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PROBABILITY OF REINFORCEMENT FOR R AND R/ AND INTENSITY
OF THE REINFORCING STIMULUS AS PARAMETERS OF
REINFORCEMENT

City University of New York

PH.D. 1981

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PROBABILITY OF REINFORCEMENT FOR R AND λ AND INTENSITY OF
THE REINFORCING STIMULUS AS PARAMETERS OF REINFORCEMENT

by

Nancy A. Shamow

A dissertation submitted to the Graduate Faculty in
Psychology in partial fulfillment of the requirements
for the degree of Doctor of Philosophy, The City
University of New York.

1981

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1981

This manuscript has been read and accepted for the Graduate Faculty in Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

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ABSTRACT

PROBABILITY OF REINFORCEMENT FOR R AND $\bar{R}$ AND INTENSITY OF THE REINFORCING STIMULUS AS PARAMETERS OF REINFORCEMENT

by

Nancy A. Shamow

Adviser: Professor Thom Verhave

Five rats were exposed to two-component multiple schedules of electric shock presentation in which shock probability ($p(S^R)$) and shock intensity (I) were systematically manipulated. The probability of shock for the first response in each 4.0 sec T cycle ($p(S^R|R)$) was 0.000 and the probability of shock for not responding during the cycle ($p(S^R|\bar{R})$) was 1.000 in Component 1 and remained constant throughout the study. The values of $p(S^R|R)$ and $p(S^R|\bar{R})$ were varied in Component 2, so that the reinforcement schedules resembled those traditionally called avoidance, punishment and response-independent shock. If the probability of shock given a response is 1.000 while the probability of shock given no response in the same period of time is 0.000, then the procedure is a punishment procedure. If the conditions are reversed, such that the probability of shock given a response is 0.000 and the probability of shock given no response is 1.000, the procedure is an avoidance procedure.

In Experiment I, five pairs of $p(S^R)$ values ((0,1), (.125,.5), (.25,.25), (.5,.125), (1,0)) were presented in Component 2 for one day at each value with T constant at 4.0 sec. The procedure was replicated five times, once at each shock intensity (I = 2.000, 1.000, 0.500, 0.250 and 0.125 ma).

In order to assess the effect of shock probability on each of the response classes (R and $\bar{R}$), in Experiment II, the value of $p(S^R|R)$ during Component 2 increased in a progression from 0.000 to 1.000 (0.000, 0.125, 0.250, 0.500, 1.000) with $p(S^R|\bar{R})$ held at 1.000. The $p(S^R|R)$ was then held at 1.000 and $p(S^R|\bar{R})$ decreased through the same series from 1.000 to 0.000 (1.000, 0.500, 0.250, 0.125, 0.000). Each pair of probability values was in effect for one day, with T constant at 4.0 sec. The series of $p(S^R)$ values was repeated five times with each value of shock intensity (2.000, 1.000, 0.800, 0.500, and 0.250 ma).

The data were analyzed in terms of response rates, the proportion of T cycles in which a response was eligible for shock (T_R) that were sampled by a response, the proportion of maximum possible shocks received, total shocks received, and the proportion of the maximum shocks and total shocks received contingent upon each response class. Increases in the probability of shock produceable by a response class decreased the frequency of occurrence of behavior in that class. On proceeding from avoidance ($p(S^R) = (0,1)$) to

punishment ($p(S^R) = (1,0)$) in Experiments I and II, simultaneously or independently manipulating $p(S^R|R)$ and $p(S^R|K)$ decreased both response rates and the proportion of T_R cycles sampled. In Experiment I, the proportion of maximum shocks received was a biphasic function of the pairs of shock probabilities assigned to the response classes, with maximum shocks occurring at the point at which shock frequency was equal for both response classes. To the right of the maximum, most of the shock frequency reduction was attributable to a reduction in R-produced shocks, while to the left of the maximum, most of the reduction was attributable to a reduction in K shocks. Independently varying each of the two shock probabilities in Experiment II confirmed these findings.

For organisms with histories of responding on avoidance procedures, increases in the intensity of shock produced increases in the frequency of the avoidance response. Increases in shock intensity produced increases in both response rates and the proportion of T_R cycles sampled across all values of shock probability used in Experiments I and II except those defining punishment, where the effect was minimal and unsystematic. In Experiments I and II, the differential effect of shock intensity on the amount of shock frequency reduction obtained under schedules of response-independent shock and punishment was negligible. At the avoidance end of that continuum, a pronounced effect

of shock intensity was found, with the greatest shock frequency reduction occurring under the highest shock intensities. Elevating shock intensity for a given pair of $R/\bar{R}$ probabilities increased the proportion of shocks received for responding and, therefore, decreased the proportion of shocks received for not responding (i.e., they responded more at higher shock intensities).

Various attempts to relate the apparent differences between positive reinforcement, avoidance and punishment procedures and the behavioral effects they maintain were discussed, with emphasis placed on the identification of continua along which procedures and behavior may be ordered. The data indicated most clearly that the controlling variables in shock presentation procedures are the schedules of stimulus intrusion and the physical parameters of the intruded stimuli. The value of shock frequency reduction as a controlling variable was questioned in the light of its status as a dependent variable. Both responding and the distribution of shocks in time were described as dependent upon the schedule parameters and the parameters of the stimulus, either of which may modulate the effects of the other.

DEDICATION

This dissertation is dedicated to my loving husband, Jeffrey, whose genuine interest, enthusiasm and unfailing support contributed both to its conception and its completion. In many ways, this study was a joint venture.

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I wish to thank Professor Thom Verhave, in whose laboratory these experiments were conducted, and Professor Brett K. Cole for their help in the implementation and writing of this thesis. I would also like to thank Professor Nancy S. Hemmes, whose kind support and serious treatment of this dissertation were much needed and appreciated. A special acknowledgement is due Professor William N. Schoenfeld, whose work served as the major impetus for this study and who served as a source of continued inspiration and guidance. The thoughtful concern and encouragement of my doctoral committee and the detailed and helpful comments of Professors Philip N. Hineline and Lanny Fields contributed substantially to the writing of the final version of this dissertation.

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INTRODUCTION

I

History of the problem

"Escape," "avoidance," "punishment," and "positive reinforcement" procedures have traditionally been viewed as fundamentally different. It is possible, however, to view these procedures not as distinct entities, but rather, as points along continua defined by the physical properties of stimuli and the parameters of the schedules determining their occurrence. To do so would simplify the explanatory mechanisms necessary to account for the behavioral effects produced by these procedures. The present paper examines some of the history of and data relevant to these issues and explores one theoretical framework within which these procedures have been related.

The precursors to these issues first began to appear in the literature of conditioning and learning in the 1930s. Some uncertainty arose as to whether conditioned motor reflexes acquired and maintained under procedures in which the measured response served to delay or prevent the occurrence of a stimulus were true conditioned reflexes, and whether the avoidance procedure per se was an instance of true conditioning (Hilgard, 1936b). The similarity of the conditioned response (CR) to the unconditioned response (UR) maintained under the avoidance procedure, as well as the similarity of the procedure to conditioning procedures in which the conditioned stimulus (CS) and unconditioned

stimulus (US) were paired offered considerable evidence for the operation of the same principle, temporal contiguity of the CS and US, as the "one and only" necessary condition for all conditioning and learning to occur (Hull, 1929; Schlosberg, 1934; Sheffield, 1947, 1951; Sheffield & Temmer, 1950; Watson, 1916). The adequacy of a single or one-factor contiguity based theory of learning in which the CS would become a substitute for the US was challenged, however, as additional data began to accumulate which was contradictory to theoretical predictions. Warner (1932) questioned whether the warning signal used in shock avoidance procedures should be called a "substitute stimulus," since none of the several responses elicited initially by the US were eventually elicited by a warning signal (CS) after several CS-US pairings. Culler (1938) later argued that whether the CR was a replica of the UR or was a new activity depended on the level of development at which the CR was viewed. The lack of topographical similarity between the conditioned and unconditioned avoidance response (Culler, Finch, Girden & Brogden, 1935; Girden, 1938; Kellogg, 1938; Mowrer & Lamoreaux, 1946; Schlosberg, 1937; Warner, 1932) and the failure of the Pavlovian conditioning paradigm to account for conditioning under avoidance procedures in which Pavlovian extinction trials are inherent (Brogden, Lipman & Culler, 1938; Hunter, 1935) led Hilgard (1936b) to suggest that stimulus substitution be either abandoned as a sole explanatory principle, or supplemented

with other concepts. The wide disparities between the CR and UR were attributed by Hilgard (1936a) to the restrictions imposed by the device used for measurement.

An alternative to the stimulus substitution model was Thorndike's 1932 Law of Effect interpretation, in which emphasis was placed on the association between the response to be conditioned and the consequences of that response. The "satisfying" consequence for avoidance behavior was more difficult to specify, however, than that for procedures involving appetitive behaviors. In the avoidance procedure, the apparent consequence of the conditioned response was the absence of a specific stimulus rather than the presence of either a "satisfier" or "annoyer." Shock omission as a scheduled consequence of the avoidance CR was interpreted as a satisfier which had the effect of "stamping in" the response, whereas the presentation of shock was now regarded as an annoyer which weakened the response that preceded it. The acceptance of this interpretation questioned the Pavlovian assumption that for a conditioned response to be acquired and maintained it must always be followed by the US, with even occasional failures of the US to follow the CS resulting in the weakening of the conditioned response. Brogden, Lipman and Culler (1938) demonstrated the maintenance of a conditioned leg flexion response when relative reinforcement frequency (defined as the percentage of shock trials) was decreased. Sidman and Boren (1957a) later showed that a conditioned response could be main-

tained when the CS was only occasionally paired with the US on trials in which the animal failed to make an avoidance response. These results indicated that response maintenance was unrelated to the proportion of shock presentation trials in a conditioning procedure.

Related questions were also raised regarding the acquisition of conditioned responses (Humphreys, 1939). As a partial solution to the problem imposed by specifying the absence of stimulation as a source of reinforcement for the avoidance response, hypothetical states such as expectancy and anticipation were posited (Hilgard & Marquis, 1940; Rexroad, 1933; Tolman, 1933). Muenzinger and Fletcher (1936) suggested a tension-reduction model to account for the reinforcement of the avoidance response. Animals were said to move from states of imbalance (deprivation in the case of appetitive stimuli and stimulation in the case of aversive stimuli) to states of balance (satiation for appetitive stimuli and stimulus tension reduction for aversive stimuli). In both cases the reward was whatever event ended the state of tension. Mowrer (1938, 1939, 1940) and Mowrer and Lamoreaux (1942, 1946) adopted a tension-reduction model which was similar to that provided by Muenzinger. Mowrer likened escape from tension to a satisfying state of affairs, considering it an appropriate condition for the operation of the Law of Effect. In the presence of a warning signal, the anticipation of shock produced a state of fear or anxiety, which

in turn motivated behavior. Anxiety reduction, effected through escape from the CS, served as the reinforcing mechanism for the learning of the avoidance response:

In other words, if a conditioned avoidance reaction occurs when the subject is anxious and if the subject then ceases to be anxious (or becomes less so), such a response would be reinforced and might be perpetuated as long as the danger situation served to arouse a state of anxiety in the subject (Mowrer & Lamoreaux, 1942, p. 6).

Initially the conditioned response was strengthened by parasitic reinforcement in which reward was provided by shock termination (Mowrer & Lamoreaux, 1942). Once the conditioned response occurred, it was then independently reinforced and maintained through the termination of the CS which served as a warning signal for the approach of shock.

Although the reduction of anxiety could only be inferred from the termination of the CS and therefore could not be directly measured, the role of CS termination on the conditioning of the avoidance response was supported by Mowrer and Lamoreaux (1942, 1946) and Kamin (1957). Mowrer later modified his position (Mowrer, 1947, 1951; Mowrer & Keehn, 1958; Mowrer & Lamoreaux, 1951) when he found that the Law of Effect was not adequate to account for the acquisition of secondary drives such as anxiety. The apparent solution to this problem was to create a two-factor theory of avoidance in which shock presentation provided the necessary condition for the acquisition of the fear reaction while anxiety reduction following CS

termination provided the necessary condition for the acquisition of the avoidance response. Other two-factor theorists (Brown & Jacobs, 1949; Hefferline, 1950; Miller, 1948) also supported the idea of an anticipatory state which served as a motivator for the avoidance response. Having occurred, successful avoidance was then contingent upon the termination of the CS and the subsequent reduction or termination of the conditioned anticipatory state.

In a paper entitled "An experimental approach to anxiety, escape and avoidance behavior," Schoenfeld (1950) argued that concepts such as need reduction, drive reduction, and anxiety reduction were of no value to a science of behavior. Both anxiety and anxiety reduction could neither be observed nor experimentally controlled, and therefore, the utility of these concepts was untestable. Studies demonstrating the reinforcing effects of "sensory" stimuli which were neither need reducing nor associated with need reduction began to appear and further served to weaken the usefulness of need reduction as an explanatory concept (cf. Kish, 1966).

Schoenfeld (1950) suggested that the primary function of the avoidance response was the termination of exteroceptive stimuli and of nonavoidance responses which had acquired aversive properties through their pairing with noxious stimuli. Avoidance was seen as a by-product of its escape function. The stimuli removed by the avoidance response consisted of both proprioceptive and tactile stimuli

associated with nonavoidance behavior. In escaping from these stimuli, the organism "incidentally" happened upon the avoidance response. This position was summarized by Schoenfeld (1950) as follows:

Following several objections raised against Mowrer's anxiety-reduction hypothesis, an alternative explanation of avoidance is offered in which the response is conceived to be always a stimulus-terminating one.... It is argued that the avoidance response terminates stimulus compounds in which proprioceptive and tactile stimuli are important components.... If this formulation is correct, avoidance conditioning proves to be a form of escape training and its avoidance function is incidental to its stimulus termination function (Schoenfeld, 1950, p. 97).

Dinsmoor (1954, 1955) proposed an explanation of punishment which was similar to Schoenfeld's explanation of avoidance. The main effect of punishment was not the weakening of the punished response, but rather, it was the establishment of avoidance reactions which served as nonpunished alternatives to the punished response. Punishment was seen by Dinsmoor as a special class of avoidance schedules in which the reinforcement for the unspecified, unmeasured avoidance response was the escape from nonavoidance (and therefore punished) behavior.

These arguments were based on discriminated avoidance procedures in which the CS reliably preceded the noxious stimulus. Escape from nonavoidance behavior was also emphasized as a reinforcer in several studies in which no exteroceptive warning signal was used (Hefferline, 1950, 1958; Sidman, 1953a, 1953b, 1954, 1955a, 1955b).

Hefferline (1950) identified the warning signal in a non-cued avoidance procedure as internal stimulation resulting from the passage of time between successive shock presentations. In Sidman's experiment (1953b), rats were conditioned to avoid (postpone) a brief electric shock delivered at regular intervals. The interval between two consecutive shocks providing no avoidance response was made was designated the shock-shock (S-S) interval. Each depression of the response lever delayed the appearance of shock for a fixed duration called the response-shock (R-S) interval. In Sidman's procedure, the avoidance response could not have resulted from the generalization of a previously acquired escape response, since shock was too brief to allow escape. Sidman suggested that the reinforcer for the bar pressing response was the change from an aversive to a nonaversive proprioceptive pattern of stimulation resulting from the termination, by the occurrence of the avoidance response, of nonavoidance behavior.

While Sidman demonstrated acquisition and maintenance of avoidance in the absence of an explicit exteroceptive CS, the function of the CS in a discriminated avoidance procedure was still open to question. Herrnstein (1969) suggested that the CS in avoidance procedures was functionally similar to a discriminative stimulus used in positive reinforcement procedures (Sidman, 1955b; Sidman & Boren, 1957b; Verhave, 1962). The presence of the CS

served the function of dividing the experimental session into two "interwoven subsessions," each defined by a different consequence for responding. Sidman (1957) suggested that the discriminated avoidance situation was equivalent to a multiple schedule of reinforcement " ... in which one avoidance contingency prevails in the presence of the warning stimulus and another in its absence" (Sidman, 1957, p. 543). The warning signal becomes a discriminative stimulus for an operant avoidance response rather than " ... a vehicle for the Pavlovian conditioning of drives or aversive properties ..." (Sidman, 1957, p. 543). Other support for the discriminative function of warning signals was provided by Behrend and Bitterman (1963), Graf and Bitterman (1963), Keehn (1966, 1968), Sidman (1955b), Sidman, Mason, Brady and Thach (1962) and Ulrich, Holz and Azrin (1964).

Sidman later extended his argument to the nondiscriminated avoidance case (Sidman, 1962): Shock frequency reduction was postulated as the source of reinforcement for the avoidance response. In response to his previous (1953b) explanation of avoidance which focused on the termination of nonavoidance behaviors, Sidman stated:

The formulation has proved embarrassingly unamenable to direct test, inasmuch as unobserved behavior carries the explanatory burden ... but a few lines of evidence point to a directly observable factor which may serve to integrate findings from a number of avoidance experiments. This factor is shock frequency, or synonymously, shock density (Sidman, 1962, p. 247).

The rapidity with which the avoidance response was learned (Ader & Tatum, 1961; Black & Morse, 1961) raised doubts about the possibility that an infinitely large class of nonavoidance behaviors could all have been shocked, and therefore suppressed sufficiently to permit the avoidance response to become prepotent. Applying the shock frequency reduction argument to the pattern of responding generated by Sidman avoidance procedures, Sidman (1962) argued that the consequence of the response pattern, consisting of short bursts of responses occurring immediately after the delivery of shock followed by long pauses, was to reduce shock frequency from that specified by the S-S interval to that specified by the R-S interval. Supporting evidence for this view was drawn from the observation that with short R-S intervals (R-S less than one-half the S-S interval), animals stopped responding, since responding in this case could produce an increase in shock frequency. Verhave (1961), using a two-lever avoidance procedure, found that rats responded predominantly on the lever associated with the higher probability of postponing shock, and therefore the greatest shock reduction.

Whereas Sidman avoidance procedures eliminated the use of an explicit CS in an attempt to disprove a two-factor explanation of avoidance learning, Anger (1963) argued that the temporal regularities of Sidman's procedure produced conditioned stimuli varying in aversiveness. According to Anger:

... animals have available some events, either internal or in their behavior, that change in a consistent way with time after the last response, reinforcement, etc. These events function like external stimuli, at least to the extent that differences in responding can be conditioned to these organism differences (Anger, 1963, p. 479).

The source of reinforcement suggested by Anger was a decrease in conditioned aversiveness produced by responses which effectively changed stimuli associated with long postresponse times (PRTs) and postshock times (PSTs) to stimuli associated with short PRTs and PSTs. The low aversiveness of stimuli associated with short PRTs and PSTs was attributed to their temporal remoteness to the next scheduled shock. Sidman's 1953b finding that for long R-S intervals, changes in the S-S interval had no effect on response rate led Bolles and Popp (1964) to conclude that it was the PRT stimuli that were crucial in the acquisition of Sidman avoidance. The role of response-produced stimulus change does not, however, contradict a shock frequency reduction argument, since both shock frequency reduction and response contingent stimulus change may be important.

Herrnstein and Hineline (1966) demonstrated that response rates were directly related to the amount by which they reduced shock frequency. In answer to Anger's (1963) analysis of Sidman's procedure in which temporal regularities proved an implicit source of conditioned stimulation, Herrnstein and Hineline removed these temporal

regularities by subjecting rats to an avoidance procedure in which shocks were presented randomly in time. Two separate and independent schedules of shock presentation were available. One schedule was in effect if the animal failed to depress the lever, while the other operated if an avoidance response was made. While a response could not avoid every shock, the schedule associated with responding generated a lower overall frequency of shocks. The finding that schedules permitting a greater reduction in shock probability maintained higher rates of responding led Herrnstein and Hineline to conclude that "a response-dependent change in the amount of subsequent aversive stimulation appears to be the sine qua non of avoidance conditioning" (Herrnstein & Hineline, 1966, p. 429). The procedure developed stable avoidance responding, with a slight but persistent tendency for responses to occur in bursts immediately following shock. The authors concluded:

It is our judgment that to extend two-factor theory to the present results is to make it essentially irrefutable, for as long as a primary reinforcer occurs in any procedure it is always possible to postulate an internal event to correspond to it, and to endow the internal event with the properties of a conditioned stimulus (Herrnstein & Hineline, 1966, p. 430; cf. Schoenfeld, 1950).

Herrnstein (1969) similarly noted that in order for two-factor theory to be nontautological it had to be disprovable. The irrefutability of two-factor theory was evidenced by its extension to experimental situations in

which Pavlovian contingencies were removed. Herrnstein argued that an explanation of avoidance maintained by the random shock procedure which rested on the presence of inferred stimuli was a tautology:

Unlike the CS of standard avoidance or the temporal regularity of Sidman's procedure, the stimulus for two-factor theory here has but one attribute and that is its statistical relation to shock frequency. To detect these "stimuli," the animal must be reacting to shock frequencies in the first place. Neither the animal, nor our understanding of avoidance seems to gain by these inferred stimuli (Herrnstein, 1969, p. 59).

Historically, the necessity for a two-factor theory arose from the difficulty in specifying the reinforcer for the avoidance response without appealing to shock omission. An underlying assumption of two-factor theory was that two distinct types of conditioning existed and that "pure" cases of each could be isolated. Hilgard (1937) suggested that both types of conditioning occurred in experiments of either classical defense or avoidance. The class to which any experiment was said to belong was actually determined by the interests of the experimenter, which in turn affected which response he chose to observe or measure. Evidence for the occurrence of Pavlovian fear conditioning during avoidance learning rested on demonstrations of both excitatory and inhibitory processes operating during training of an avoidance response (Rescorla, 1968; Rescorla & LoLordo, 1965; Stretch, 1972). Stretch (1972), for example, used inhibition of delay as an explanation for

the positively accelerated responding observed under FI schedules of response-produced shock, with differential rates throughout the interval reflecting a temporal gradient of conditioned fear. The presence of both types of conditioning in both procedures suggested, however, that the distinction might be an arbitrary one. As early as 1951, Sheffield argued for the identity of the two learning processes based on the similarity of the phenomena exhibited by both types of conditioning:

In such matters as acquisition, extinction, differentiation, effect of partial reinforcement, and so forth, it makes no difference whether we are talking about a Thorndikian or a Pavlovian learning situation. The impressive fact is that we can translate from one discipline to the other by the simple expedient of interchanging appropriately the terms "reward" and "unconditioned stimulus." To me this makes it very improbable on a priori grounds that there is not a common process.... This suggests looking extensively for a hidden similarity in operations or process - it does not readily suggest that there is a different process to go with each experimental operation (Sheffield, 1951, p. 363).

Rescorla and Solomon (1967) asserted that, while on a descriptive level, the laws of Pavlovian conditioning and those of Thorndikian learning must differ, since the experimental procedures from which they are derived differ,

... if some theoretical system could be developed to unify the different empirical laws, to reduce them to the same general underlying principles, then the laws of behavioral modification would deduce the outcomes of both types of experiment. In an important sense, the history of learning theories is a succession of attempts to specify the re-

lation between the outcomes of the two types of experiment (Rescorla & Solomon, 1967, p. 152).

The only data obtained, however, which supported a two-factor theory in Rescorla and Solomon's (1967) paper rested on demonstrations of the control of instrumental responding by means of Pavlovian procedures (Estes & Skinner, 1941; Herrnstein & Sidman, 1958; Kelleher, Riddle & Cook, 1963; Rescorla & LoLordo, 1965; Sidman, Herrnstein & Conrad, 1957; Stein, Sidman & Brady, 1958; Waller & Waller, 1963). The mere demonstration of an interaction between the effects of both types of procedures (Pavlovian and instrumental) does not by itself provide evidence, however, for the mediation of one class of behavior by another, and therefore obviates the need for intervening variables (e.g., inhibition and excitation) to explain the mediation. Rather than lending support to a two-factor theory, these data simply demonstrate the effects of combining procedures. The combination of these procedures, in fact, presents no bar to the reduction in the number of underlying processes. The degree of suppression or facilitation produced by the introduction of a Pavlovian conditioning procedure appears to depend on several factors, including the schedule of reinforcement maintaining ongoing behavior and the history of the organism. Additional experiments, for example, (Brady, 1955; Brady & Hunt, 1955; Libby, 1951) demonstrated that the acquisition and extinction of a conditioned emotional response was affected by the schedule of positive

reinforcement used to maintain an ongoing operant response. In these experiments, differences in the pattern of operant behavior maintained by different reinforcement schedules produced large differences in the development of an autonomic response.

