necessarily implied aggressive responding, as the preferred mode of escape/avoidance during reinforcement was the non-aggressive button press response and the only alternative variation during extinction was the aggressive cushion punch response. Although Kelly & Hake (1970) demonstrated that subjects did not switch to a non-preferred, non-aggressive response during extinction, Nation & Cooney (1982) had some difficulty in replicating this result, and the studies by Harrell and his associates (Harrell, 1972; Harrell & Giovine, 1974; Harrell & Ross, 1974) did not even test this control procedure. An advantage of the study by Frederiksen & Peterson (1974) was that although the opportunity for an aggressive response was available (i.e., punches against a Bobo doll), there were many alternative non-aggressive responses possible since there were many toys in the experimental enviroment. The Bobo doll was not singled out above all other toys and, unlike the Kelly & Hake (1970) design studies, did not serve the dual purpose of an escape response. However, because no data were

reported concerning the frequency of contact with other toys during extinction, this study is open to the criticism that play with all toys in the enviroment assumed reinforcing proporties for the children when bar presses ceased to produce pennies. Thus, a child's interaction with the Bobo doll would be expected to increase not because it was an aggressive response, but because it was one of many toys that was played with during extinction periods. To avoid the shortcomings of the "either-or" situation in the Kelly & Hake (1970) design studies and the incomplete data analysis of the Frederiksen & Peterson (1974) study while still making available a response which is clearly aggressive-like in topography, future SIA studies should employ a methodology whereby there are provisions for measurements of a wide assortment of possible responses, with a designated aggressive response being only one alternative.

Length of the experiment. The Kelly & Hake (1970) design studies--excluding Nation & Cooney (1982)--employed extended series of experimental sessions; e.g., five or more 40 min reinforcement sessions followed by three extinction sessions (e.g., Kelly & Hake, 1970). The effect may have been twofold. First, response cost of participation was high; i.e., subjects were volunteering a good deal of their time to the experiment and "expected" to be paid accordingly. Response cost may have increased the

aversiveness of the extinction condition, and thus enhanced the SIA effect. As noted earlier, four of the seven subjects who demonstrated extinction-induced aggression in the study by Kelly & Hake (1970) did not do so until the third 40 min extinction session. In Experiment 2, response cost was low; i.e., subjects were exposed to only one, 1 hr session. This was confirmed by the fact that some subjects refused payment.

Second, a subject's initial tendencies, such as suppressing aggression due to past contingencies of reinforcement or responding erratically due to unfamiliarity with the task, may decrease as time of participation in the experiment increases. As Baron & Perone (1982) suggest:

> [T]he extended series of experimental sessions...provides an opportunity for pre-existing reactions to extinguish. Progressive weakening of these reactions allows control to be assumed by the contingencies and other forms of controlled stimulation introduced into the experimental enviroments.
> (p. 147).

If, as Kelly & Hake (1970) noted from casual observation, humans hold back and emit aggression only after long series of instances capable of producing it, then perhaps long extinction periods such as successive extinction sessions are required to observe these brief

bouts of extinction-induced aggression. In contrast to this suggestion, two studies (Frederiksen & Peterson, 1974; Nation & Cooney, 1982) produced SIA within only one session. Unlike these two studies, however, the present investigation had difficulty in condensing reinforcement and nonreinforcement periods into one session without extending the session past a reasonable amount of time for the subjects. Some subjects in both Experiment 1 and Experiment 2 showed evidence of a fatigue effect, as response force for these subjects tended to decrease across trials regardless of the condition. A fatigue effect may have counteracted the enhancing response force effects of nonreinforcement. When reversal effects were being examined in Method D of Experiment 2, both subjects complained that the session was too long and another subject left the experiment before the reversal could be implemented. Therefore, not only may one session experiments lead to counteracting fatigue effects, but they may also limit the investigation of other variables (e.g., a reversal effect). These factors should be given consideration in future SIA research when deciding whether to employ an extended series of experimental sessions or an economical one-session experiment (i.e., in the sense that many subjects could be used in the same amount of time as one subject in the former).