An interpretation of the conditioned suppression phenomenon based on the mediation of instrumental behavior by Pavlovian CRs (conditioned emotional reactions or anxiety) was further questioned by Azrin and Hake (1969). Conditioned suppression was found to occur during a CS signalling the noncontingent presentation of food, water and intracranial stimulation. The suppression of behavior which occurred when the CS was intruded into a variable interval food maintained baseline could hardly be explained by inhibitory processes operating as a result of the pairing of the CS with an aversive event.

The necessity for a two-factor learning theory to account for avoidance was also questioned by efforts to describe the effects of "positive" and "aversive" stimuli on behavior within a single framework. Schuster and Rachlin (1968) trained animals on a concurrent chain schedule in which identical variable interval (VI) schedules of positive reinforcement were programmed on the initial links of the chain while different schedules of shock presentation (punishment and noncontingent shock) superimposed on a VI schedule of positive reinforcement were programmed in the terminal links. They found that the animals preferred the

condition associated with the lowest rates of shock. Later, deVilliers (1974) extended Herrnstein's (1970) matching equation for describing interactions between response rate and reinforcement frequency to negative reinforcement schedules and assumed the reinforcer controlling responding under avoidance schedules to be shock frequency reduction. The lawful matching relation between relative response rates and relative shock frequency reduction suggested the abandonment of a two-factor learning theory. Thorndike's negative Law of Effect now seemed to have reappeared as a result of the discovery of a general equation capable of accounting for both appetitive and aversive stimulus procedures.

Shock frequency reduction as a source of reinforcement for the avoidance response, however, has come under considerable attack on both logical and empirical grounds. Schoenfeld (1969) argued that:

... to look to reduction in [shock] frequency as the cause of avoidance responding is once again to appeal to the non-occurrence of a stimulus as reinforcing. The absurdity of this appeal is evident because at any moment an infinite number of stimuli are not occurring, and we would therefore have to assume that all behavior is avoidant (Schoenfeld, 1969, p. 672).

The shock frequency reduction explanation of avoidance failed to account for how animals detect changes in the intervals between shocks (cf. Anger, 1963), particularly in those cases in which a variable S-S interval is used (Bolles & Popp, 1964; deVilliers, 1974). Behrend and

Bitterman (1963) found no effect of a substantial increase in shock frequency on the maintenance of avoidance responding. Both Anger (1963) and Bolles and Popp (1964) concluded that although shock frequency reduction may be effective early in acquisition, it could not account for maintained responding long after shock frequency had been reduced below a level that was discriminable. Herrnstein and Hineline (1966) also recognized the problem for behavior theory created by the notion that a change in the rate of occurrence of a stimulus served as a reinforcing event. A shock frequency reduction explanation fails to specify any temporal relation between the avoidance response and the consequences of that response. Dinsmoor (1977) pointed out that:

... it is difficult, logically, to see how a reduction in shock density could, by itself, serve as a reinforcing event. It has no locus in time.... If the reduction in estimated shock density is a continuous process, not localized in time, how can it become correlated with any specific item of behavior? It follows all behavior, but none more closely or more consistently than any other (Dinsmoor, 1977, p. 90).

The shock frequency reduction account of avoidance learning was further weakened by Hineline (1970) in a study which showed stable lever pressing responses in rats produced and maintained by a discrete trial avoidance procedure in which responding delayed shock without decreasing overall shock frequency. In this study, responding merely influenced the position of electric shock within a 20 sec cycle, having no effect on the frequency of shocks per

trial. Hineline concluded "... that behavior strongly resembling avoidance can be produced without providing the feature that gives a standard avoidance procedure its name" (Hineline, 1970, p. 267). Benedict (1975) and Gardner and Lewis (1976) similarly demonstrated response-produced delay of shock without shock frequency reduction as a reinforcer for avoidance behavior. In the Gardner and Lewis study, rats received shock at variable time (VT) intervals in the absence of a bar press response. Responding could produce an alternate condition in which a train of shocks was delivered after a period of time during which no shocks occurred. The study showed that animals preferred the condition in which shock was delayed, with the extent of the preference a function of the length of the delay. In the same paper, the reinforcing effects of delayed shock, when responding actually increased the frequency of shock presentation, was also demonstrated. A complementary experiment which examined shock frequency reduction while reducing delay of shock onset (Lambert, Bersh, Hineline & Smith, 1973), however, demonstrated both acquisition and maintenance of avoidance responding. In this study, a response which occurred early in an interval produced one immediate shock but was instrumental in avoiding a sequence of five electric shocks scheduled to occur at a frequency of one per second at the end of the interval. The acquisition of avoidance responding, which contradicted Bolles and Popp's (1964) earlier failure to demonstrate

successful avoidance under similar conditions, led these authors to conclude that either shock frequency reduction or delay of shock onset was a sufficient basis for avoidance conditioning. All of these studies seem to suggest the obvious: there are a number of factors to be taken into consideration.

II

Unifying attempts

As shock frequency reduction came under scrutiny, a rapidly growing literature questioned the notion that electric shock is inherently aversive. Although previous investigations showed the suppressive effects of electric shock on responding (Appel, 1968; Appel & Peterson, 1965; Azrin, 1959, 1960; Azrin & Holz, 1961; Hake, Azrin & Oxford, 1967; Church, Raymond & Beauchamp, 1967; Cohen, 1968; Ferraro, 1965; Filby & Appel, 1966; Karsh, 1962), with response rates inversely related to punishment frequency, the effect of electric shock was found to depend on several factors, such as the reinforcing schedule maintaining ongoing behavior onto which shock was intruded, the schedule of shock presentation, and the animal's history with respect to different reinforcement schedules and shock intensity. Given appropriate parameter values, responding could be maintained or even increased by the schedule of shock presentation alone (Byrd, 1969, 1972; Eubanks, Killeen, Hamilton & Wald, 1975; Gardner & Lewis, 1976, 1977; Kelleher & Morse, 1968; McKearney, 1968, 1969, 1972;

Morse & Kelleher, 1966, 1970; Stretch, 1972). Under these conditions, the similarities in the patterns of behavior maintained by identical schedules of shock and food presentation, and the empirical evidence demonstrating that slight variations in experimental contingencies could generate behavioral changes such that the same stimulus could meet the defining criteria for both positive and negative reinforcers led behavior theorists to question the nature of this distinction. Holz and Azrin (1961), for example, demonstrated that electric shock did not appear to be aversive when used as a discriminative stimulus for positive reinforcement. Positively accelerated patterns of responding were maintained by response-produced shock in pigeons given a prior history of variable interval responding for food with punishment given for each response. Kelleher and Morse (1968) similarly reported a positively accelerated response pattern maintained by squirrel monkeys responding on a fixed interval 10 min schedule of shock presentation. Animals were initially given a history of training in which a two-component multiple fixed interval 10 min, fixed ratio 1 schedule of shock presentation was programmed concurrently with a VI schedule of food presentation. It is possible, however, to argue that in both of these studies the maintenance of responding by electric shock was dependent on the history of prior food-shock pairings. Holz and Azrin (1962) observed that the amount of suppression engendered by response-produced shock de-

pended on its temporal location relative to food delivered on a FI reinforcement schedule. Shock following each response during the first three quarters of the interval decreased responding while shock presented during the last quarter increased responding. Increased responding was attributed to the discriminative properties of punishment resulting from the differential pairing of shock with food. Both McMillan and Morse (1967), and Murray and Nevin (1967) found similar effects, demonstrating that the aversiveness of electric shock was a function of its temporal relationship to availability of positive reinforcement.

While most of the punishment studies focused on experimental contingencies in which shock was applied to responses maintained under schedules of positive reinforcement, later investigations applied the punishment contingency to responses maintained by avoidance or response-independent shock presentation schedules. McKearney (1968) superimposed an FI 10 min schedule of shock presentation on a Sidman avoidance schedule ($S-S=10$ sec, $R-S=30$ sec), and then discontinued the Sidman avoidance schedule. Although little effect on the pattern of avoidance responding was reported when the FI 10 min shock schedule was programmed concurrently, characteristic FI performance was maintained when the avoidance schedule was eliminated. A later replication of this study (McKearney, 1969) in which the duration of the FI was varied (1, 3, or 5 min) yielded an inverse relationship between FI duration and response rate.

McKearney (1970, 1972) also demonstrated characteristic patterns of responding similar to those maintained by food presentation and shock termination schedules under FR, multiple FI FR, VI and multiple VI FR schedules of electric shock presentation. Maintained responding under a VI schedule of electric shock presentation was also demonstrated by Eubanks, Killeen, Hamilton and Wald (1975) when a time out followed each response-produced shock. Responding decreased with decreases in the duration of the time out and was not maintained when time out was eliminated. Although McKearney (1968, 1969, 1970 and 1972) and Kelleher and Morse, (1968) used response-contingent time out following the delivery of response-produced shock, while others used shocks delivered if the experimental subjects failed to respond (Morse & Kelleher, 1970), these studies supported the notion that the schedule of electric shock presentation was of overriding importance in determining the effect of shock on behavior.

Morse, Mead and Kelleher (1967) showed that prior exposure to a schedule in which shock could be postponed or was paired with food was not a necessary condition for the maintenance of responding when the only programmed consequence of responding was the delivery of response-produced shock. In this study, a FI 30 sec schedule of electric shock presentation was superimposed onto a 60 sec response-independent shock schedule. Under this schedule, the first response 30 seconds after the last shock produced the next

shock. A pattern of maximal responding immediately following shock delivery, characteristic of responding maintained under response-independent shock schedules (Azrin, 1956; Hendry, Yarczower & Switalski, 1969; Sidman, Herrnstein & Conrad, 1957) was altered to one in which maximal responding occurred just before shock, a pattern which was maintained after the elimination of the response-independent shock schedule.

Byrd (1969) reported that cats given a prior history of shock avoidance (S-S=5 sec, R-S=60 sec), maintained a steady rate of key pressing responses which increased in frequency when a response-independent 15 sec schedule of shock presentation was superimposed onto the shock avoidance schedule. Response rate was maintained by the delivery of "free" shocks when the avoidance schedule was omitted. The maintained responding under periodic delivery of response-independent shocks in animals given a history of avoidance responding replicated earlier findings reported by Herrnstein and Sidman (1958), Kelleher, Riddle and Cook (1963), Sidman, Herrnstein and Conrad (1957) and Waller and Waller (1963); however, these earlier studies reported positively accelerated responding in the presence of a stimulus which terminated with response-independent shock. In Byrd's study, a positively accelerated pattern of responding only emerged when the shock schedule was changed so that shocks were produced by responses on a 15 min FI schedule.

Escape behavior maintained by schedules of stimulus termination has also shown response characteristics comparable to those maintained by schedules of positive reinforcement (Azrin, Holz, Hake & Ayllon, 1963; Dinsmoor, 1959, 1962; Dinsmoor & Winograd, 1958; Hineline & Rachlin, 1969; Kaplan, 1952; Morse & Kelleher, 1966; Winograd, 1965). By the late 1960s several theorists had drawn similar conclusions. For example, McKearney (1969) stated that:

... to expect that any environmental event will have invariant effects is unreasonable; yet for traditional behavior theories such invariance has usually been a tacit assumption. For a properly deprived animal, stimuli such as food or water are assumed to be inherently "positive," in the sense that the animal will work "for" them, and stimuli such as electric shock are thought to be invariably "negative" stimuli which animals will avoid or escape; exceptions are usually described as "paradoxical." However, there is evidence that a given stimulus can have different and even opposite effects in the same organism at the same time. For example, in the present experiments, electric shocks of the same intensity that functioned to maintain responses that postponed them later functioned to maintain responding preceding their presentation.... Clearly, the manner in which a stimulus is scheduled can be a more crucial determinant of its effects than any inherent qualities of that stimulus (McKearney, 1969, p. 311).

Morse and Kelleher (1966) concluded:

... the schedule of reinforcement can be more important in the control of behavior than the nature of the reinforcer (Morse & Kelleher, 1966, p. 836),

while Schoenfeld similarly concluded that:

... no stimulus is aversive in itself without regard to the parameter of its intensity and

the circumstances of its delivery.... we must conclude that "aversive schedules" are only arbitrarily, even conventionally and nominally, classed under that title (Schoenfeld, 1969, p. 673).

The conclusions drawn from the similarities in the behavior maintained by schedules of food presentation, shock presentation and shock termination must lead inevitably to the abandonment of such arbitrary distinctions as "positive" and "negative" reinforcers, "escape," "avoidance" and "punishment." Rather than an emphasis on differences, the continuities and similarities in behavior and its controlling conditions may then become paramount. In a paper in which a new theoretical approach to the avoidance problem was attempted, Schoenfeld (1969) extended the notion that it was the schedule of reinforcement which determined behavior to the avoidance case. Avoidance behavior was conceptualized as part of a continuum of behavioral effects. The avoidance procedure was seen as parametrically linked to other conditioning procedures previously thought to be unrelated:

This new approach is essentially a re-statement leading not to the "solution" of a problem, but to its dissolution; framed in proper terms, the phenomenon of avoidance simply disappears as a separate category of behavior, or at least becomes a derivable spin-off from a more general treatment of behavior. It seems to me that because "aversive" responding is not different in either principle or process from the acquisition and maintenance of other types of responding, it is involved in the broader question of "reinforcement" in general (Schoenfeld, 1969, p. 669).

According to Schoenfeld (1969), our understanding of avoidance rests on the "temporal relations and the associated probability relations between the experimentally manipulated stimuli and those responses chosen from the behavior stream for observation" (Schoenfeld, 1969, p. 674). No stimulus was seen as intrinsically aversive without regard to the physical parameters of the stimulus, the schedule of stimulus delivery and the response class to which the experimenter chose to direct his attention:

The effects of any intruded stimulus on responding (whether "reinforcing" or "emotionalizing," etc.) depend on what behavior changes we are willing to accept as classes of effect, and what we are willing to include as part of any effect, as well as on a number of other variables such as the state of the organism, or the response composition of the behavior stream at the moment of [stimulus] intrusion. Among these latter variables is one fundamental to any discussion of aversive schedules; namely, stimulus intensity" (Schoenfeld, 1969, p. 672).

If under the proper set of conditions, the same stimulus can meet the defining criteria for both positive and negative reinforcers, the argument for the existence of two separate classes of reinforcing stimuli and the assumption that the appetitiveness or aversiveness of a stimulus is an inherent and invariant property of that stimulus is inadequate. For example, high intensity stimuli have been shown to maintain high response rates (Boren, Sidman & Herrnstein, 1959; McKearney, 1969; Powell, 1970b) while other studies have shown that high in-

tensity stimuli maintain low response rates (Appel, 1968; Appel & Peterson, 1965; Azrin, 1959, 1960; Azrin, Holz & Hake, 1963; Bolles & Warren, 1965; Church, Raymond & Beauchamp, 1967; Filby & Appel, 1966; Moyer & Korn, 1964; Theios, Lynch & Lowe, 1966). An alternative to this approach has focused on the search for the similarities between procedures and their behavioral effects which have previously been treated as unrelated. Many of these experiments have attempted to look at similarities in the experimental operations along the temporal continua that define reinforcement schedules (Dunn, Foster & Hurwitz, 1971; Ferraro, 1965; Hurwitz & Millenson, 1961; Sidley, 1963). These experiments have been conducted within the framework provided by the t - T systems (cf. Schoenfeld, Cole, Blaustein, Iachter, Martin & Vickery, 1972). The t system, first introduced in 1956 by Schoenfeld, Cumming and Hearst, provided a set of temporal parameters (T , $\bar{T}$ and p) along which schedules previously treated as unrelated could be located. The t system rests on a repeating time cycle of fixed length, T . Each T cycle may be divided into two alternating time periods, t^D and t^A , such that the first response in t^D may be reinforced. By convention, no response in t^A may be reinforced. T then is equal to t^D plus t^A , with the ratio of t^D to T called $\bar{T}$. At $\bar{T}=1.0$, the first response that occurs anywhere in the T cycle is eligible for reinforcement. At $\bar{T}=0.5$, that first response must occur in the first one-half of the T cycle in

order to be eligible for reinforcement, while $\bar{T}=0.0$ defines extinction. Whether or not an eligible response (by convention the first in t^D) is reinforced is determined by an a priori probability, p . At $p=1.0$, each first response in each t^D period produces a reinforcer. At $p=0.5$, 50 percent of the first responses in t^D periods produce reinforcers, while at $p=0.0$, no responses produce reinforcers and the schedule may be called extinction. The mean expected inter-reinforcer time (IS^rT) is defined by the ratio T/p .

The early t system work, however, ignored the continuous nature of the "behavior stream" (Schoenfeld & Farmer, 1970) into which the reinforcers were intruded. The recognition that each response occurs within the context of "other" behavior and that "... the outcome of every experiment depends as much upon what responses are not reinforced as upon those that are" (Schoenfeld & Farmer, 1970, p. 219), led to the identification of "not responding," or $\bar{R}$, as a defining response class. The behavior stream consisted of two mutually exclusive and exhaustive categories of behavior, R and $\bar{R}$, with $\bar{R}$ defined as a predetermined interval of time of fixed length in which R did not occur. When two independent probabilities of aversive stimulus (S^R) presentation were assigned to R and $\bar{R}$ and were combined with the parameters of the t system, a variety of negative reinforcement schedules were generated (Blaustein, 1975; Kadden, 1973; Kop, 1972; Neffinger & Gibbon, 1975; Schoenfeld & Farmer, 1970). Mean inter-shock

time in these schedules is determined by T_R and $T_{\bar{R}}$, two concurrent and repeating time cycles, and $p(S^R|R)$ and $p(S^R|\bar{R})$, the probability of S^R presentation in a T_R cycle in which at least one R has occurred and the probability of S^R presentation at the end of a $T_{\bar{R}}$ cycle in which no R has occurred, respectively. When each T_R cycle is sampled by at least one response, $T_R/p(S^R|R)$ represents the mean time between response-produced shocks. Mean time between shocks delivered in the absence of responding is similarly represented by $T_{\bar{R}}/p(S^R|\bar{R})$. The frequency and temporal distribution of reinforcements for R and $\bar{R}$ depend on the value of $T_R/p(S^R|R)$ and $T_{\bar{R}}/p(S^R|\bar{R})$, the frequency of R and $\bar{R}$, and the distribution of cycles sampled by R (Schoenfeld & Farmer, 1970; Schoenfeld & Cole, 1972).

III

Rationale

The present paper may be seen as an extension of this work. Experiments I and II systematically explored the effects of shock intensity within an experimental space defined by $p(S^R|R)$ and $p(S^R|\bar{R})$. Figure 1 shows the experimental space defined by the coordinates $p(S^R|R)$ and $p(S^R|\bar{R})$. Assuming T_R and $T_{\bar{R}}$ to be equal and coterminous for all probability values, a number of reinforcement schedules may be defined within this space. For example, at values of $p(S^R|R)$ and $p(S^R|\bar{R})$ of 1.000 and 0.000, respectively, or (1,0), the schedule resembles fixed interval, regardless of the intensity of the stimulus and provides for response-

produced decreases in the interstimulus time. Different labels have been assigned to this schedule depending on the stimulus intruded. If the stimulus is food, the schedule is fixed interval. If the stimulus is shock, the schedule has traditionally been called punishment but may also be called FI shock. At values of $p(S^R|R)$ and $p(S^R|\bar{R})$ of 0.000 and 1.000, respectively, or (0,1), the schedule resembles DRO, although when the stimulus is electric shock, this schedule has traditionally been called avoidance. In both the DRO and avoidance cases, the delivery of a stimulus is made contingent on the occurrence of "other" behavior, or $\bar{R}$. The schedule provides for response-produced increases in interstimulus time. At all values of $p(S^R|R)=p(S^R|\bar{R})$, the schedule resembles response-independent stimulus delivery, or Pavlovian conditioning when the stimulus is food, and classical defense conditioning when the stimulus is shock. A limiting case of response-independent stimulus delivery is defined by $p(S^R|R)$ and $p(S^R|\bar{R})$ values of 0.000, or (0,0). The schedule resembles extinction.

Figure 1: Experimental space defined by $p(S^R|R)$ and $p(S^R|\neg R)$.

Figure 1 shows the experimental space defined by $p(S^R|R)$ and $p(S^R|\neg R)$. Line AC represents the range of $p(S^R)$ values used in Experiment I. Lines AB and BC show the range of $p(S^R)$ values used in Experiment II. Closed circles represent the values of $p(S^R|R)$ and $p(S^R|\neg R)$ actually tested.

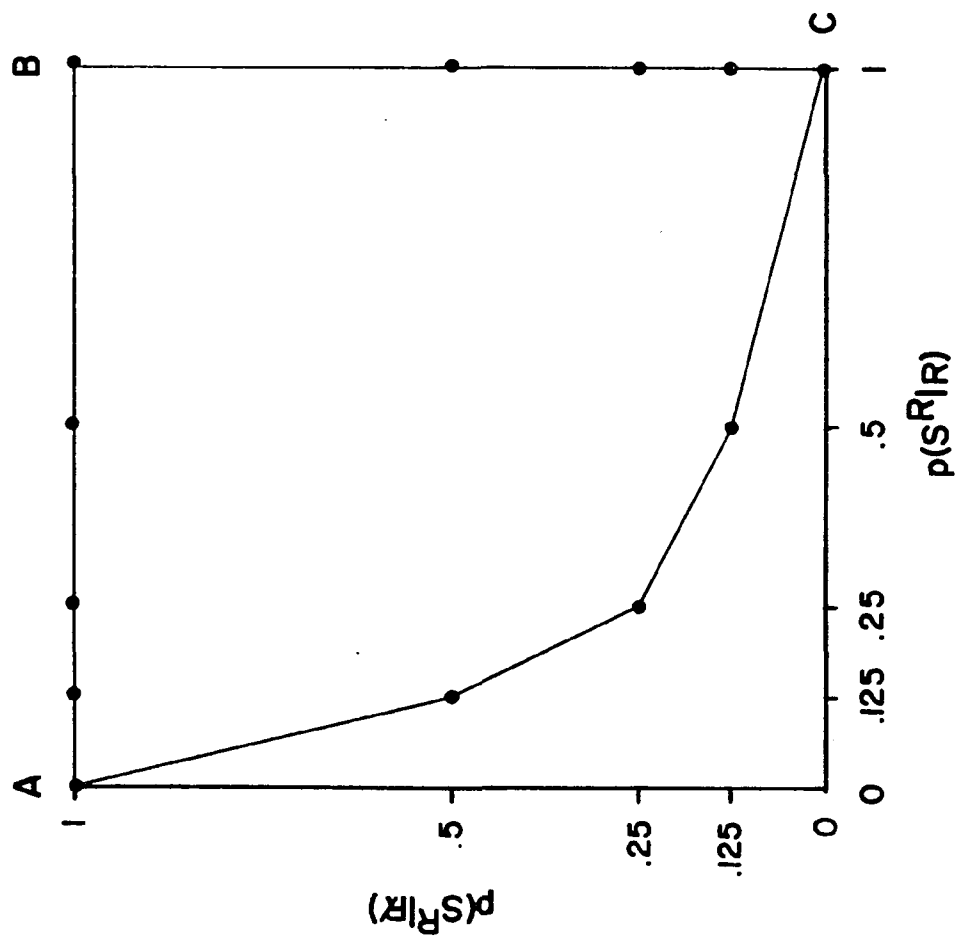


Figure 1

METHOD

Subjects. Subjects were five naive male Long Evans hooded rats, approximately 90 days old at the start of the experiment. Each subject was individually housed with ad lib access to food and water for the duration of the experiment.

Apparatus. The experimental chamber was a Scientific Prototype A100 rodent test cage, housed in a Scientific Prototype SPC300 sound attenuating enclosure. The cage was equipped with a Scientific Prototype PLS100 response lever located 5.08 cm above the grid floor and required a force of 0.1 N or more to close a microswitch. The floor of the cage consisted of 16 stainless steel grid bars, 0.40 cm in diameter spaced 1.43 cm apart. A cue light, consisting of a #1828 28-volt bulb driven by a 24 VAC transformer isolated from the controlling circuitry, was mounted behind a 2.54 cm white translucent bezel. The cue light was located in the center of the front panel, 2.54 cm above the response lever. General illumination was provided by a 115-volt AC 7 watt houselight mounted on the ceiling of the enclosure above the center of the cage. A continuously operating ventilating fan and white noise source (Grason Stadler #901B Noise Generator) driving a 10.16 cm 8 ohm speaker located behind the front panel of the cage provided masking noise during the experiment.