<u>Subject pool</u>. The strongest SIA effect was

demonstrated by Frederiksen & Peterson (1974): no subjects emitted non-functional Bobo doll hits during continuous reinforcement, while 12 of the 16 subjects substantially increased the frequency of hits during signalled and unsignalled extinction periods. Although many methodological differences could be singled out to account for the more robust findings of this study, one stands above all others: the subjects employed were nursery school children. It is not unreasonable to assume that children in this age group have less inhibitions about displaying aggressive behaviors than more "socially conscious" adult individuals who have learned that aggression usually leads to unfavourable outcomes (e.g., social disapproval). Thus, to maximize the SIA effect, children would be the subjects of choice. A further advantage of employing children as subjects is that toys can be incorporated into the procedure as various response measures, and thus the apparatus would be easily accessable, inexpensive, and the setup similar to typical child play situations.

Presence of the experimenter. In all of the SIA studies, the experimenter was not present, and in some experiments the subject was enclosed in an experimental chamber (e.g., Kelly & Hake, 1970). Although Experiment 2 attempted to camouflage the presence of the experimenter with a partition, his presence was a given, and subjects occasionally addressed comments to him and asked questions

during the experimental session. The fact that the experimenter was in the same room as the subjects may have resulted in suppressed reactions because of previous exposure to social punishment contingencies for displaying aggression. The video camera, which was not hidden from the subject, may have had the same effect.

Theoretical Considerations for Future SIA Experimentation

A number of theoretical issues arose during the course of the present investigation which deserve clarification by future SIA experimentation. What follows is a list of some of these specific issues.

Schedule aversiveness. The present investigation has taken the view that response vigor is directly related to the aversiveness of schedule conditions. Consistent with this hypothesis, Experiment 1 showed that five of six subjects demonstrated higher mean force on R2 during the loss conditions theoretically more aversive than individual loss trials; i.e., after a big loss, after three or more losses in a row. An aversive Taking condition comprised of a string of 30 loss trials in Method C of Experiment 2 enhanced mean force of responding from Reinforcement on all three responses for at least six of the eight subjects. However, in both experiments, response magnitudes in the aversive schedule condition were not "comparable to responses of humans that deface objects or produce counter-aggression from other humans" (Kelly & Hake, 1970,

p. 154). To produce extreme force levels characteristic of aggression, it follows, from the present line of discussion, that the aversiveness of the experimental condition (i.e., Taking) must be increased. Suggestions for enhancing schedule aversiveness include: (1) increasing response cost of participation for each subject by employing an extended series of experimental sessions (see p. 125); (2) increasing the saliency of reinforcement (e.g., subjects could be asked not to eat for a few hours prior to the experimental session, and tasty foods could be employed as reinforcement); (3) providing a maximal contrast between Reinforcement and Taking by scheduling CRF in the former. This last suggestion stems from the graphs presented in the Nation & Cooney (1982) study which showed that the frequency and intensity of aggressive responding during extinction was greater following CRF than following PRF (i.e., VR2).

Adjunctive behavior. Consistent with both the response vigor studies and the SIA studies, response force as well as the probability of an aggressive response topography being emitted increased during Taking relative to Reinforcement in Experiment 2. However, unlike these reports, another effect was observed: the probability that new non-aggressive behaviors (e.g., wiggling a pen, tapping on the desk, talking to the experimenter, etc.) would be observed also increased from Reinforcement to Taking. This

raises an interesting question: Did other non-aggressive modes of behavior increase during extinction periods in the SIA studies? As these investigators were concerned with only aggressive behaviors, perhaps they overlooked schedule-induced non-aggressive behaviors occurring in the experimental enviroment. Wayner (1970) proposed:

> Reinforcement during intermittent schedules not only increases the probability of the preceding response upon which reinforcement is contingent but also increases momentarily the probability of all potential responses which might follow the reinforcement; that is, evoked by the available enviromental stimuli. (p.321)