Scrambled constant current AC shock of 0.50 sec dur-

ation delivered through the grid bars, was provided by a Grason Stadler #E1064GS shock generator. The front and rear walls of the chamber and lever were included in the shock circuit.

Experimental contingencies were controlled using a series of relays, timers and Sodeco predetermining counters located in a room isolated from the experimental chamber. The time base for all experimental operations was a BRS/LVE #TI903 electronic timer which provided a 40 msec pulse every 0.50 sec. BRS/LVE #PG901 probability gates determined shock probabilities. Data were recorded using a Grason Stadler Harvard C3 cumulative recorder and Sodeco impulse counters.

Procedure. Acquisition (Multiple avoidance-avoidance).

During the 20 days prior to the start of the experiment proper, all subjects were trained to press the lever under a multiple avoidance-avoidance schedule. The schedule of reinforcement was the same in both components: $p(S^R|R)=0.000$, $p(S^R|\bar{R})=1.000$, $T_R=T_{\bar{R}}=4.0$ sec (T_R and $T_{\bar{R}}$ were co-terminous). A 2.000 ma shock of 0.50 sec duration was delivered at the end of each T cycle in which there was no response. The first response in each T cycle cancelled the shock for that cycle. Additional responses beyond the first in each T cycle had no effect. During Component 1, the cue light was dark while Component 2 was signalled by the illumination of the cue light. The components of the multiple schedule were five minutes in length and were

timed from the start of the first T cycle. All timing was stopped during the delivery of 0.50 sec shock. The components of the multiple schedule alternated, with experimental sessions consisting of 12 presentations of each component. The houselight was turned on at the start of the session and remained on until the session ended.

Experiment I. Beginning on the day immediately following the last acquisition session, the animals were exposed to a series of multiple schedules. The value of shock intensity for both components was 2.000 ma. $P(S^R|R)$ and $p(S^R|\bar{R})$ for Component 1 remained constant at 0.000 and 1.000, respectively, while five pairs of shock probability for R and $\bar{R}$ ((0,1), (.125,.5), (.25,.25), (.5,.125), (1,0)) were assigned to Component 2. Each pair of $p(S^R)$ values was in effect for one day. Shock intensity was then decreased in both components to 1.000 ma while $p(S^R)$ in Component 2 was again set equal to (0,1), and the series of five pairs of $p(S^R)$ values was repeated. Shock intensity was reduced three more times to 0.500, 0.250 and 0.125 ma. At each intensity, the $p(S^R)$ in Component 2 varied from (0,1) to (1,0) over a five-day period. After completion of the final probability value for the 0.125 ma shock intensity, each subject was given a single session on the original avoidance baseline ($p(S^R)=(0,1)$) at each of the levels of shock intensity. The values of p and intensity and the order in which they were presented are shown in Table 1. Sessions during acquisition and Experiment I were

conducted seven days per week at approximately the same time each day. The components of the multiple schedule alternated and were five minutes in length, with experimental sessions consisting of 12 presentations of each component.

Experiment II. During sessions 51 to 55, the $p(S^R)$ in Component 2 was set equal to (0,1) and the value of shock intensity in both components of the multiple schedule was 2.000 ma. On the sixth day (session 56), the schedule in Component 1 remained unchanged ($p(S^R)=(0,1)$, $T=4.0$ sec). $P(S^R|\bar{R})$ was held constant at 1.000 in Component 2, while the value of $p(S^R|R)$ in Component 2 increased in a progression from 0.000 to 1.000 (0.000, 0.125, 0.250, 0.500 and 1.000). Each value of $p(S^R|R)$ was in effect for one day. The $p(S^R|R)$ was then held at 1.000 and $p(S^R|\bar{R})$ decreased through the same series (1.000, 0.500, 0.250, 0.125, 0.000), with each value again in effect for one day. On the next session (session 64), shock intensity was reduced from 2.000 to 1.000 ma in both components, the $p(S^R)$ in Component 2 was again set equal to (0,1), and the series of $p(S^R|R)$ and $p(S^R|\bar{R})$ values again repeated. Shock intensity was reduced three more times (0.800, 0.500, and 0.250 ma). At each intensity, the $p(S^R)$ in Component 2 varied from (0,1) to (1,0) over a nine-day period. The value of the experimental parameters and the order in which they were presented are shown in Table 2. Subjects in Experiment II were run six days each week at the same time

each day.

Tables 1 and 2 show the order in which animals were exposed to the various schedule and shock intensity parameters. Chronologically, Experiment 1 preceded Experiment 2 for all subjects. In the presentation of the results to follow, Experiment 2 is discussed first.

Table 1

Order of presentation of each value of $p(S^R|R)$
and $p(S^R|\bar{R})$ for each value of shock intensity.

Session numbers are shown in the left-most column, corresponding intensity values in the second column, p values for R and $\bar{R}$ in Component 1 in the third and fourth, respectively and p values for R and $\bar{R}$ in Component 2 in the fifth and sixth columns, respectively.

Session #	Intensity	Component 1		Component 2	
		$p(S^R R)$	$p(S^R \bar{R})$	$p(S^R R)$	$p(S^R \bar{R})$
21	2.000 ma	0.000	1.000	0.000	1.000
		0.000	1.000	0.125	0.500
		0.000	1.000	0.250	0.250
		0.000	1.000	0.500	0.125
		0.000	1.000	1.000	0.000
26	1.000 ma	0.000	1.000	0.000	1.000
		0.000	1.000	0.125	0.500
		0.000	1.000	0.250	0.250
		0.000	1.000	0.500	0.125
		0.000	1.000	1.000	0.000
31	0.500 ma	0.000	1.000	0.000	1.000
		0.000	1.000	0.125	0.500
		0.000	1.000	0.250	0.250
		0.000	1.000	0.500	0.125
		0.000	1.000	1.000	0.000
36	0.250 ma	0.000	1.000	0.000	1.000
		0.000	1.000	0.125	0.500
		0.000	1.000	0.250	0.250
		0.000	1.000	0.500	0.125
		0.000	1.000	1.000	0.000
41	0.125 ma	0.000	1.000	0.000	1.000
		0.000	1.000	0.125	0.500
		0.000	1.000	0.250	0.250
		0.000	1.000	0.500	0.125
		0.000	1.000	1.000	0.000
46	2.000 ma	0.000	1.000	0.000	1.000
47	1.000 ma	0.000	1.000	0.000	1.000
48	0.500 ma	0.000	1.000	0.000	1.000
49	0.250 ma	0.000	1.000	0.000	1.000
50	0.125 ma	0.000	1.000	0.000	1.000

Table 2

Order of presentation of each value of $p(S^R|R)$
and $p(S^R|\bar{R})$ for each value of shock intensity.

Session numbers are shown in the left-most column, corresponding intensity values in the second column, p values for R and $\bar{R}$ in Component 1 in the third and fourth, respectively and p value for R and $\bar{R}$ in Component 2 in the fifth and sixth columns, respectively.

Session #	Intensity	Component 1		Component 2	
		$p(S^R R)$	$p(S^R \bar{R})$	$p(S^R R)$	$p(S^R \bar{R})$
51-55 56	2.000 ma	0.000	1.000	0.000	1.000
		0.000	1.000	0.125	1.000
		0.000	1.000	0.250	1.000
		0.000	1.000	0.500	1.000
		0.000	1.000	1.000	1.000
		0.000	1.000	1.000	0.500
		0.000	1.000	1.000	0.250
		0.000	1.000	1.000	0.125
		0.000	1.000	1.000	0.000
64	1.000 ma	0.000	1.000	0.000	1.000
		0.000	1.000	0.125	1.000
		0.000	1.000	0.250	1.000
		0.000	1.000	0.500	1.000
		0.000	1.000	1.000	1.000
		0.000	1.000	1.000	0.500
		0.000	1.000	1.000	0.250
		0.000	1.000	1.000	0.125
		0.000	1.000	1.000	0.000
73	0.800 ma	0.000	1.000	0.000	1.000
		0.000	1.000	0.125	1.000
		0.000	1.000	0.250	1.000
		0.000	1.000	0.500	1.000
		0.000	1.000	1.000	1.000
		0.000	1.000	1.000	0.500
		0.000	1.000	1.000	0.250
		0.000	1.000	1.000	0.125
		0.000	1.000	1.000	0.000
82	0.500 ma	0.000	1.000	0.000	1.000
		0.000	1.000	0.125	1.000
		0.000	1.000	0.250	1.000
		0.000	1.000	0.500	1.000
		0.000	1.000	1.000	1.000
		0.000	1.000	1.000	0.500
		0.000	1.000	1.000	0.250
		0.000	1.000	1.000	0.125
		0.000	1.000	1.000	0.000

Table 2 (continued)

Order of presentation of each value of $p(S^R|R)$
and $p(S^R|\bar{R})$ for each value of shock intensity.

Session #	Intensity	Component 1		Component 2	
		$p(S^R R)$	$p(S^R \bar{R})$	$p(S^R R)$	$p(S^R \bar{R})$
91	0.250 ma	0.000	1.000	0.000	1.000
		0.000	1.000	0.125	1.000
		0.000	1.000	0.250	1.000
		0.000	1.000	0.500	1.000
		0.000	1.000	1.000	1.000
		0.000	1.000	1.000	0.500
		0.000	1.000	1.000	0.250
		0.000	1.000	1.000	0.125
		0.000	1.000	1.000	0.000
		0.000	1.000	1.000	0.000

RESULTS AND DISCUSSION

The data from Experiment I reflect the effects of simultaneous and inverse changes in the probability of electric shock presentation assigned to the two response classes (bar pressing, R, and not bar pressing, $\bar{R}$) at five values of shock intensity upon response rate, the proportion of T_R cycles sampled, the proportion of shocks received and total shocks received. In the figures depicting the effects of shock probability on R, the values of the independent variable along the abscissa are ordered in terms of $p(S^R|R)$, with the corresponding values of $p(S^R|\bar{R})$ indicated immediately below. The reverse is true when the response class examined is $\bar{R}$. Neither $p(S^R|R)$ nor $p(S^R|\bar{R})$ in this experiment may be separately considered a true independent variable, even though both may be independently manipulated. Rather, the independent variable consists of pairs of probability values located along the line AC drawn through the coordinate space in Figure 1.

The data from Experiment II reflect the effects of independent changes in the values of $p(S^R|R)$ and $p(S^R|\bar{R})$ and of shock intensity on responding. In Figures 4, 5, 8, 9, 16 through 21, 34 and 35, the data are presented in two panels. The left panel shows the effects of $p(S^R|R)$ in ascending order from 0.000 to 1.000, with $p(S^R|\bar{R})$ held constant at 1.000. To more accurately reflect the order in

which the animals were exposed to the pairs of probability values, the right panel shows the effects of $p(S^R|X)$ in descending order from 1.000 to 0.000, with $p(S^R|R)$ held constant at 1.000. The $p(S^R)=(1,1)$ value is represented in both panels, however, to serve as a reference point, although each animal was exposed to this pair of $p(S^R)$ values only once. Group functions in both Experiments I and II represent mean values pooled for all five animals at each value of shock probability and shock intensity.

Since the first experiment varied the probability of shock for R and X simultaneously, the effects of changing shock probability for either response class are not readily detectable. Therefore, the results of Experiment II are presented before the results of Experiment I. There were no detectable effects of the first procedure on data from the second.

Because it was not possible to predict whether responding would survive under the punishment condition, a multiple schedule was used, with one component consisting of avoidance. Response rates in the unchanged avoidance component of the multiple schedule (Component I) remained constant, with few exceptions, over successive sessions at each shock intensity and are shown in Tables 3 and 4.

A. Response rate.

In order to compare the effects of shock probability in Component 2 to those obtained under conventional schedules of avoidance, response-independent reinforcement and

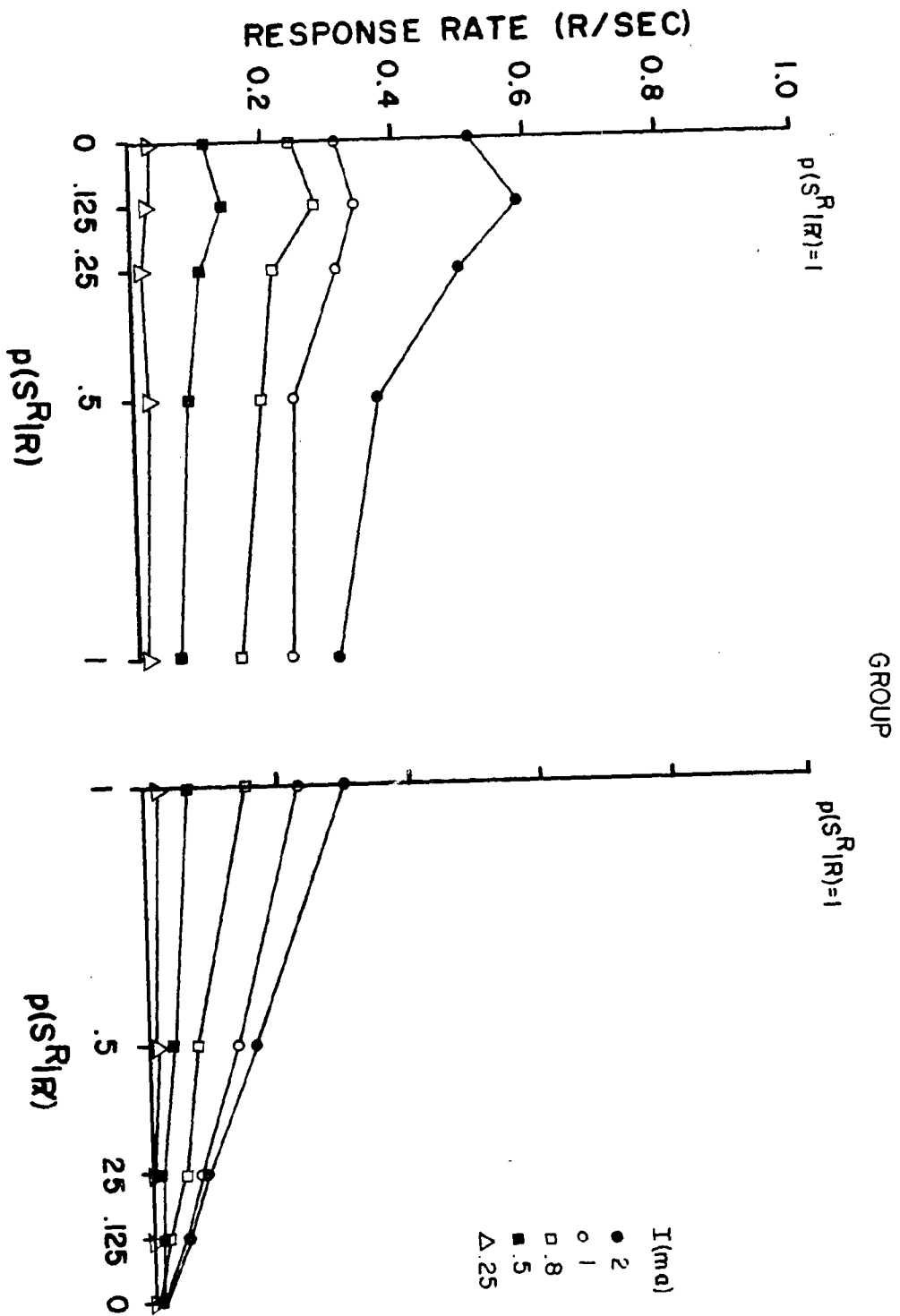
punishment, response rates (responses per second with shock duration subtracted from the time base used for the rate computation) in Component 2 are plotted. Figures 2-5 show group and individual organism functions relating response rates to each pair of probability values and shock intensity used in Experiments I and II. Response rates for Component 2 of both experiments are found in Tables 5 and 6.

In general, the individual organism curves for Experiment II (Figure 3) are sufficiently similar to each other to be accurately represented in a group figure (Figure 2). The results of Experiment II showed that for all shock intensities greater than 0.250 ma, response rate was generally a biphasic function of $p(S^R|R)$, with maxima occurring at $p(S^R|R)=0.125$ (Figure 2, Panel A). To the right of the maximum, response rate was a decreasing function of $p(S^R|R)$. For two of the animals (Figure 3, Panel A), maxima occurred at $p(S^R|R)$ values other than 0.125 at some shock intensity values (R1, $I=1.000, 0.800, 0.500$ ma; R5, $I=2.000$ ma). The effects of shock intensity on response rate for R1 were less clear than for the remaining four animals, with multiple crossovers at intermediate shock intensities ($I=1.000, 0.800$ ma) and negligible responding at low shock intensities ($I=0.500, 0.250$ ma). R4 showed increases in rate at $I=1.000$ and 0.800 ma when $p(S^R|R)$ was increased from 0.500 to 1.000. Response rate was an increasing function of $p(S^R|R)$ for all shock intensity values. The functions described in Panel B for some of the animals

Figures 2 and 3: Response rate as a function of $p(S^R|R)$ and $p(S^R|\bar{R})$ in Experiment II.

Figures 2 and 3 show group and individual organism curves for response rate (R/sec) as a function of $p(S^R|R)$ and $p(S^R|\bar{R})$ in Experiment II, with shock intensity as a parameter. Left-hand panels in both figures show the effects of $p(S^R|R)$ with $p(S^R|\bar{R})=1.000$. Right-hand panels in both figures show the effects of $p(S^R|\bar{R})$ with $p(S^R|R)=1.000$. Shock intensities were represented as follows: 2.000 ma (closed circles), 1.000 ma (open circles), 0.800 ma (open rectangles), 0.500 ma (closed rectangles), 0.250 ma (open triangles). The legend for both figures is shown in Figure 2.

Figure 2



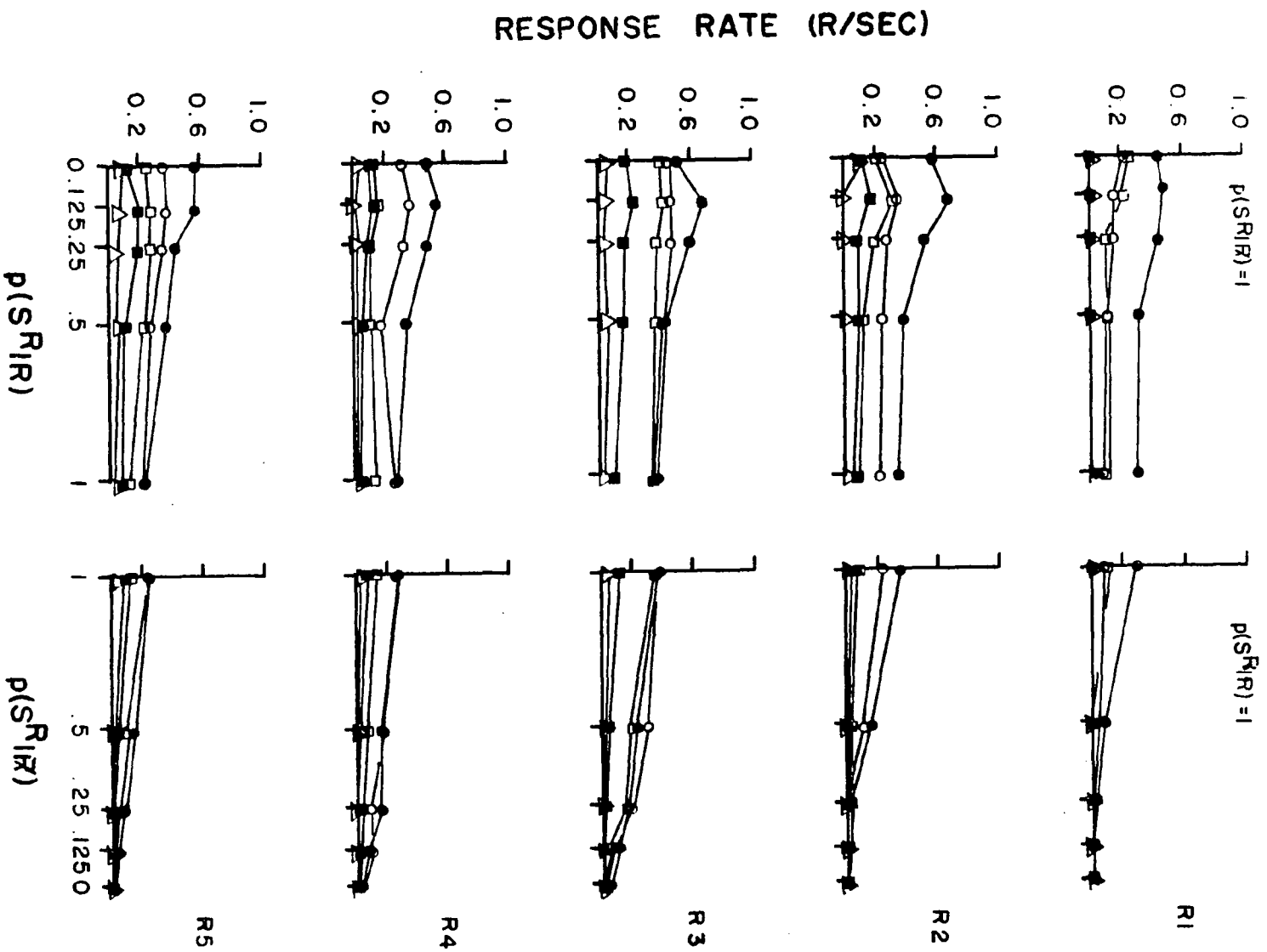
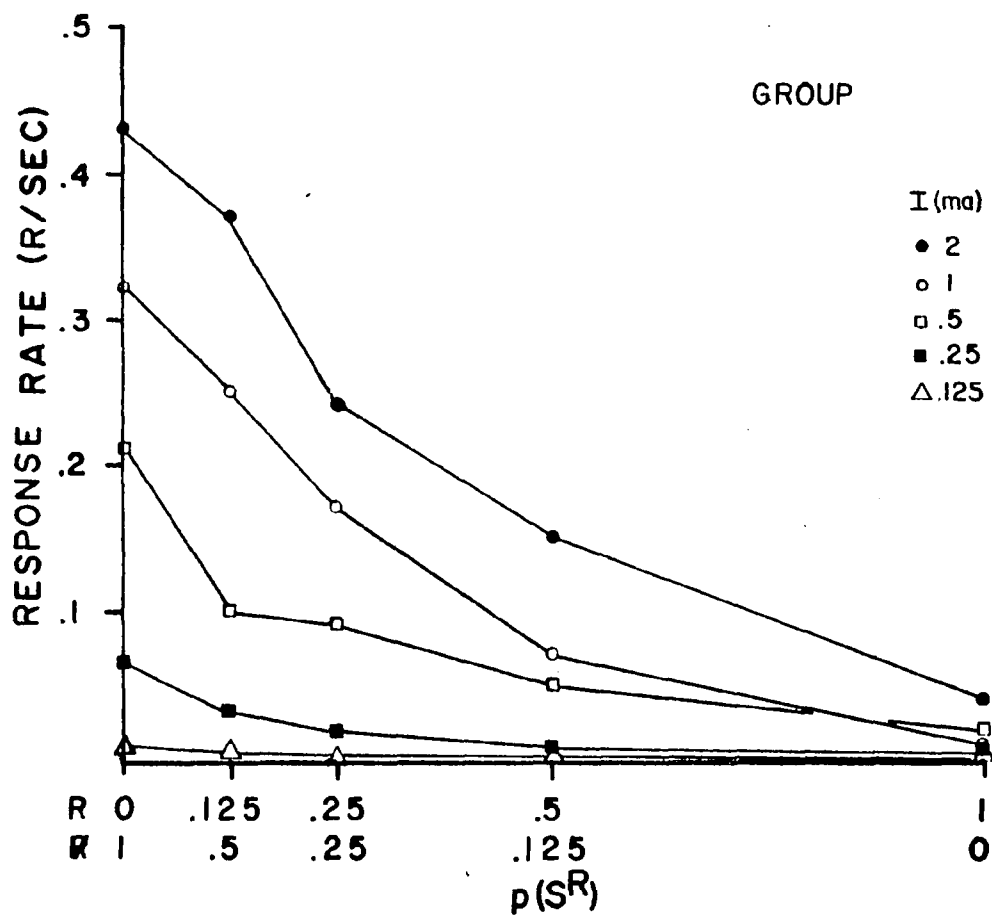


Figure 3

Figures 4 and 5: Response rate as a function of $p(S^R)$ in Experiment I.

Figures 4 and 5 show group and individual organism curves showing response rate (R/sec) as a function of $p(S^R)$ in Experiment I, with shock intensity as a parameter. Shock intensities were represented as follows: 2.000 ma (closed circles), 1.000 ma (open circles), 0.500 ma (open rectangles), 0.250 ma (closed rectangles), 0.125 ma (open triangles). The legend for both figures is shown in Figure 4.

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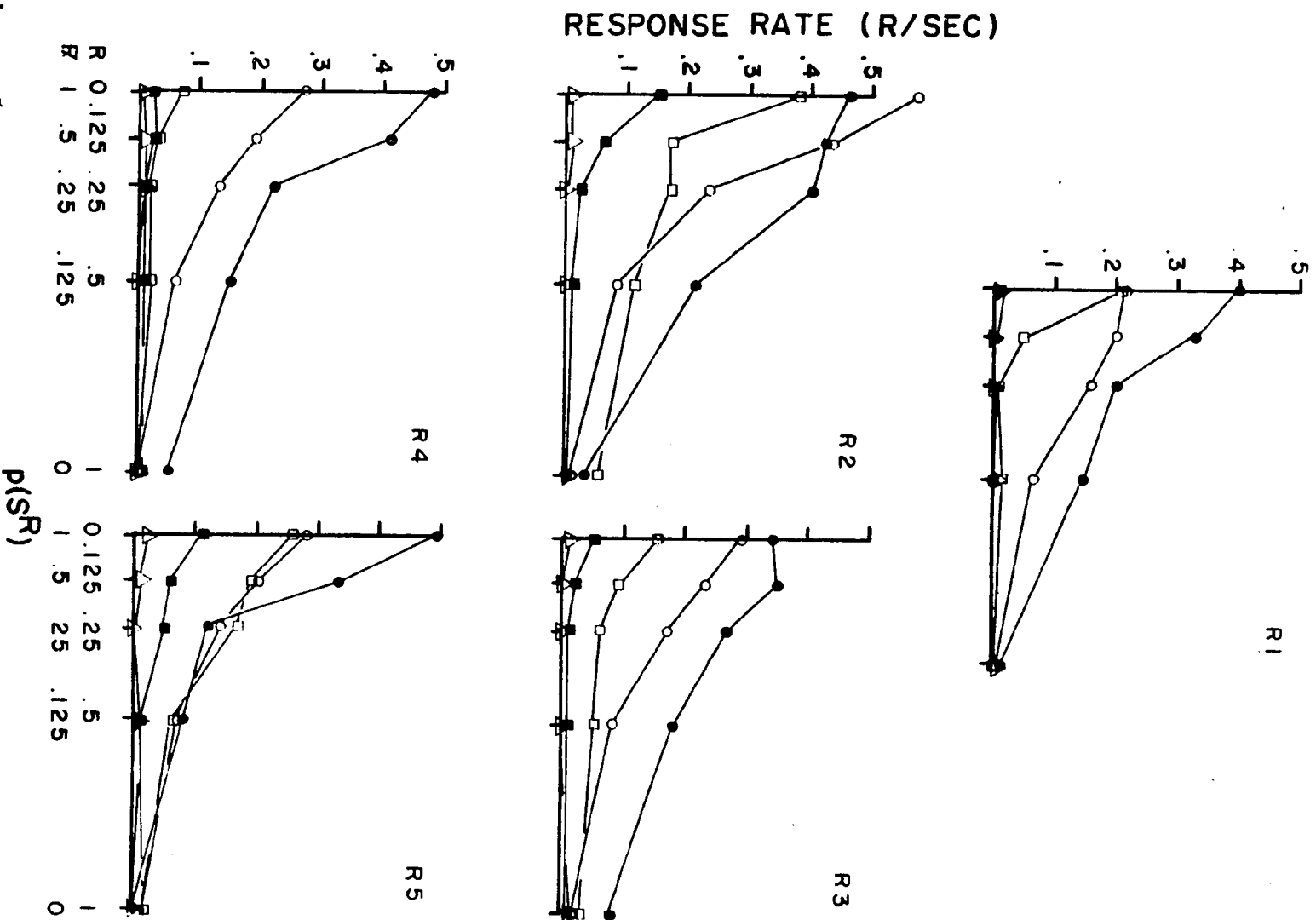


Figure 5

were considerably less orderly than those shown in Panel A, with multiple inversions in the response rate-shock intensity relation. Response rates in Experiment II generally increased with increasing shock intensity. Low response rates were maintained at the lowest shock intensity (0.250 ma) and reflected little systematic effect of p . Minimal responding was maintained at low $p(S^R|K)$ values. With the exception of R3, rate did not exceed 0.2 responses per second at $p(S^R|K)=0.500, 0.250, 0.125$ and 0.000 .

Unlike the biphasic functions obtained in Experiment II, when $p(S^R|R)$ was increased from 0.000 to 1.000 while $p(S^R|K)$ was simultaneously decreased in Experiment I, response rates were decreasing negatively accelerated monotonic functions of the combined shock probabilities. Shock intensity influenced the slope of the functions which converged at $p(S^R)=(1,0)$. In general, the higher the intensity of electric shock, the higher the response rate and the greater the curvature of the function. At $p(S^R)$ values of $(1,0)$, little differential effect of shock intensity on response rate was obtained. For all five animals, minimal responding was maintained at the two lowest shock intensities ($I=0.250$ and 0.125 ma) across all values of $p(S^R)$. R4 maintained minimal responding at the 0.500 ma shock intensity. Several crossovers in the individual subjects' data were found (R2 and R5, $I=2.000, 1.000, 0.500$ ma).

The effects of shock probability on response rates were similar to those obtained under conventional schedules

of avoidance, response-independent reinforcement and punishment, and replicated those obtained within the t system literature (cf. Schoenfeld, Cole, Blaustein, Lachter, Martin & Vickery, 1972). Neffinger and Gibbon (1975) found that when $p(S^R|\bar{R})$ was held at 1.000 and $p(S^R|R)$ assumed values greater than zero (0.250, 0.500, 0.750, 1.000), animals generally decreased responding with increasing punishment probability. Kop (1972) similarly found that adding a punishment contingency to a discriminated avoidance procedure decreased responding. In Kop's study, median response rates decreased when $p(S^R|R)$ and $p(S^R|\bar{R})$ were either simultaneously or independently varied. The initial reaction to an increase in $p(S^R|R)$ was an increased response rate which gradually decayed. Facilitation of response rates following avoidance training was also reported by Appel (1960a, 1960b), Azrin and Holz (1966), Byrd (1969), and McKearney (1968, 1969) when shock was made dependent on responding, and by Kadden (1973) when the proportion of shocks for responding and not responding was varied. Facilitation effects were obtained by Kadden when $p(S^R|R)$ increased from zero to some other value, with maximum response rates occurring with increasing regularity of shock delivery. The highest rates were observed under a periodic response-independent shock schedule and the lowest rates when the intershock interval was variable and shock delivery was response-dependent. The maintenance of lower response rates under punishment than response-independent shock

schedules was also reported by Gibbon (1967) and Blaustein (1975).

While facilitation of response rates was not shown in Experiment I of the present paper, it was observed for all animals in Experiment II when $p(S^R|R)$ increased from 0.000 to 0.125 at intensity values greater than 0.125 ma. The higher response rates at $p(S^R|R)=0.125$ were possible transient effects resulting from the initial introduction of a shock contingency to animals with histories on avoidance procedures. Animals were exposed to each pair of $p(S^R)$ values for only one session, however, and continued exposure to these schedules may have eliminated the maximum.

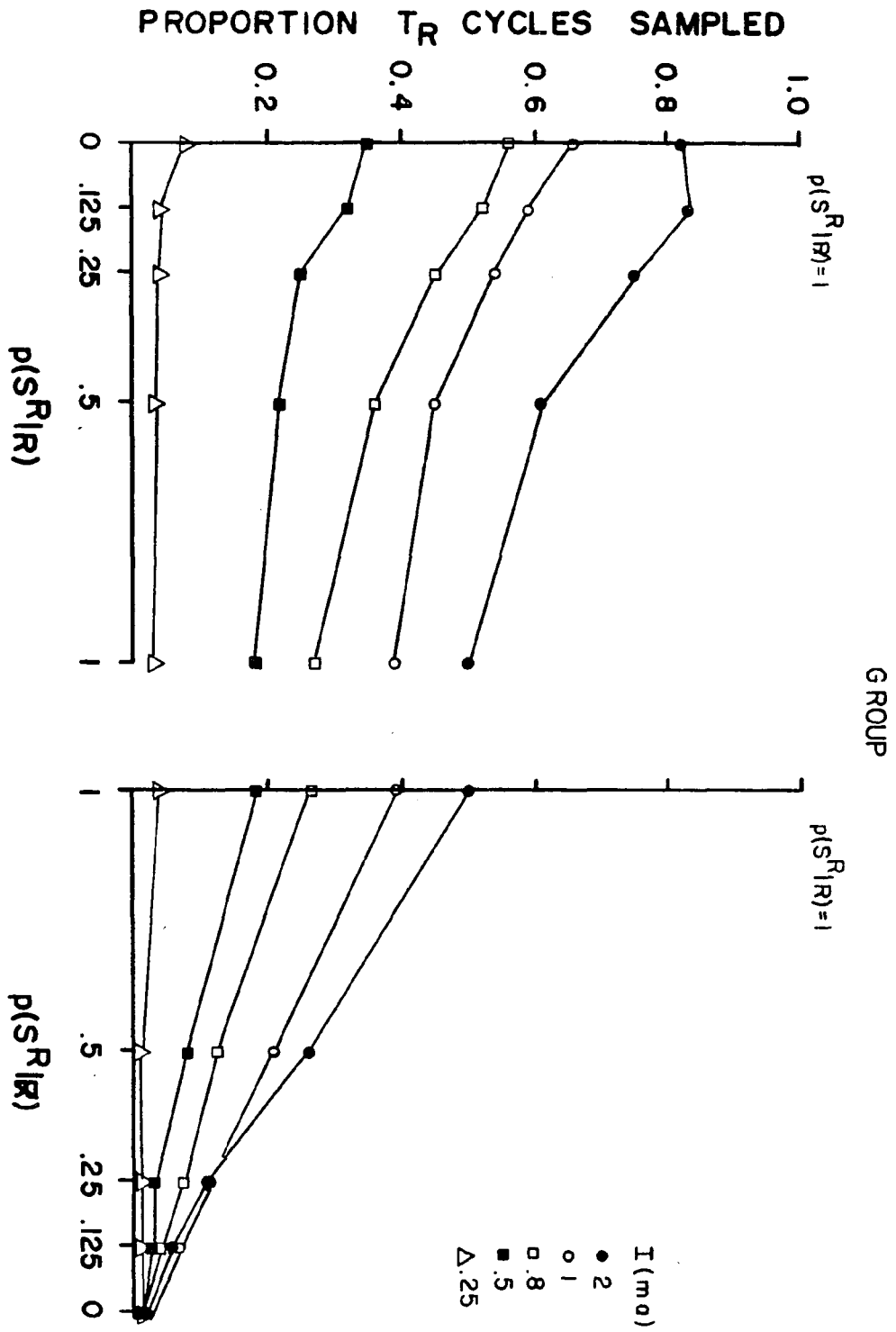
B. Proportion of T_R cycles sampled.

The proportion of T_R cycles sampled has an upper limit, thus attenuating high response rates while amplifying low response rates. In addition, it selectively eliminates bursts of responses and permits the assessment of the degree to which a category of behavior makes contact with a class of environmental events (Hineline, 1980). Figures 6 and 7 (Experiment II) and Figures 8 and 9 (Experiment I) show group and individual organism functions for the proportion of T_R cycles sampled at each pair of $p(S^R)$ values and shock intensity. The data from which these functions were drawn are found in Tables 7 and 8. The data from Experiment II (Figures 6 and 7, pp. 55-56) closely resembled the response rate data. Unlike the biphasic functions describing response rates (Panel A of Figures 2 and

Figures 6 and 7: The proportion of T_R cycles sampled as a function of $p(S^R|R)$ and $p(S^R|\bar{R})$ in Experiment II.

Figures 6 and 7 show the group and individual organism curves for the proportion of T_R cycles sampled as a function of $p(S^R|R)$ and $p(S^R|\bar{R})$ in Experiment II, with shock intensity as a parameter. Left-hand panels in both figures show the effects of $p(S^R|R)$ with $p(S^R|\bar{R})=1.000$. Right-hand panels in both figures show the effects of $p(S^R|\bar{R})$ with $p(S^R|R)=1.000$. Shock intensities were represented as follows: 2.000 ma (closed circles), 1.000 ma (open circles), 0.800 ma (open rectangles), 0.500 ma (closed rectangles), 0.250 ma (open triangles). The legend for both figures is shown in Figure 6.

Figure 6



3) across values of $p(S^R|R)$, maxima occurred at $p(S^R|R)=0.000$ for all shock intensity values except $I=2.000$ ma. The 2.000 ma shock intensity curve showed a slight increase between $p(S^R|R)=0.000$ and 0.125. This increase is attributable to the behavior of two of the five animals (R2 and R3). Similar effects occurred at lower intensity values for R2 and R5 at $p(S^R|R)=0.125$. The proportion of T_R cycles sampled was an increasing function of $p(S^R|R)$ for all shock intensity values (Panel B, Figures 6 and 7), and in general, scaled with intensity at all $p(S^R|R)$ values. As $p(S^R|R)$ approached zero, the effects of shock intensity diminished.

The data from Experiment I (Figures 8 and 9, pp. 59-60) also closely resembled the response rate data, with the proportion of T_R cycles sampled a decreasing function of $p(S^R)$. The proportion of T_R cycles sampled was systematically related to shock intensity at all $p(S^R)$ values except at $p(S^R)=(1,0)$, where the proportion of T_R cycles sampled was so low that no systematic effect of shock intensity was detectable.

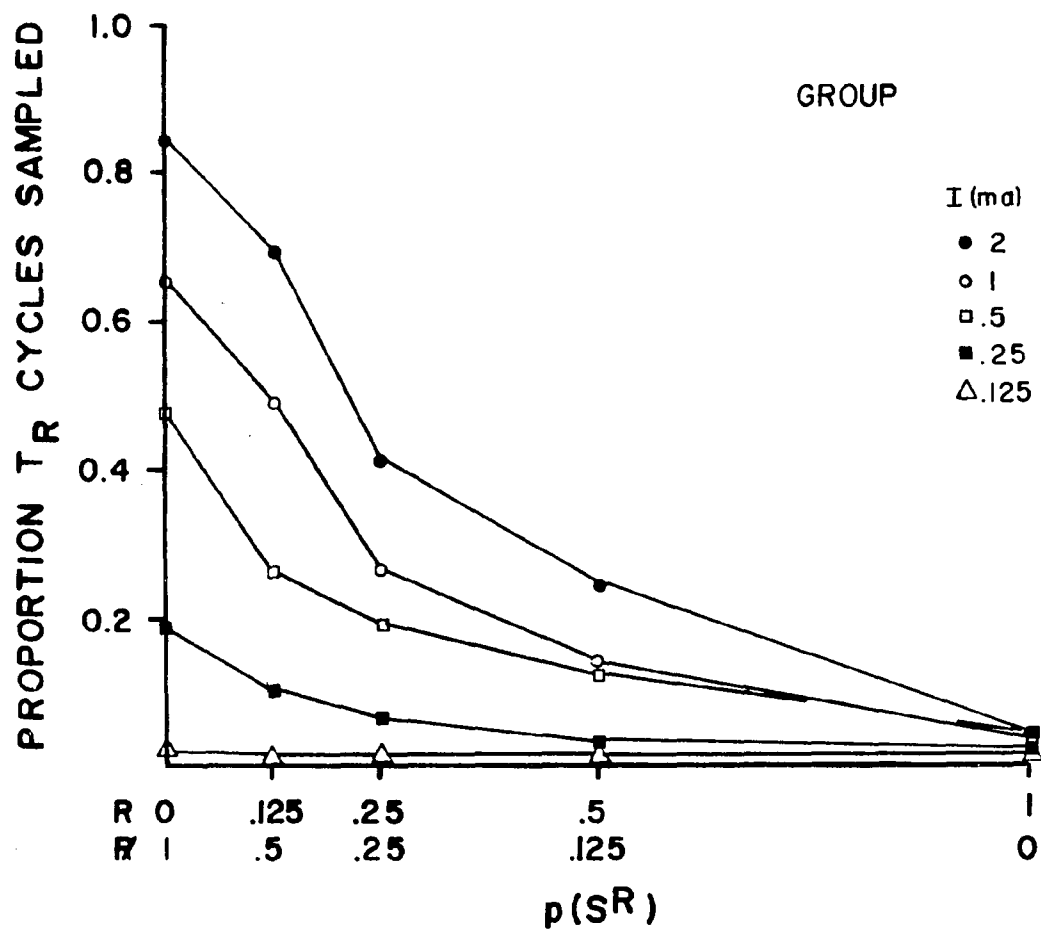
C. Proportion of maximum shocks received.

The role of response-produced shock reduction has been central to the history of avoidance learning. One way to determine the extent to which responding reduces shock frequency is to examine the difference between the maximum shocks possible under a given procedure with those actually obtained. In the current procedure, the maximum possible number of shocks, the maximum response-produced shocks (R

Figures 8 and 9: The proportion of T_R cycles sampled as a function of $p(S^R)$ in Experiment I.

Figures 8 and 9 show the group and individual organism curves for the proportion of T_R cycles sampled as a function of $p(S^R)$ in Experiment I, with shock intensity as a parameter. Shock intensities were represented as follows: 2.000 ma (closed circles), 1.000 ma (open circles), 0.500 ma (open rectangles), 0.250 ma (closed rectangles), 0.125 ma (open triangles). The legend for both figures is shown in Figure 8.

Figure 8



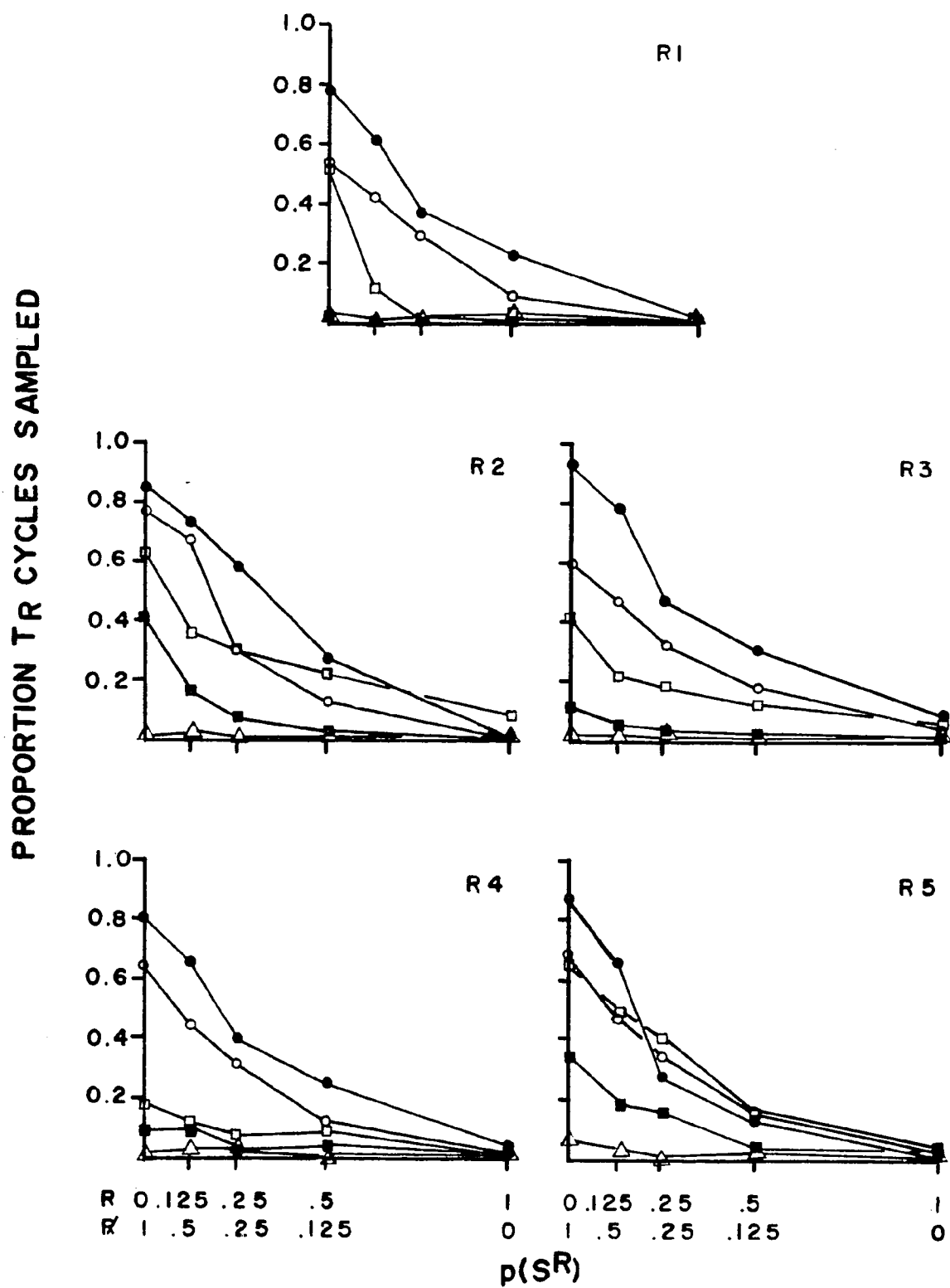


Figure 9

shocks) and the maximum shocks produced by not responding within T cycles ($\bar{R}$ shocks) were calculated by multiplying the total number of T cycles per session (900) by: the highest value of shock probability in each pair of probability values for responding and not responding (for the pooled R and $\bar{R}$ data); the relevant shock probability for R (R data) and the shock probability value for $\bar{R}$ ($\bar{R}$ data). Figures 10 through 21 show group and individual organism functions for the proportion of maximum shocks ($S_{\max}^R$), maximum response-produced shocks ($S_{\max}^R | R_{\max}$), and maximum shocks produced in the absence of responding ($S_{\max}^R | \bar{R}_{\max}$) received in Experiments I and II for each pair of shock probability values and shock intensity. Data for both experiments are shown in Tables 9 and 10.