Consistent with this proposal are adjunctive behavior studies. During postreinforcement periods on FI schedules, increased frequency of non-aggressive human behaviors such as eating and drinking, grooming, gross movement, smoking, and pacing have been demonstratated (Clarke, Gannon, Hughes, Keogh, Singer, & Wallace, 1976; Wallace, Sanson, & Singer, 1976; Wallace & Singer, 1977). Similarly, the new behaviors which were observed to emerge during the period of nonreinforcement in Experiment 2 included many which were not aggressive-like in topography. As both Wayner (1970) and Falk (1971) have stated, adjunctive behaviors are dependent on the available enviromental stimuli. In the present investigation, a subject could not wiggle a pen

if there was no pen present. Perhaps in the Kelly & Hake (1970) design studies, the cushion punch response would have occurred even less frequently if many alternative non-aggressive escape/avoidance response choices had been available. Or, perhaps aggression would not have been observed in any form if there had been no aggressive response available. The variables controlling the effects of nonreinforcement periods on aggressive behavior, increased vigor of responding, and non-aggressive, non-vigorous responding (i.e., the variables determining which form of adjunctive behavior will occur, and to what degree) should be considered for future research. For example, given a choice during nonreinforcement periods, will an individual choose a vigorous, aggressive response (e.g., punching a cushion), a non-vigorous, aggressive response (e.g., pressing a button to shock another individual), a vigorous, non-aggressive response (e.g., pulling a knob which requires a forceful effort), or a non-aggressive, non-vigorous response (e.g., pressing a button)?

Prior learning experience. Both PEA and SIA studies have shown that socially deprived organisms will aggress when exposed to physically or "psychologically" painful conditions, suggesting that there is an unconditioned component to the pain-aggression relationship. It is easy to speculate how this type of reaction has survival value.

The baby who did not cry and thrash about when suckling was terminated, although hunger persisted, could be weakened to the point of malnutrition and thus be more vunerable to disease, predation, or even death. However, this instinctual pain-aggression relationship is still open to the laws of learning as even proponents of the Direct Linkage Hypothesis have demonstrated (see pp. 4-6). Perhaps as other reinforcement contingencies take precedence for survival at later stages in the life of an individual, the probability that other non-aggressive responses will be emitted during aversive conditions increases. If the baby who thrashed about which resulted in continued suckling emitted the same type of behavior as an adult because of a demotion at the office in the presence of the boss, then he/she would not only find this behavior to be ineffective in producing reinforcement but also detrimental. It is to the hockey player's advantage not to fight an opponent and be penalized every time he shoots on net and does not score. This discussion raises some interesting questions for research. Will "socially conscious" adults, who by all likelihood have been exposed to more punishment contingencies for displaying aggression, display less SIA than children? Can population samples be selected to maximize the SIA effect? For example, atheletes learn to intensify physical effort to avoid losing during competition probably more so than an average

individual. Can specifics of prior reinforcement histories of individuals who demonstrate no SIA effect or individuals who demonstrate a large SIA effect be determined? If so, then control of this form of human aggression would be possible by implementing the specific reinforcement continigencies which minimize SIA and avoiding those which enhance it.

Other considerations. Experiment 2 showed that the Reinforcement-Taking response force difference was significant across subjects on only R1. It was suggested that R1 (or other stimuli present at R1) became a discriminatory stimulus signalling an imminent aversive event during Taking. That this effect would be the most consistent was unexpected, and shows that the effects of discriminatory stimuli are potent and deserving of future investigation in relation to SIA. It was also suggested that R2 did not show as consistent an effect as R1 because of its close temporal relation to the outcome, a period of time most sensitive to previously learned punishment contingencies. The effects of the intertrial temporal relation of a response to a repeated outcome during an aversive condition is also deserving of future examination.

In previous SIA research, the aggressive response was clearly defined; e.g., the Kelly & Hake (1970) design studies employed punches against a cushion. In the present investigation, a lever press was ambiguous in terms of

response force and topography; i.e., both aggressive and non-aggressive modes of responding were possible. Future SIA studies should consider the question: Are some response demands more facilitative of aggression by humans than others (e.g., a cushion punch as opposed to a lever press)? Allowing for a distinctly aggressive response may desensitize previous punishment contingencies by exlicitly showing a subject that it is permissible to aggress.