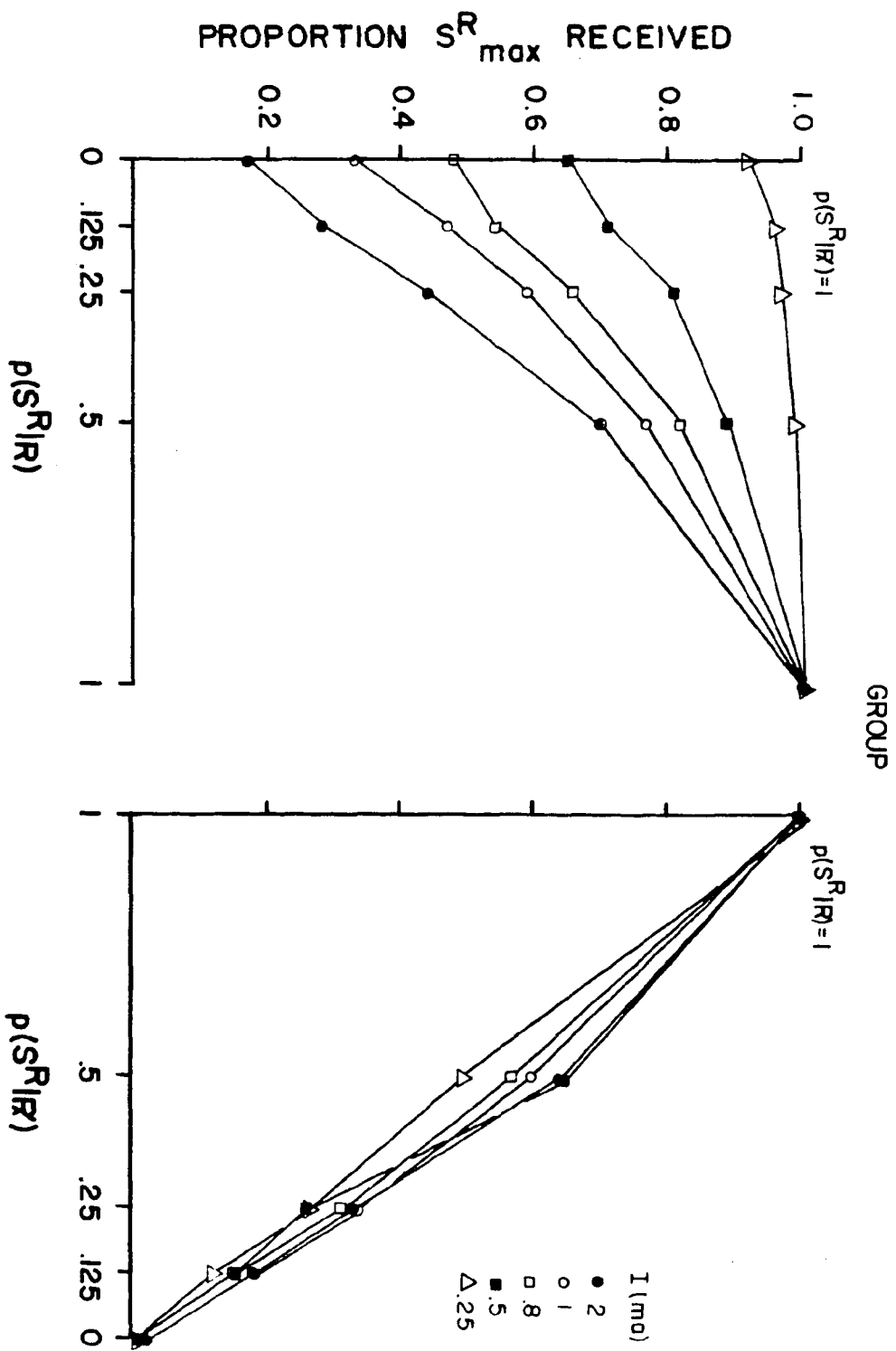
In Experiment II, the probability of shock for one of the two response classes was always 1.000 at all pairs of $p(S^R)$ values, and the maximum possible shocks scheduled at all pairs of $p(S^R)$ values was 900. Only at $p(S^R)=(1,1)$ was the number of scheduled shocks (900) received independent of the number of T_R or $T_{\bar{R}}$ cycles sampled, and the number of and distribution of responses within T cycles had no effect on the proportion of maximum scheduled shocks received. Unlike the response-independent shock case, animals could minimize the proportion of maximum shocks received under the remaining pairs of $p(S^R)$ values in Experiment II, with the degree to which shocks could be reduced equal for the $p(S^R)=(0,1)$ and $(1,0)$, $(.125,1)$ and

(1,.125), (.25,1) and (1,.25), and (.5,1) and (1,.5) values. When $p(S^R)=(0,1)$, animals could receive a maximum of 900 scheduled shocks by not responding in any of the T cycles, or they could reduce the number of scheduled shocks to zero by responding at least once in each T cycle. The reverse is true when $p(S^R)=(1,0)$. Under this condition, sampling every T cycle produces the maximum 900 scheduled shocks, while failing to respond in any of the T cycles reduces the number of shocks to zero. When $p(S^R)=(.125,1)$ or (1,.125), the maximum (900) and minimum (113) number of scheduled shocks is identical, and the proportion of maximum shocks received is determined by the frequency of each response class. Animals could minimize shock frequency by predominantly responding when $p(S^R)=(.125,1)$, (.25,1) and (.5,1) or by not responding when $p(S^R)=(1,.125)$, (1,.25) and (1,.5).

Under the pairs of $p(S^R)$ values for which responding affected shock frequency in Experiment II, the proportion of $S_{\max}^R$ received was less than 1.0 (Panel A and B, Figures 10 and 11, pp. 64-65). In other words, at all but the response-independent shock point, it appeared that shock frequency was reduced from its maximum possible value. The functions were asymmetrical, however, about the (1,1) point. For all animals, when $I=2.000$ ma the proportion of $S_{\max}^R$ received was similar for complementary pairs of shock probability values. Differences emerged when shock intensity assumed values below 2.000 ma. De-

Figures 10 and 11: The proportion of $S_{\max}^R$ received as a function of $p(S^R|R)$ and $p(S^R|\bar{R})$ in Experiment II.

Figures 10 and 11 show group and individual organism curves for the proportion of $S_{\max}^R$ received as a function of $p(S^R|R)$ and $p(S^R|\bar{R})$ in Experiment II, with shock intensity as a parameter. Left-hand panels in both figures show the effects of $p(S^R|R)$ with $p(S^R|\bar{R})=1.000$. Right-hand panels in both figures show the effects of $p(S^R|\bar{R})$ with $p(S^R|R)=1.000$. Shock intensities were represented as follows: 2.000 ma (closed circles), 1.000 ma (open circles), 0.800 ma (open rectangles), 0.500 ma (closed rectangles), 0.250 ma (open triangles). The legend for both figures is shown in Figure 10.



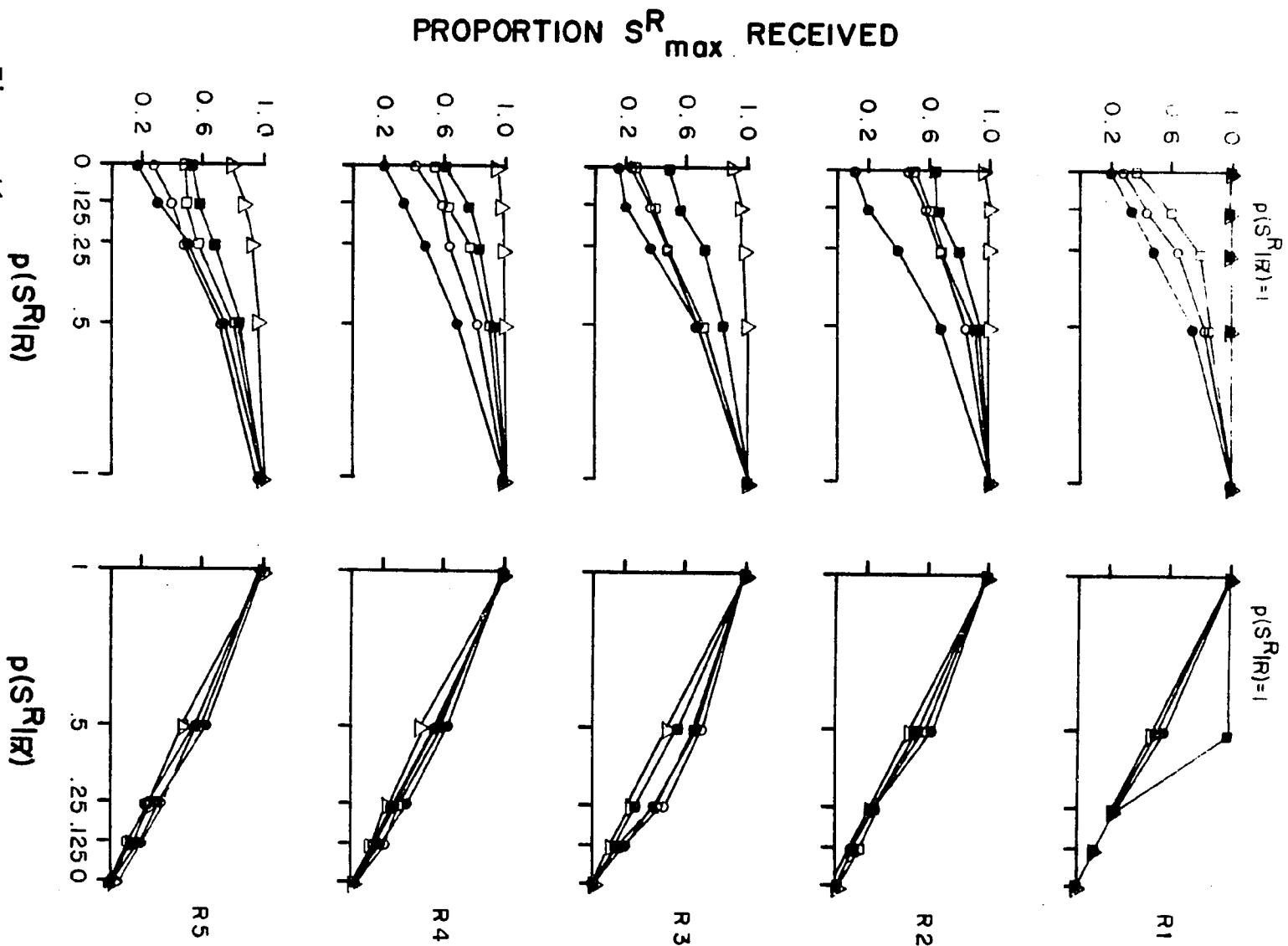


Figure 11

creasing shock intensity produced marked effects in Panel A (Figures 10 and 11, pp. 64-65). With the exception of the $p(S^R)=(1,1)$ case, the proportion of maximum shocks received increased with decreasing shock intensities. Panel B (Figures 10 and 11) shows virtually no systematic effect of shock intensity on the proportion of maximum shocks received, although the functions tended to diverge slightly at midrange values. The data closely approximated the theoretical values obtained by multiplying $p(S^R|\bar{R})$ by 900 at all shock intensities. It is apparent from these data that the effect of shock intensity depends not only on the probability value, but on the response class to which it is applied. In the present experiment, R and $\bar{R}$ are not symmetrical. $\bar{R}$ is defined temporally, whereas R is defined in terms of the force sufficient to close a microswitch behind the bar. As such, R has no temporal duration while $\bar{R}$ is not definable in terms of force or location.

At shock intensities of 2.000, 1.000 and 0.800 ma, the proportion of maximum shocks received was an increasing function of $p(S^R|R)$. In four of the five animals (R2-R5), this effect was also clearly evident at the 0.500 ma shock intensity. R1 showed a negligible effect of $p(S^R|R)$ at 0.500 ma. The 0.250 ma data are somewhat more equivocal, with four of the five animals (R2-R5) showing shallow, but increasing functions. R1 again showed no effect of $p(S^R|R)$ at this lowest shock intensity. The proportion of maximum shocks received was also an increasing function of

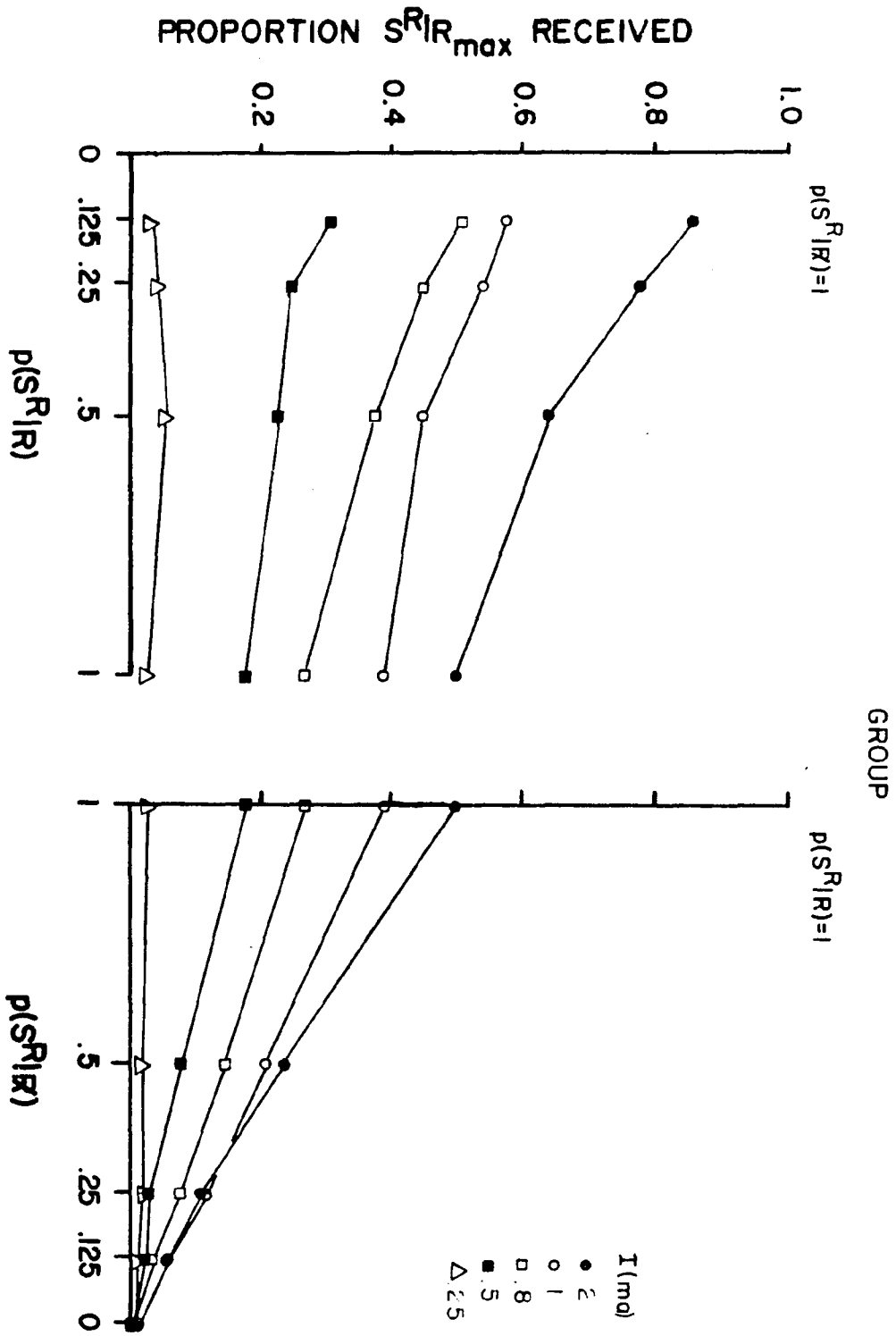
$p(S^R|\bar{X})$ (Panel B, Figures 10 and 11). The increase in the proportion of maximum shocks received with increases in $p(S^R|R)$ can largely be attributed to increases in the proportion of $\bar{X}$ shocks received. A comparison of the group data in Panel A of Figures 12 and 14 (pp. 69 and 72) shows that, with the exception of the 0.250 ma function in Figure 12, increases in $p(S^R|R)$ produced decreases in the proportion of $S^R|R$ received and corresponding increases in the proportion of $S^R|\bar{X}$ received. At the lowest shock intensity ($I=0.250$ ma), the proportion of $S^R|R_{\max}$ received hovered close to 0.0 at all $p(S^R|R)$ values. Examination of the individual organism functions at this low value of shock intensity (Figure 13, p. 70) suggests considerable variability between subjects and no systematic effect of $p(S^R|R)$. A comparison of Panel B of Figures 12 and 14 shows that increases in $p(S^R|\bar{X})$ from 0.000 to 1.000 produced decreases in the proportion of $S^R|\bar{X}$ received and increases in the proportion of $S^R|R$ received. Minimal effects of $p(S^R|\bar{X})$ were found at the lowest shock intensity. For all values of $p(S^R|\bar{X})$, increases in shock intensity increased the proportion of $S^R|R$ received (Figure 12) and decreased the proportion of $S^R|\bar{X}$ received (Figure 14).

In Experiment I, only at $p(S^R)=(.25,.25)$ was the number of scheduled shocks (225) received independent of the number of T_R or $T_{\bar{X}}$ cycles sampled. Animals could minimize the proportion of maximum shocks received under the remaining pairs of $p(S^R)$ values, with the degree to which

Figures 12 and 13: The proportion of $S^R|R_{\max}$ received as a function of $p(S^R|R)$ and $p(S^R|\bar{R})$ in Experiment II.

Figures 12 and 13 show group and individual organism curves for the proportion of $S^R|R_{\max}$ received as a function of $p(S^R|R)$ and $p(S^R|\bar{R})$ in Experiment II, with shock intensity as a parameter. Left-hand panels in both figures show the effects of $p(S^R|R)$ with $p(S^R|\bar{R})=1.000$. Right-hand panels in both figures show the effects of $p(S^R|\bar{R})$ with $p(S^R|R)=1.000$. Shock intensities were represented as follows: 2.000 ma (closed circles), 1.000 ma (open circles), 0.800 ma (open rectangles), 0.500 ma (closed rectangles), 0.250 ma (open triangles). The legend for both figures is shown in Figure 12.

Figure 12



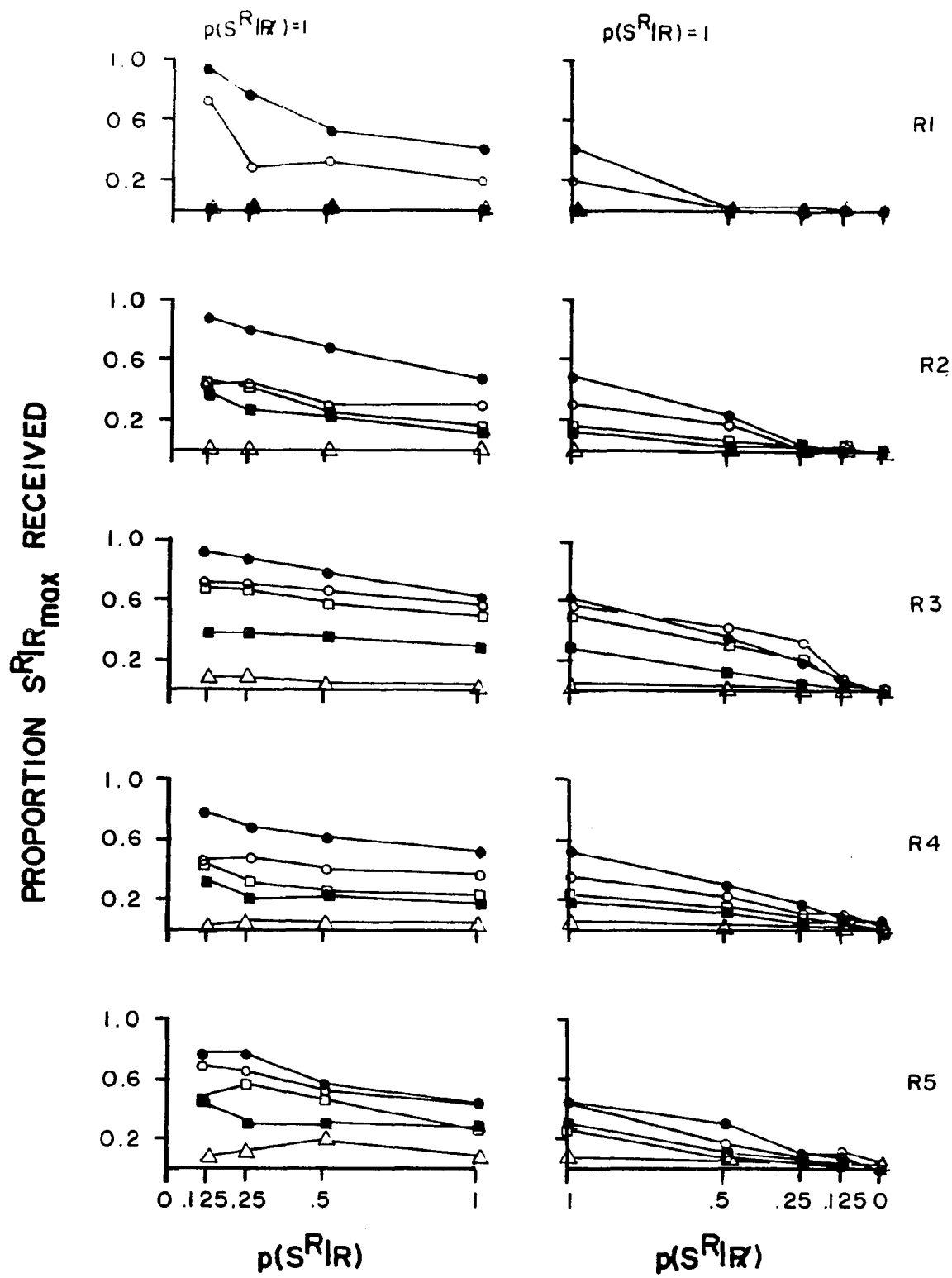
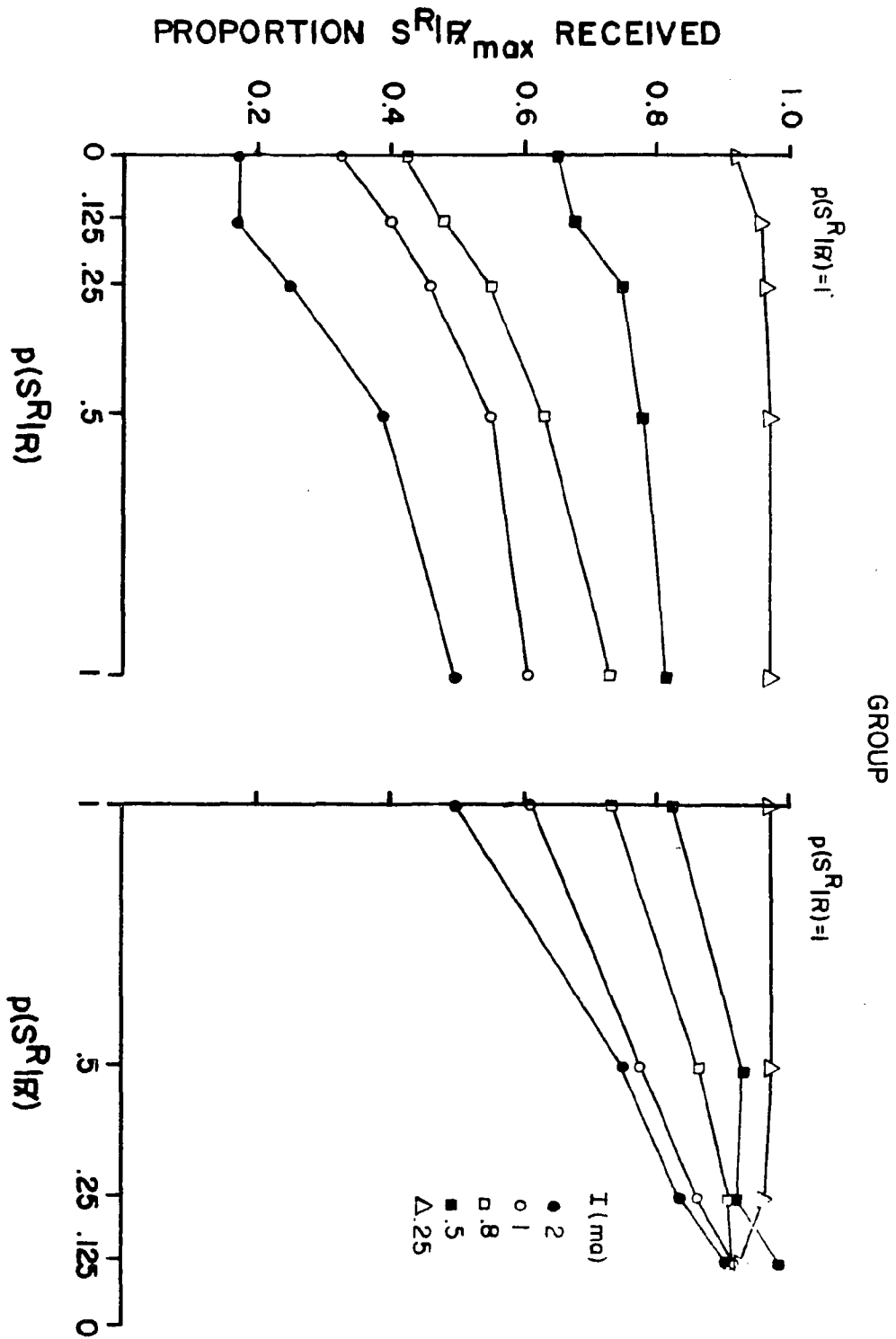


Figure 13

Figures 14 and 15: The proportion of $S^R|K_{\max}$ received as a function of $p(S^R|R)$ and $p(S^R|K)$ in Experiment II.

Figures 14 and 15 show group and individual organism curves for the proportion of $S^R|K_{\max}$ received as a function of $p(S^R|R)$ and $p(S^R|K)$ in Experiment II, with shock intensity as a parameter. Left-hand panels in both figures show the effects of $p(S^R|R)$ with $p(S^R|K)=1.000$. Right-hand panels in both figures show the effects of $p(S^R|K)$ with $p(S^R|R)=1.000$. Shock intensities were represented as follows: 2.000 ma (closed circles), 1.000 ma (open circles), 0.800 ma (open rectangles), 0.500 ma (closed rectangles), 0.250 ma (open triangles). The legend for both figures is shown in Figure 14.

Figure 14



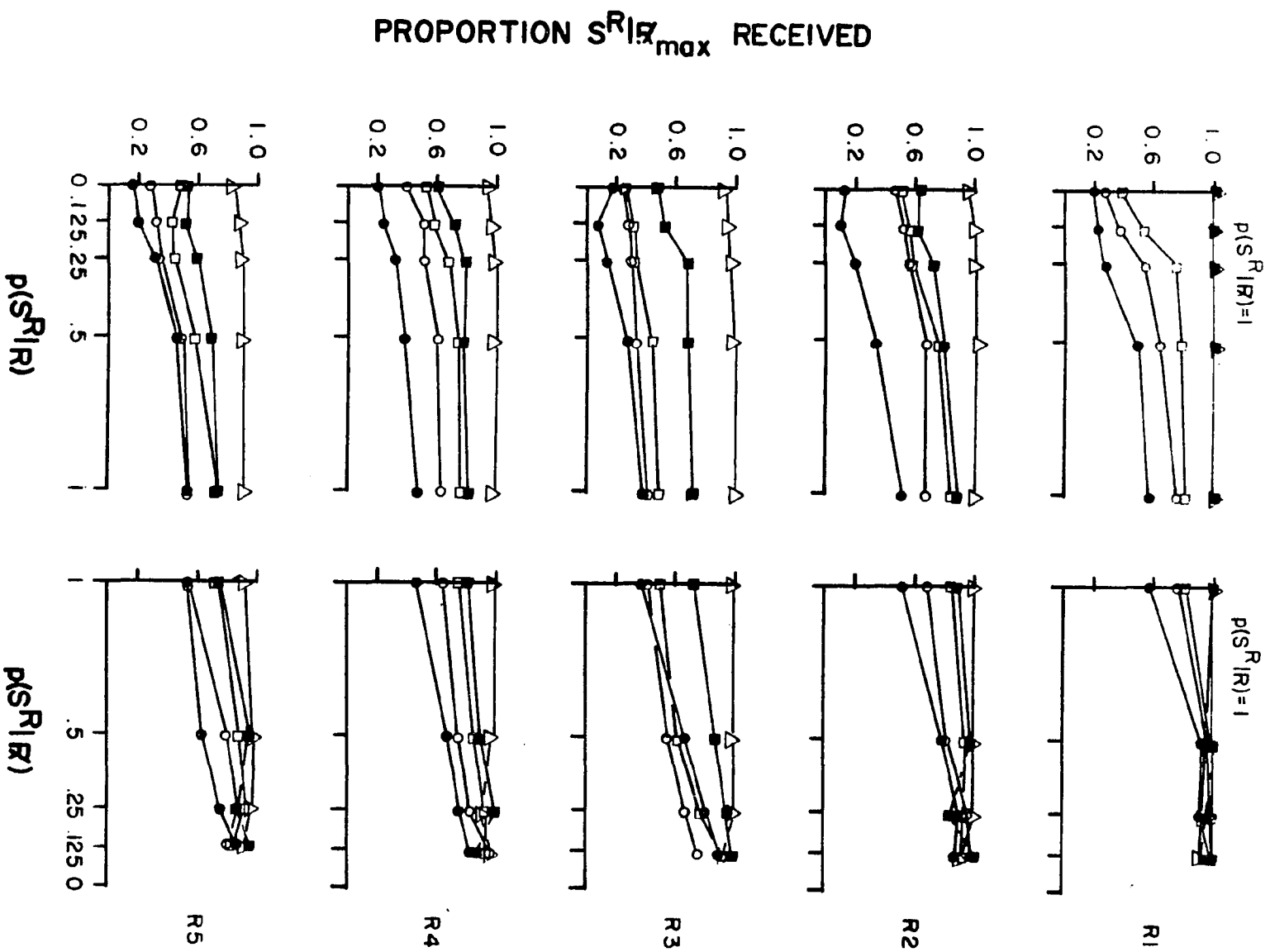


Figure 15

shocks could be reduced equal for the $p(S^R)=(.125,.5)$ and $(.5,.125)$ and for the $p(S^R)=(0,1)$ and $(1,0)$ values. While for all animals, the proportion of $S_{\max}^R$ received was similar when $I=2.000$ ma (Figures 16 and 17, pp. 76-77) at $p(S^R)=(.125,.5)$ and $(.5,.125)$, differences emerged when shock intensity assumed values below 2.000 ma. Asymmetrical effects were also found at all shock intensities when the proportion of $S_{\max}^R$ received was compared under $p(S^R)$ values of $(0,1)$ and $(1,0)$.

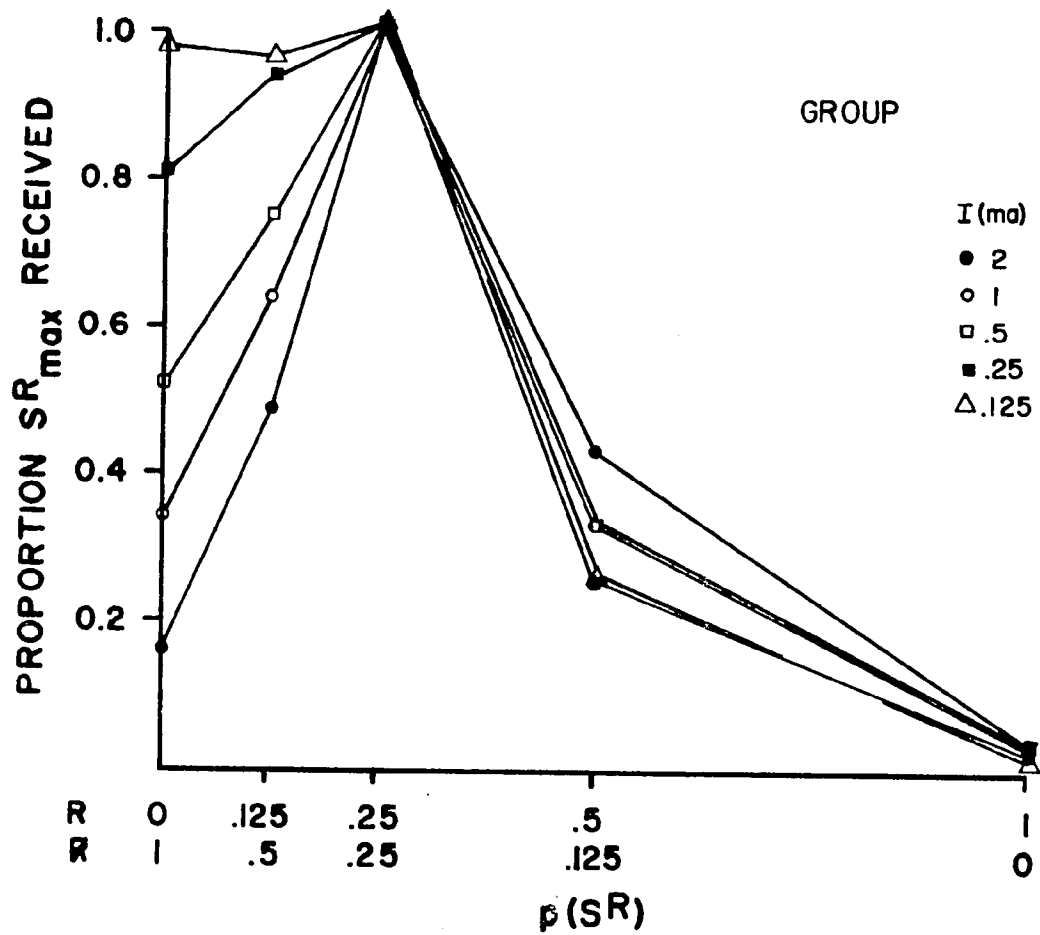
The effect of shock probability was dependent on shock intensity. When $p(S^R)=(1,0)$, no systematic effect of shock intensity on the proportion of $S_{\max}^R$ received was obtained. At $p(S^R)=(.5,.125)$, where $p(S^R|R)$ assumed values greater than $p(S^R|\bar{R})$, higher shock intensities produced a greater proportion of $S_{\max}^R$ received. When $p(S^R)=(0,1)$ and $(.125,.5)$, and $p(S^R|R)$ assumed values smaller than $p(S^R|\bar{R})$, an inverse relation was found. Higher shock intensities produced lower proportions of $S_{\max}^R$ received. Figures 18 and 19 (pp. 79-80) show the effects of simultaneously increasing $p(S^R|R)$ and decreasing $p(S^R|\bar{R})$ on the proportion of $S_{\max}^R|R$ received, while Figures 20 and 21 (pp. 82-83) show the effects of simultaneous changes in $p(S^R|R)$ and $p(S^R|\bar{R})$ on the proportion of $S_{\max}^R|\bar{R}$ received. Increasing the probability of shock for any given response class (R and $\bar{R}$) while simultaneously decreasing shock probability for the complementary response class, decreased the proportion of maximum shocks received for that response class. At the 2.000

Figures 16 and 17: The proportion of $S_{\max}^R$ received as a function of $p(S^R)$ in Experiment I.

Figures 16 and 17 show group and individual organism curves for the proportion of $S_{\max}^R$ received as a function of $p(S^R)$ in Experiment I, with shock intensity as a parameter.

Shock intensities were represented as follows: 2.000 ma, (closed circles), 1.000 ma (open circles), 0.500 ma (open rectangles), 0.250 ma (closed rectangles), 0.125 ma (open triangles). The legend for both figures is shown in Figure 16.

Figure 16



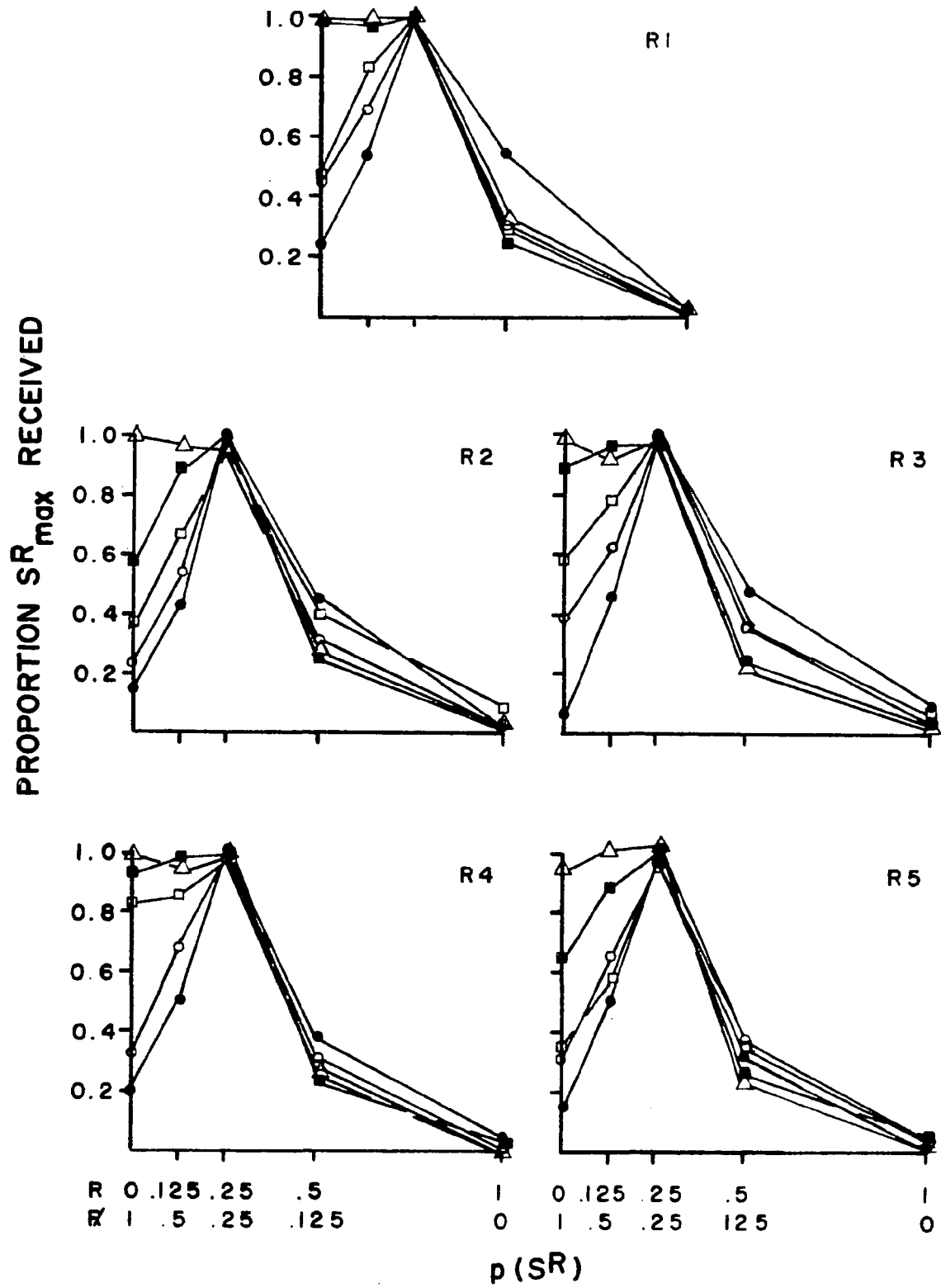
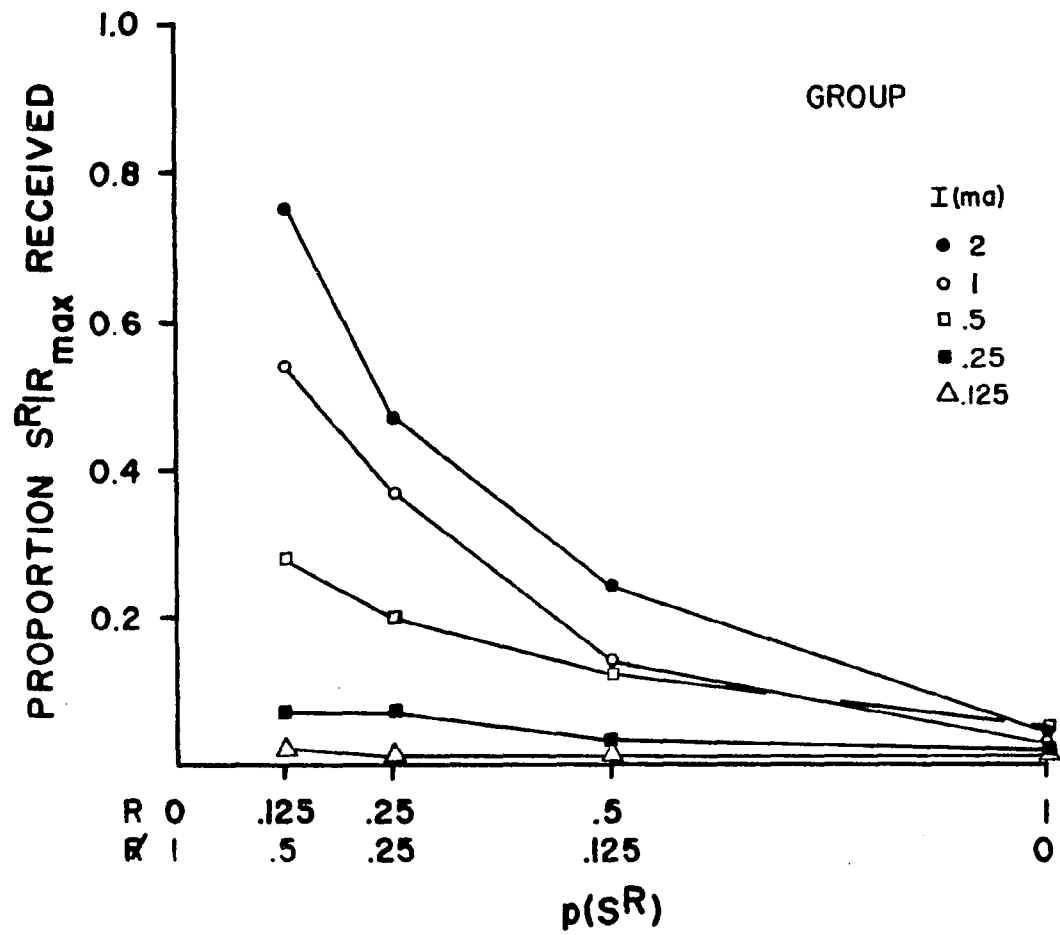


Figure 17

Figures 18 and 19: The proportion of $S^R|R_{\max}$ received as a function of $p(S^R)$ in Experiment I.

Figures 18 and 19 show group and individual organism curves for the proportion of $S^R|R_{\max}$ received as a function of $p(S^R)$ in Experiment I, with shock intensity as a parameter. Shock intensities were represented as follows: 2.000 ma (closed circles), 1.000 ma (open circles), 0.500 ma (open rectangles), 0.250 ma (closed rectangles), 0.125 ma (open triangles). The legend for both figures is shown in Figure 18.

Figure 18



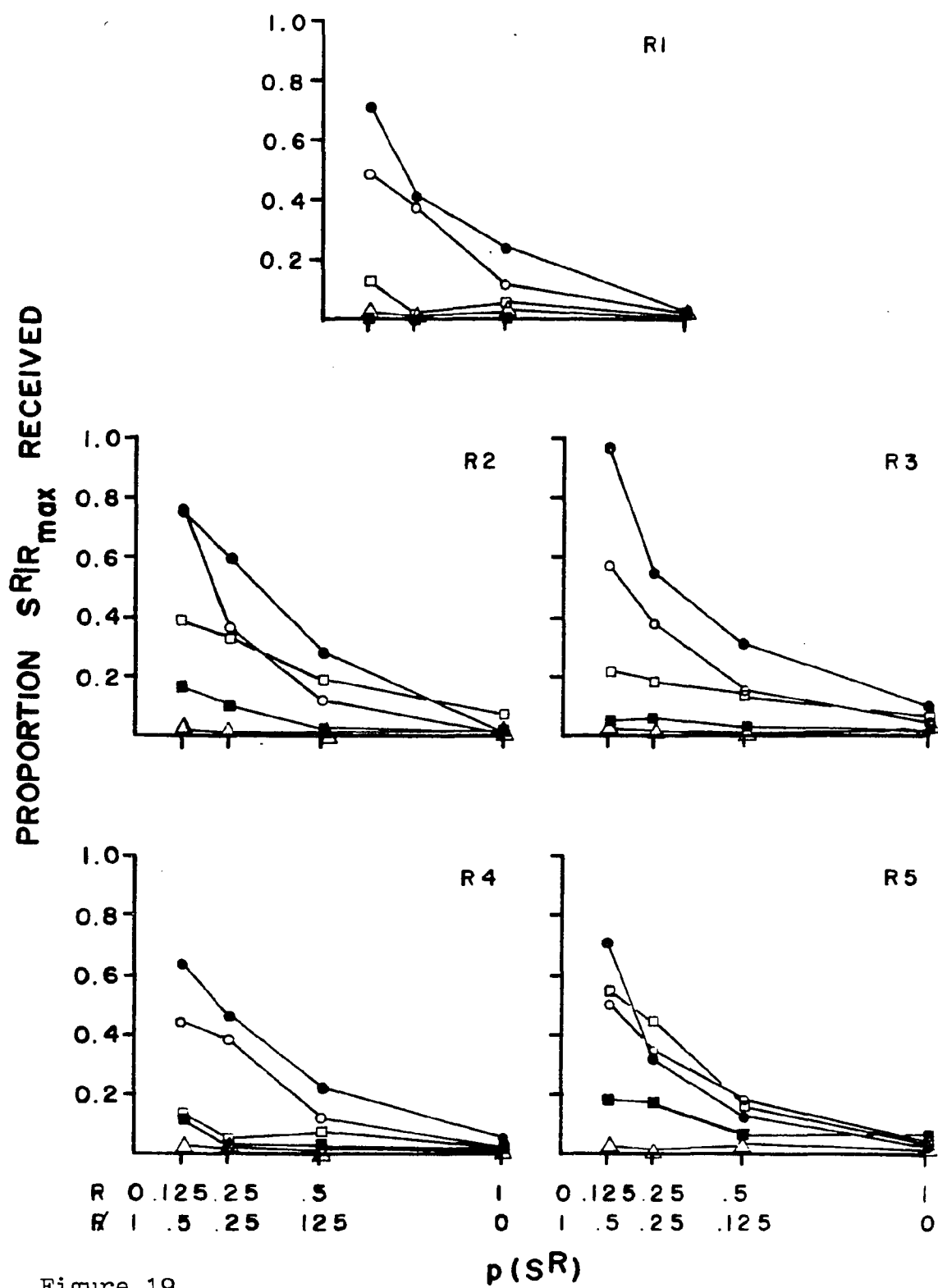
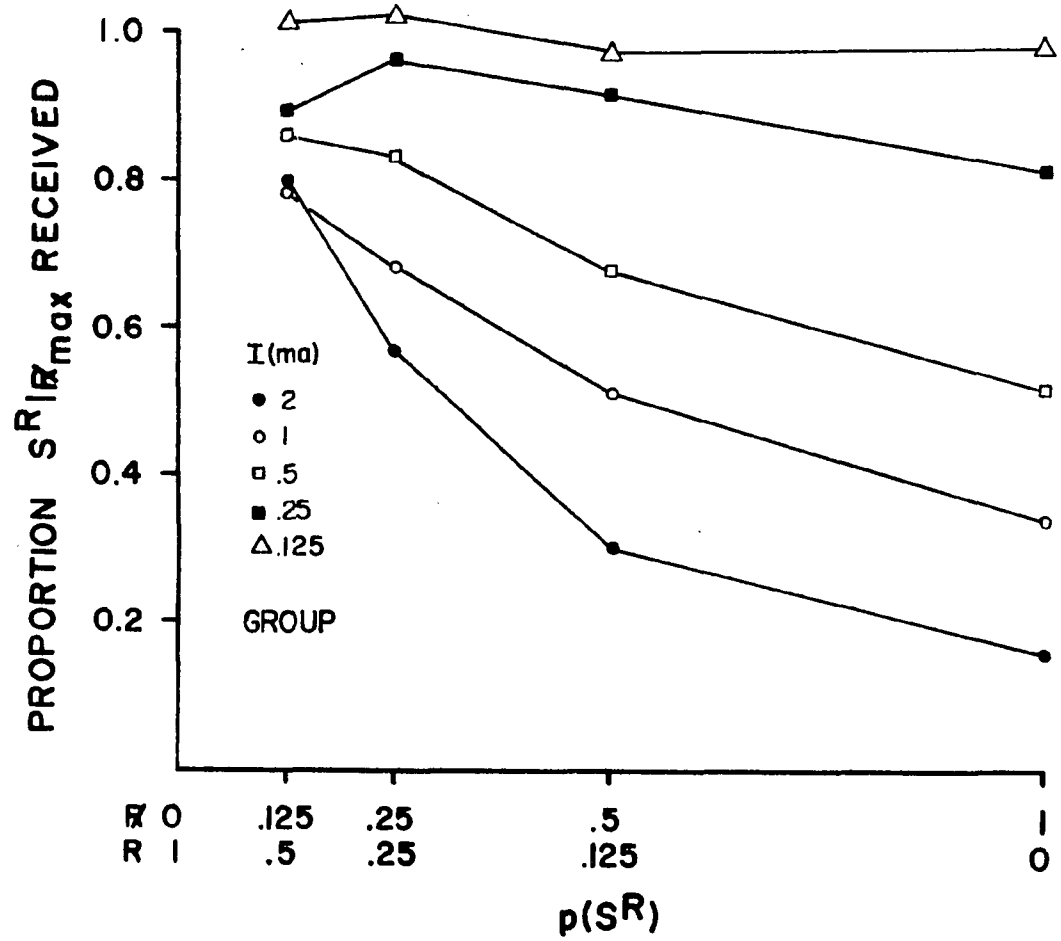


Figure 19

Figures 20 and 21: The proportion of $S^R/K_{\max}$ received as a function of $p(S^R)$ in Experiment I.