Summary

The present investigation was an exploratory study with the purpose of examining new measures of SIA, and determining the ideal procedural conditions to maximize the treatment effect; i.e., changes in response force resulting from both decreases and increases in reinforcement. Throughout the course of the investigation, it was necessary to rethink previous assumptions and redesign the procedure to achieve this aim. Experiment 1 studied the effects of individual loss trials (a negative change in reinforcement) and win trials (a postive change in reinforcement) on the operant response force as well as the response force on a concurrent escape response. From the literature review, the prediction was that response force would increase following both loss and win outcomes relative to baseline in which neither losses nor wins occurred. To test this hypothesis, (a) the difference in response force means between the operant immediately

preceding the outcome (R1) and the operant immediately following the outcome (R2) on baseline trials was compared to the R1-R2 difference on (i) loss trials and (ii) win trials, and (b) mean response force on R2 on baseline trials was compared the means on (i) loss trials and (ii) win trials. Although some isolated incidences were suggestive of an effect, overall it was concluded that chance-based losses and wins on a trial-by-trial basis in a gambling paradigm were not sufficient to consistently induce higher response force following the outcome. However, Experiment 1 did find that five of six subjects increased mean response force on R2 during the theoretically most aversive loss trials (i.e., big losses, after three or more losses in a row) relative to all other loss trials. Experiment 2 hypothesized that a string of losses (a Taking condition) after a series of wins and losses (a Reinforcement condition) would increase the aversiveness of the situation to the point that mean response force would be greater during Taking than during Reinforcement. This procedure was designed to more closely replicate previous SIA studies with humans. Consistent with the response vigor studies, the results of Method C--which was the accumulation of efforts to maximize the treatment effect--showed that response force was greater during Taking for seven of the eight subjects on R1, six of the subjects on R2, and six of the subjects on the escape

response; however, only the R1 result was significant. According to previous research, if this effect was to be demonstrated, then it should have appeared on R2 (i.e., immediately following the outcome). Two reasons were offered for this discrepancy. (1) Although aggressive response topography was observed on R2, this tendency was only part of a larger tendency to vary behavior during the period immediately after the outcome, having the overall effect of stabilizing mean response force during Taking relative to Reinforcement. (2) Immediate vigorous reactions to an aversive event may have been punished with social disapproval in the past, and thus subjects may have suppressed high response force on R2 and responded instead with substitute, more acceptable behaviors (e.g., talking to the experimenter). That response force was greater during Taking than during Reinforcement on R1 was attributed to the fact that the response itself and/or other enviromental and task variables may have become discriminatory stimuli signalling an imminent aversive loss outcome during Taking. Because R1 was further temporally removed from the period following a loss outcome than R2, it may have been less likely to be suppressed during Taking. Overall, the resultant response magnitudes during Taking were not comparable to the levels to which Kelly & Hake (1970) were referring when they defined human aggression. Aggressive response topographies were more

readily observed during Taking, but these responses were relatively infrequent compared to non-aggressive response topographies. Thus, it appeared that the results of Experiment 2 were inconsistent with previous SIA reports with humans. However, a reexamination of these studies revealed that non-aggressive responses as opposed to aggressive responses were the norm during extinction periods, and it was the probability that an aggressive response would occur which increased from reinforcement to extinction; therefore, the results of Experiment 2 and previous SIA reports with humans were similar in this respect. If aggression is an extreme on the response vigor continuum and if the aversiveness of a nonreinforcement period is directly related to response vigor, then it follows that individual loss trials in Experiment 1 and the Taking condition in Experiment 2 were not aversive enough to reliably produce aggression.

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Schedule-Induced Aggression: The Effects of Changes in Reinforcement on Force of Responding in College Students

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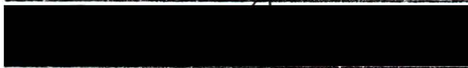

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