Figures 20 and 21 show group and individual organism curves for the proportion of $S^R/K_{\max}$ received as a function of $p(S^R)$ in Experiment I, with shock intensity as a parameter. Shock intensities were represented as follows: 2.000 ma (closed circles), 1.000 ma (open circles), 0.500 ma (open rectangles), 0.250 ma (closed rectangles), 0.125 ma (open triangles). The legend for both figures is shown in Figure 20.

Figure 20



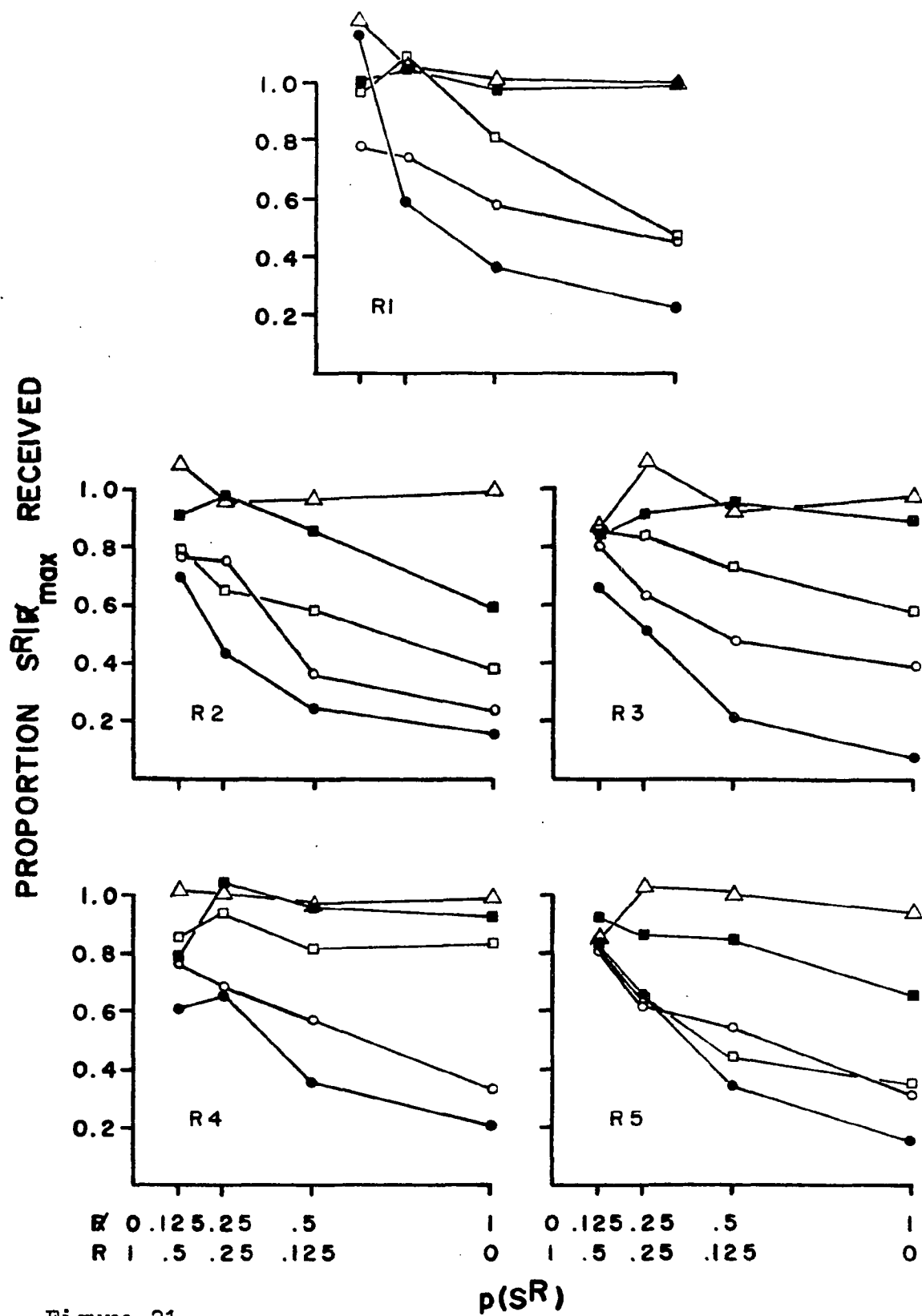


Figure 21

ma shock level, the function describing the proportion of $S^R|R_{\max}$ received was virtually identical with the corresponding $S^R|X_{\max}$ function. As the intensity of shock decreased, however, the functions diverged, with those representing the proportion of $S^R|X_{\max}$ received (Figures 20 and 21) increasing and flattening with decreasing intensity while those representing the proportion of $S^R|R_{\max}$ received (Figures 18 and 19) decreased and flattened.

D. Total shocks received.

An examination of the total shocks received for the pooled response classes and for each response class separately permits the exploration of effects not readily evident when only the proportion of maximum possible shocks received for each of the response classes is explored. Total S^R , total $S^R|R$ and total $S^R|X$ received at each pair of shock probabilities and intensity are shown in Figures 22 through 25 (Experiment II) and Figures 26 through 31 (Experiment I). The data are presented in Tables 11 and 12.

In Experiment II, at all pairs of $p(S^R)$ values, the probability of shock for one of the two response classes is always 1.000 and the maximum possible shocks scheduled at all $p(S^R)$ values is therefore 900. Since the proportion of $S^R_{\max}$ received was calculated by dividing the total S^R received by the constant 900 shocks, the general shape of the functions showing the proportion of $S^R_{\max}$ received is identical to the total S^R received, and only the proportion of $S^R_{\max}$ received was plotted. Data for the total S^R re-

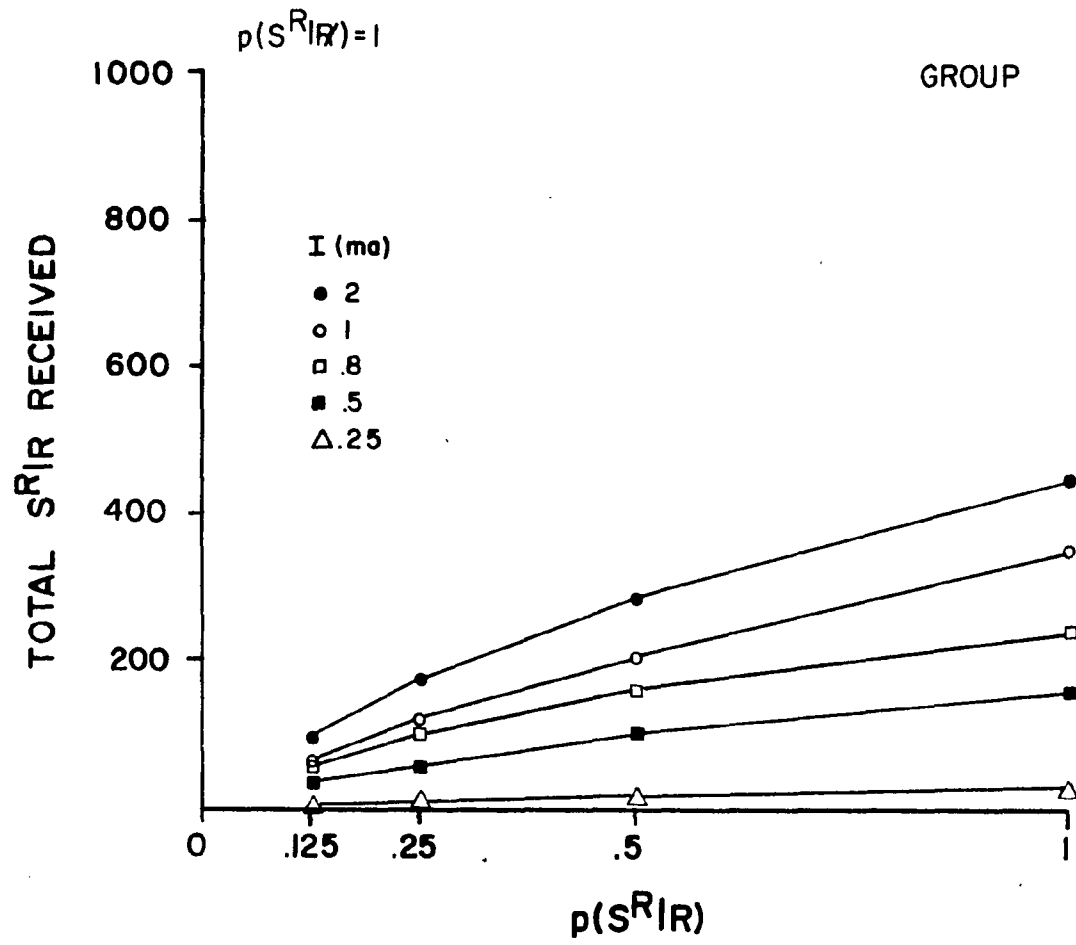
ceived are shown in Table 11. Similarly, the shapes of the curves describing the proportion of $S^R|R$ received across values of $p(S^R|K)$ and the proportion of $S^R|K$ received across values of $p(S^R|R)$ were identical to the curves describing the total $S^R|R$ received across values of $p(S^R|K)$ and total $S^R|K$ received across values of $p(S^R|R)$, and only the proportion of shocks received for each response class was plotted. Data for the total $S^R|R$ and total $S^R|K$ received are presented in Table 11. Figures 22 and 23 (pp. 87-88) show that the total $S^R|R$ received increased with increases in $p(S^R|R)$ for all values of shock intensity, while Figures 24 and 25 (pp. 90-91) show increases in the total $S^R|K$ received with increases in $p(S^R|K)$. In other words, increasing shock probability increased the total number of shocks delivered for that response class. Whereas increases in shock intensity produced increases in the total $S^R|R$ received at all values of $p(S^R|R)$, with higher shock intensities producing steeper functions, the reverse was true when the effect of shock intensity on the total $S^R|K$ received was examined. Increasing shock intensity decreased the total $S^R|K$ received at $p(S^R|K)=1.000$ and 0.500 . The effect of shock intensity at $p(S^R|K)=0.250$ and 0.125 was negligible.

In Experiment I, increasing $p(S^R|R)$ from 0.000 to 1.000 while systematically decreasing $p(S^R|K)$ from 1.000 to 0.000 decreased the total number of shocks received (Figures 26 and 27, pp. 93-94). The 2.000 ma function

Figures 22 and 23: Total $S^R|R$ received as a function of $p(S^R|R)$ in Experiment II.

Figures 22 and 23 show group and individual organism curves for the total $S^R|R$ received as a function of $p(S^R|R)$ in Experiment II, with $p(S^R|\bar{R})=1.000$ and shock intensity as a parameter. Shock intensities were represented as follows: 2.000 ma (closed circles), 1.000 ma (open circles), 0.800 ma (open rectangles), 0.500 ma (closed rectangles), 0.250 ma (open triangles). The legend for both figures is shown in Figure 22.

Figure 22



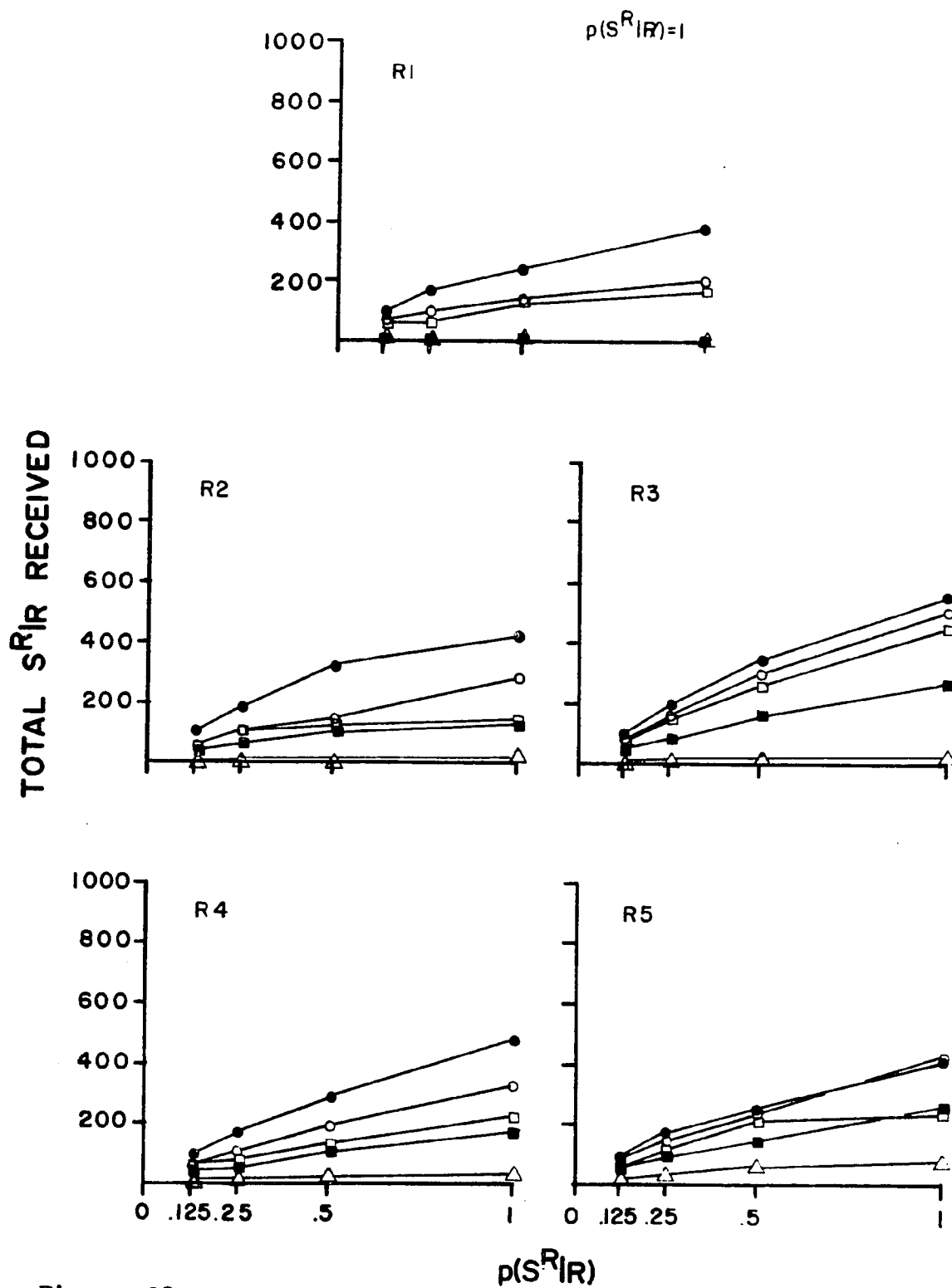
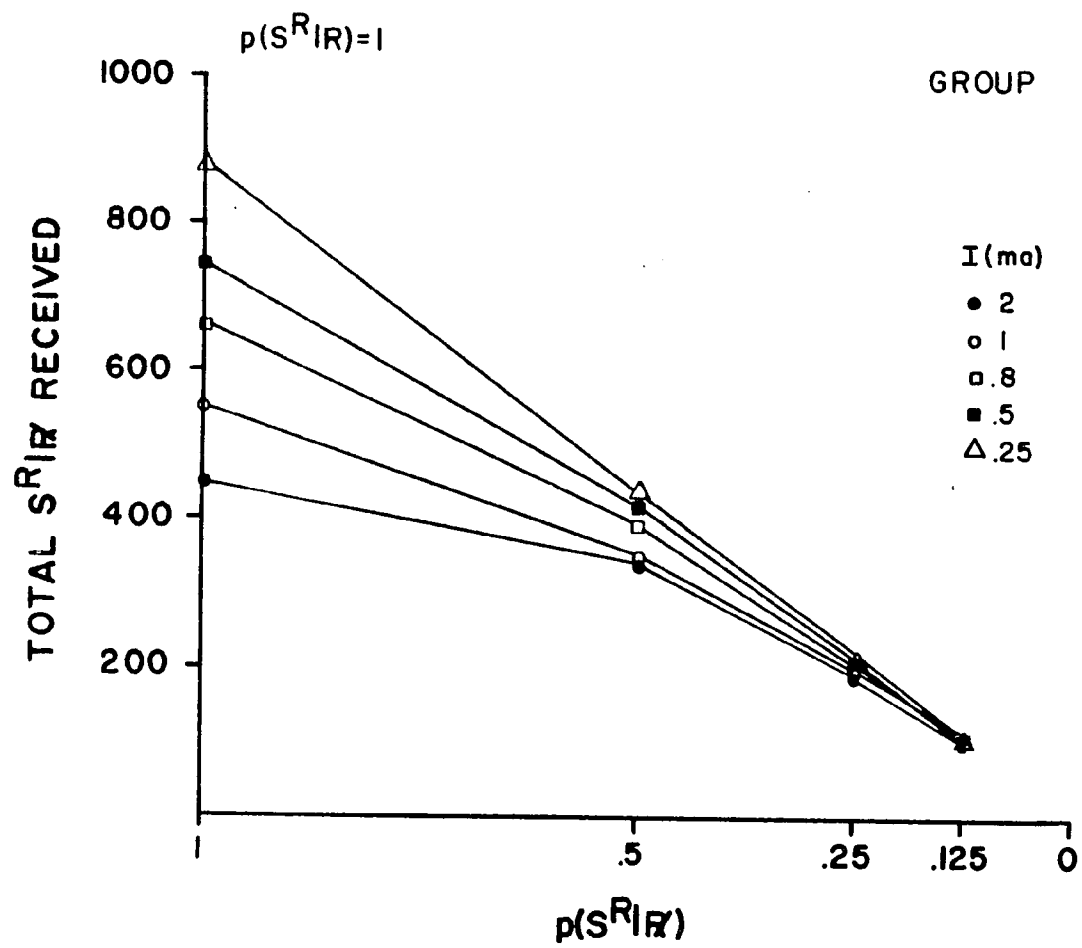


Figure 23

Figures 24 and 25: Total $S^R|X$ received as a function of $p(S^R|X)$ in Experiment II.

Figures 24 and 25 show group and individual organism curves for the total $S^R|X$ received as a function of $p(S^R|X)$ in Experiment II, with $p(S^R|R)=1.000$ and shock intensity as a parameter. Shock intensities were represented as follows: 2.000 ma (closed circles), 1.000 ma (open circles), 0.800 ma (open rectangles), 0.500 ma (closed rectangles), 0.250 ma (open triangles). The legend for both figures is shown in Figure 24.

Figure 24



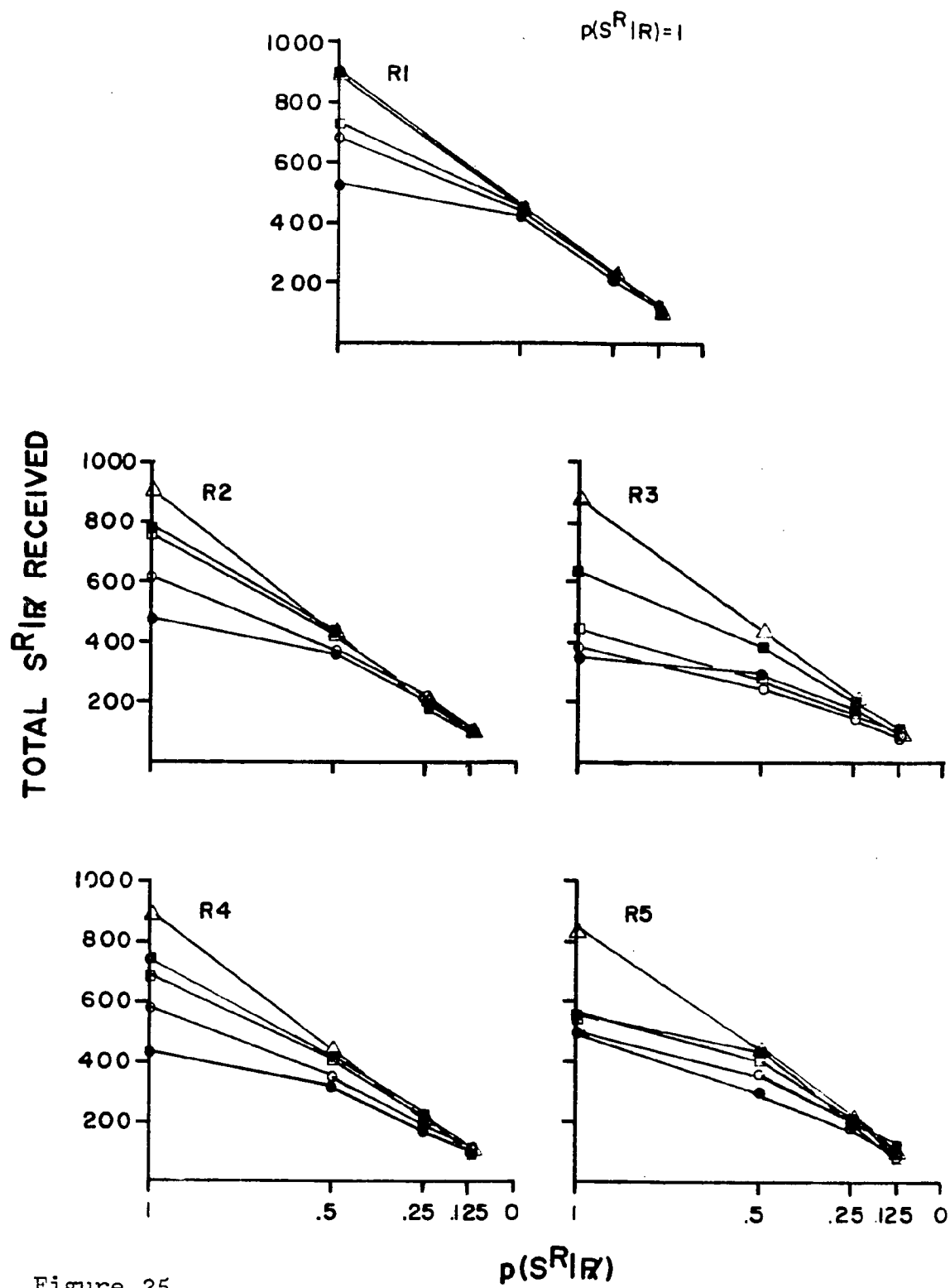
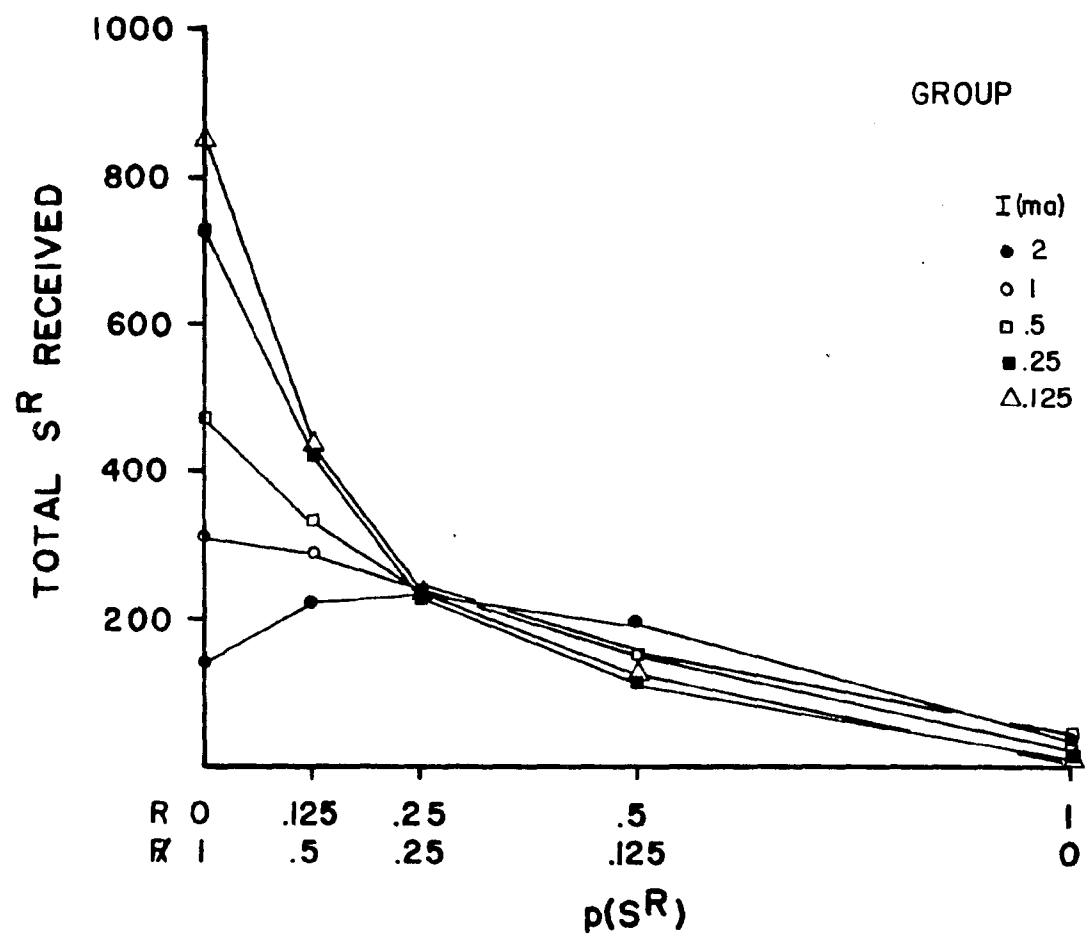


Figure 25

Figures 26 and 27: Total S^R received as a function of $p(S^R)$ in Experiment I.

Figures 26 and 27 show group and individual organism curves for the total S^R received as a function of $p(S^R)$ in Experiment I, with shock intensity as a parameter. Shock intensities were represented as follows: 2.000 ma (closed circles), 1.000 ma (open circles), 0.500 ma (open rectangles), 0.250 ma (closed rectangles), 0.125 ma (open triangles). The legend for both figures is shown in Figure 26.

Figure 26



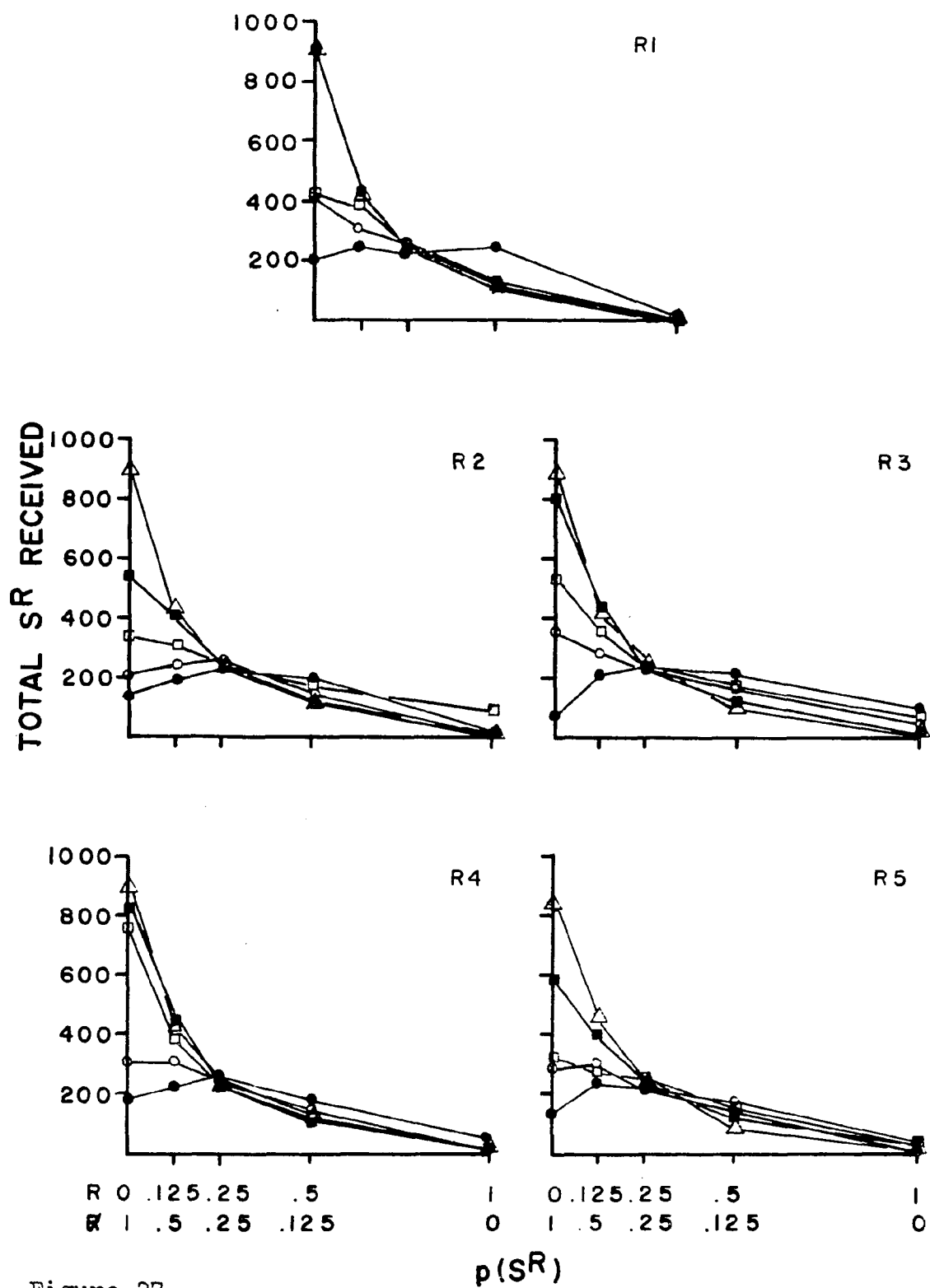


Figure 27

reached a maximum at $p(S^R)=(.25,.25)$ for three of the animals (R2, R3, and R4), while for the remaining two animals (R1 and R5) maxima appeared at $p(S^R)$ values of $(.5,.125)$ and $(.125,.5)$, respectively. No systematic effect of shock intensity was obtained at $p(S^R)$ values of $(.25,.25)$, $(.5,.125)$ and $(1,0)$. The effect of shock intensity was clearly seen at the $p(S^R)=(0,1)$ and $(.125,.5)$ values, with increasing shock intensity generally producing a decrease in the total number of shocks received. The effect of simultaneously increasing $p(S^R|R)$ and decreasing $p(S^R|\bar{R})$ on the total $S^R|R$ received was minimal (Figures 28 and 29). Increasing shock intensity increased the total $S^R|R$ received across all values of $p(S^R)$. A clear effect on the number of $S^R|\bar{R}$ received was obtained, however, with increasing values of $p(S^R|\bar{R})$ producing increases in the total $S^R|\bar{R}$ received. Increasing shock intensity decreased the total $S^R|\bar{R}$ received at all pairs of $p(S^R)$ values except at $p(S^R)=(.5,.125)$, where only a minimal effect of shock intensity was found (Figures 30 and 31, pp. 100-101). In other words, proceeding from avoidance to punishment results in a decrease in the total shocks received. The bulk of that decrease is due to a decrease in the number of shocks delivered for not responding, while the shocks delivered for responding remained relatively constant.

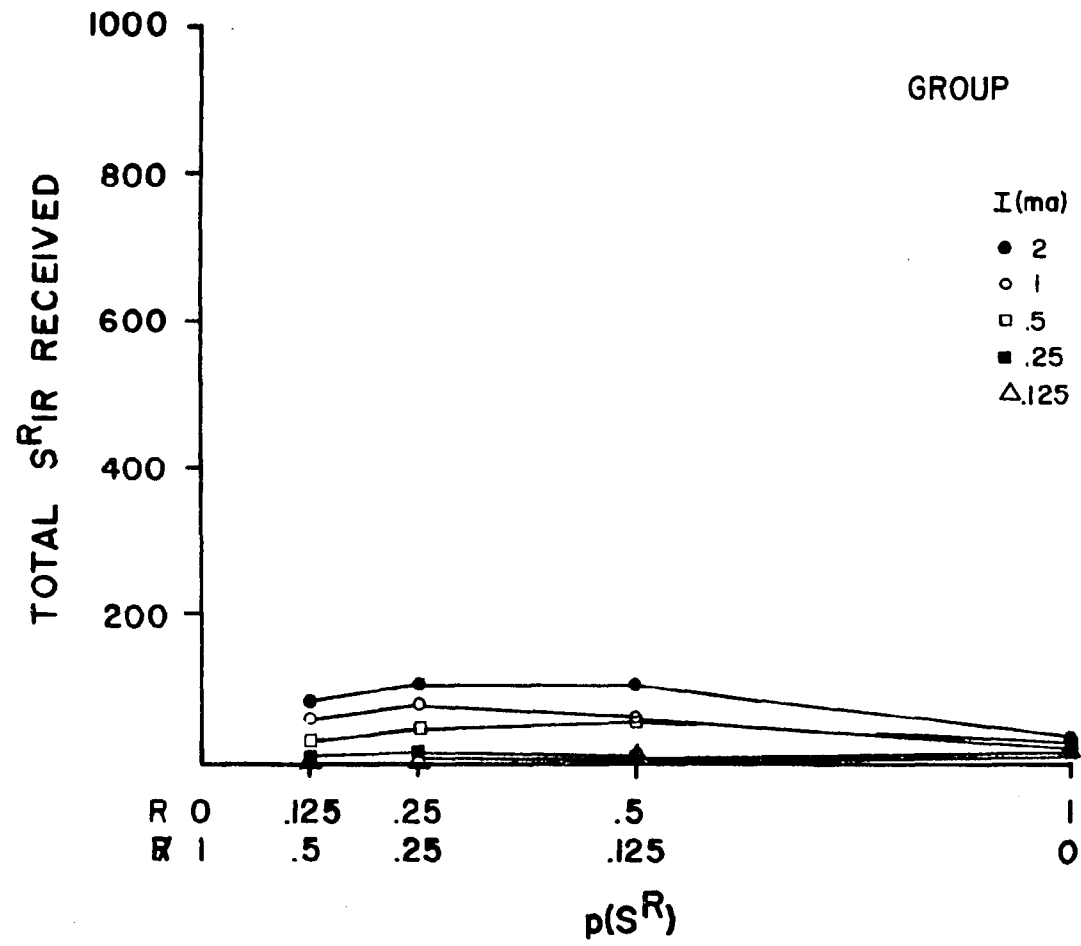
E. Shock intensity.

The increase in total $S^R|R$ received with increases in

Figures 28 and 29: Total $S^R|R$ received as a function of $p(S^R)$ in Experiment I.

Figures 28 and 29 show group and individual organism curves for the total $S^R|R$ received as a function of $p(S^R)$ in Experiment I, with shock intensity as a parameter. Shock intensities were represented as follows: 2.000 ma (closed circles), 1.000 ma (open circles), 0.500 ma (open rectangles), 0.250 ma (closed rectangles), 0.125 ma (open triangles). The legend for both figures is shown in Figure 28.

Figure 28



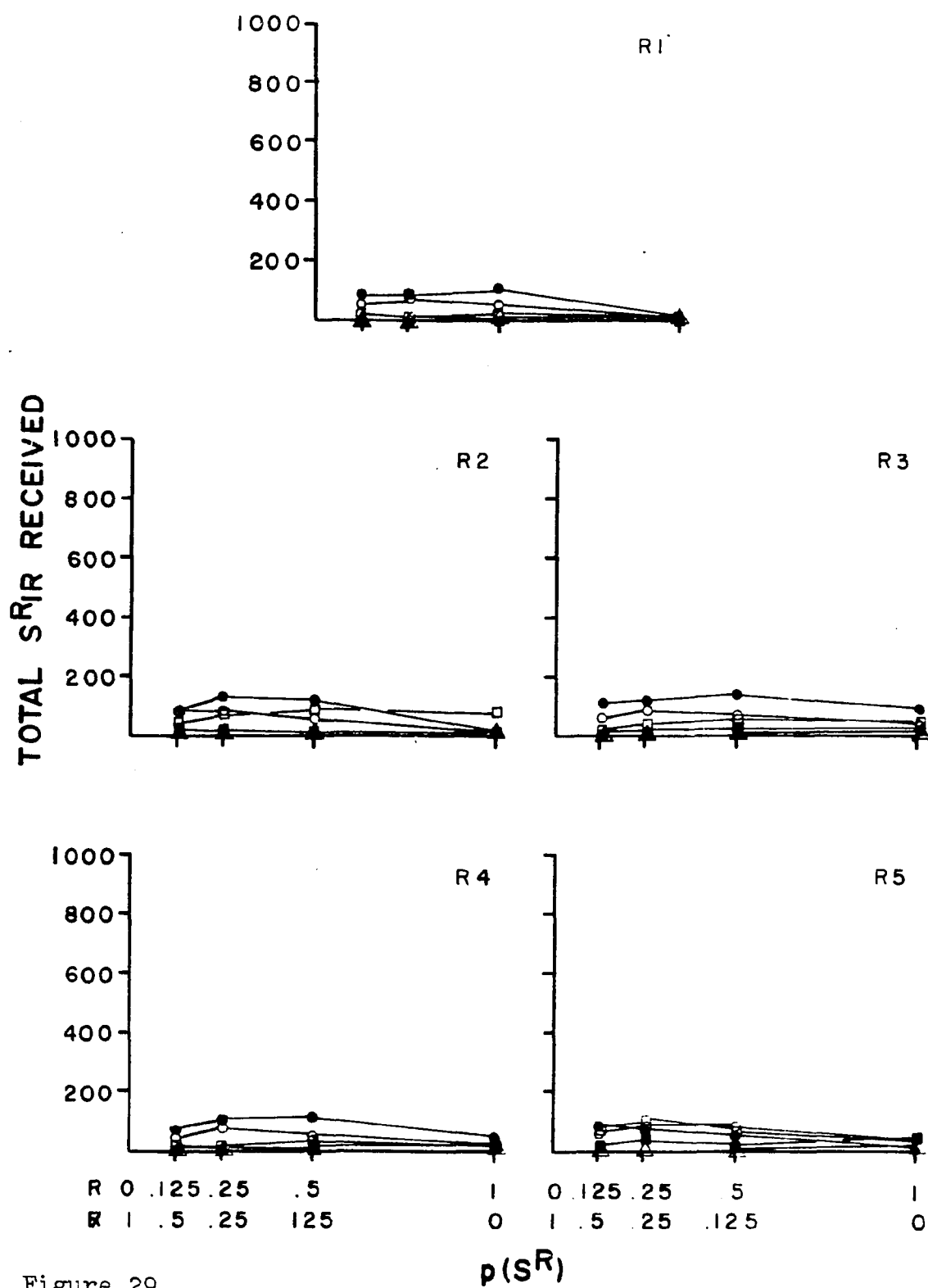


Figure 29

Figures 30 and 31: Total S^R received as a function of $p(S^R)$ in Experiment I.

Figures 30 and 31 show group and individual organism curves for the total S^R received as a function of $p(S^R)$ in Experiment I, with shock intensity as a parameter. Shock intensities were represented as follows: 2.000 ma (closed circles), 1.000 ma (open circles), 0.500 ma (open rectangles), 0.250 ma (closed rectangles), 0.125 ma (open triangles). The legend for both figures is shown in Figure 30.

Figure 30

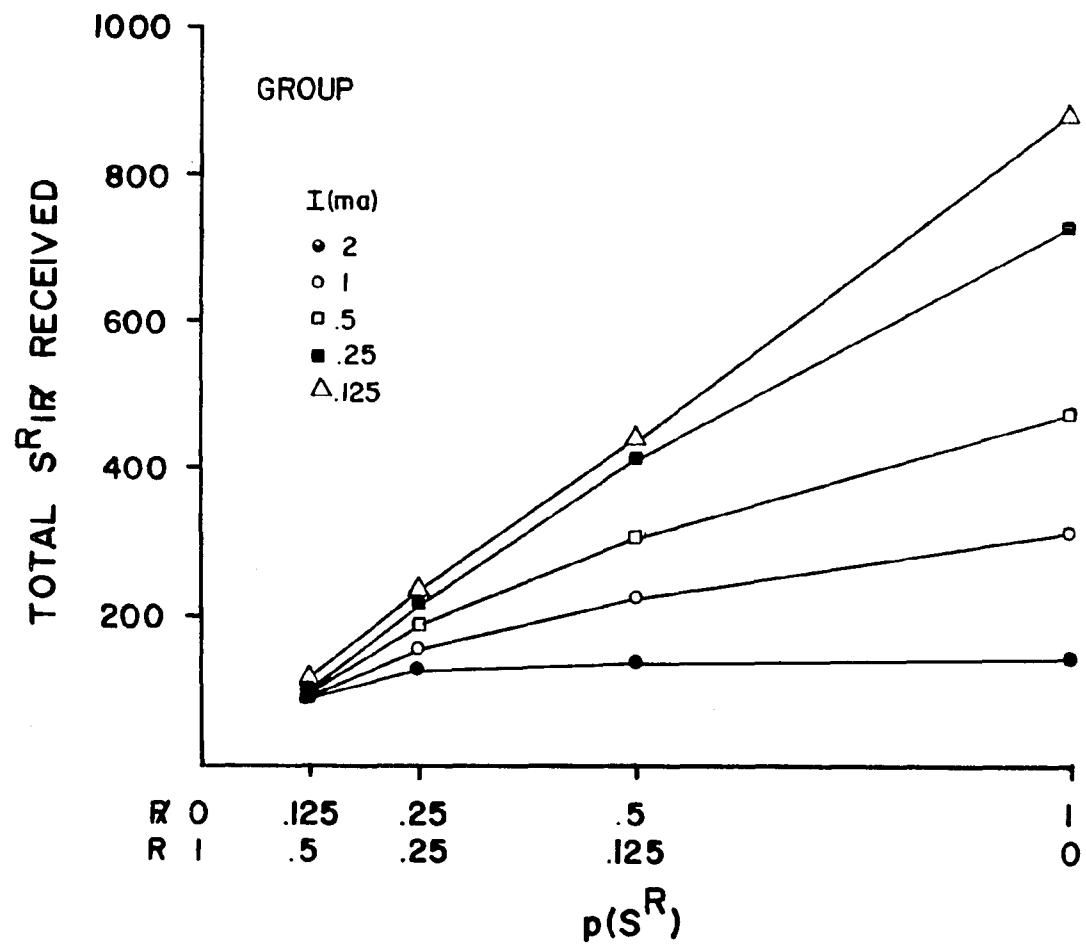


Figure 31

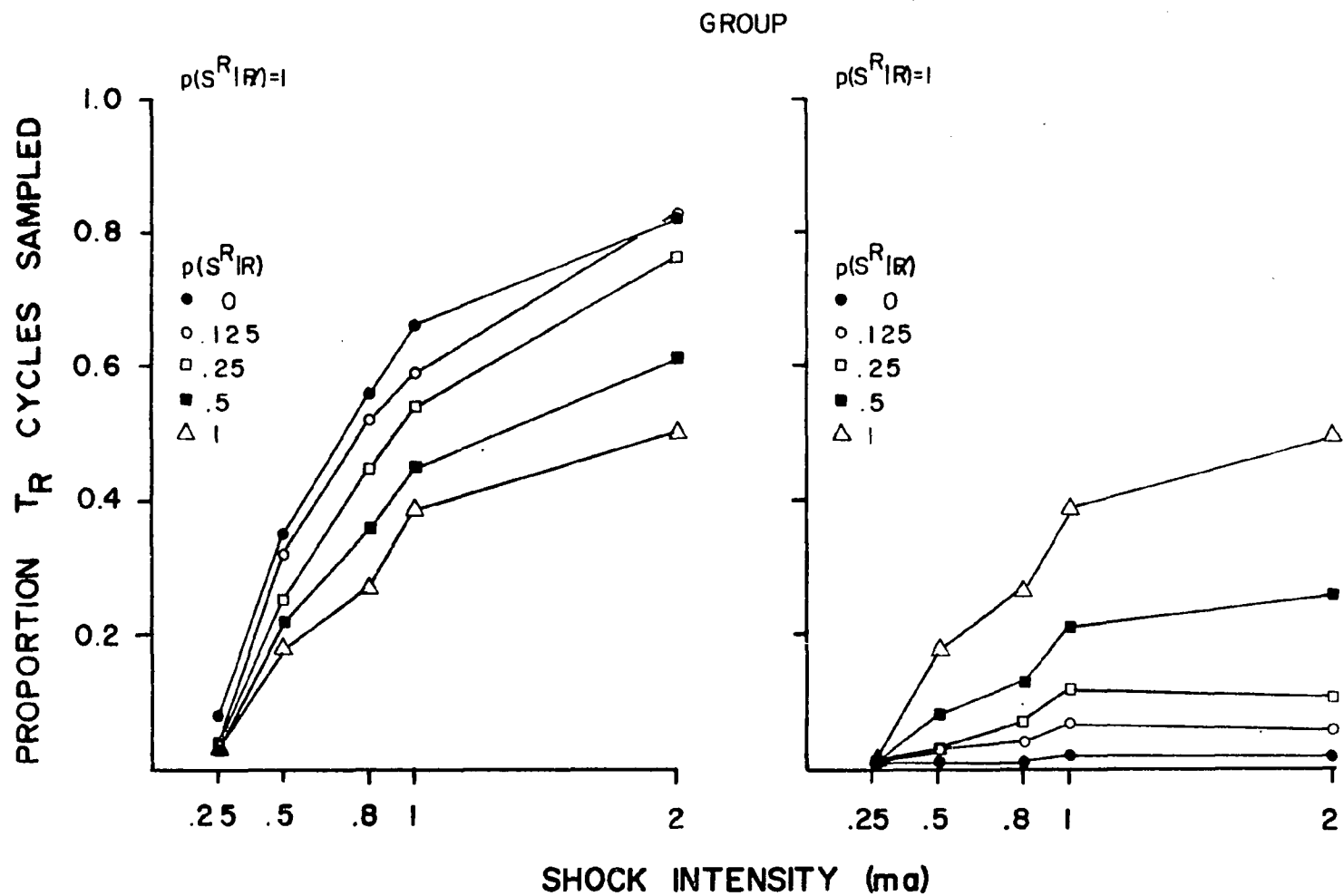
shock intensity can be attributed to corresponding increases in the proportion of T_R cycles sampled. The effect of shock intensity on the proportion of T_R cycles sampled is seen clearly in Figures 32 and 33 (Experiment II) and Figures 34 and 35 (Experiment I). Group and individual organism data for both experiments are found in Tables 7 and 8. In both experiments at all $p(S^R)$ values, the proportion of T_R cycles sampled was an increasing negatively accelerated function of shock intensity, with some exceptions (Experiment II: R1, $p(S^R|\bar{R})=0.000, 0.125, 0.250$). Minimal responding was maintained at $I=0.250$ ma (Experiment II) and at $I=0.125$ ma (Experiment I) regardless of the values of shock probability assigned to both R and $\bar{R}$. In general, as the experimental parameters were varied such that the procedures moved from avoidance ($p(S^R)=(0,1)$) to punishment ($p(S^R)=(1,0)$), the effects of shock intensity systematically decreased. The steepest function was at the $p(S^R)=(0,1)$ value; the flattest at $p(S^R)=(1,0)$, where the proportion of T_R cycles sampled was negligible across all intensity values. Recovery values obtained in Experiment I at $p(S^R)=(0,1)$ at all shock intensities are shown in Table 8. Initial determinations of the proportion of T_R cycles sampled were replicated for all animals upon redetermination at each level of shock intensity.

There is some variability in the literature reporting the effects of shock intensity under conditions of response-produced shock (punishment) and shock postponement (avoid-

Figures 32 and 33: The proportion of T_R cycles sampled as a function of shock intensity in Experiment II.

Figures 32 and 33 show group and individual organism curves for the proportion of T_R cycles sampled as a function of shock intensity in Experiment II, with probability of shock as a parameter. Left-hand panels in both figures show the effects of $p(S^R|R)$ with $p(S^R|\bar{R})=1.000$. Right-hand panels in both figures show the effects of $p(S^R|\bar{R})$ with $p(S^R|R)=1.000$. $p(S^R)$ values were represented as follows: 0.000 (closed circles), 0.125 (open circles), 0.250 (open rectangles), 0.500 (closed rectangles), and 1.000 (open triangles) for the appropriate response class. Legends for both figures are shown in the appropriate panels of Figure 32.

Figure 32



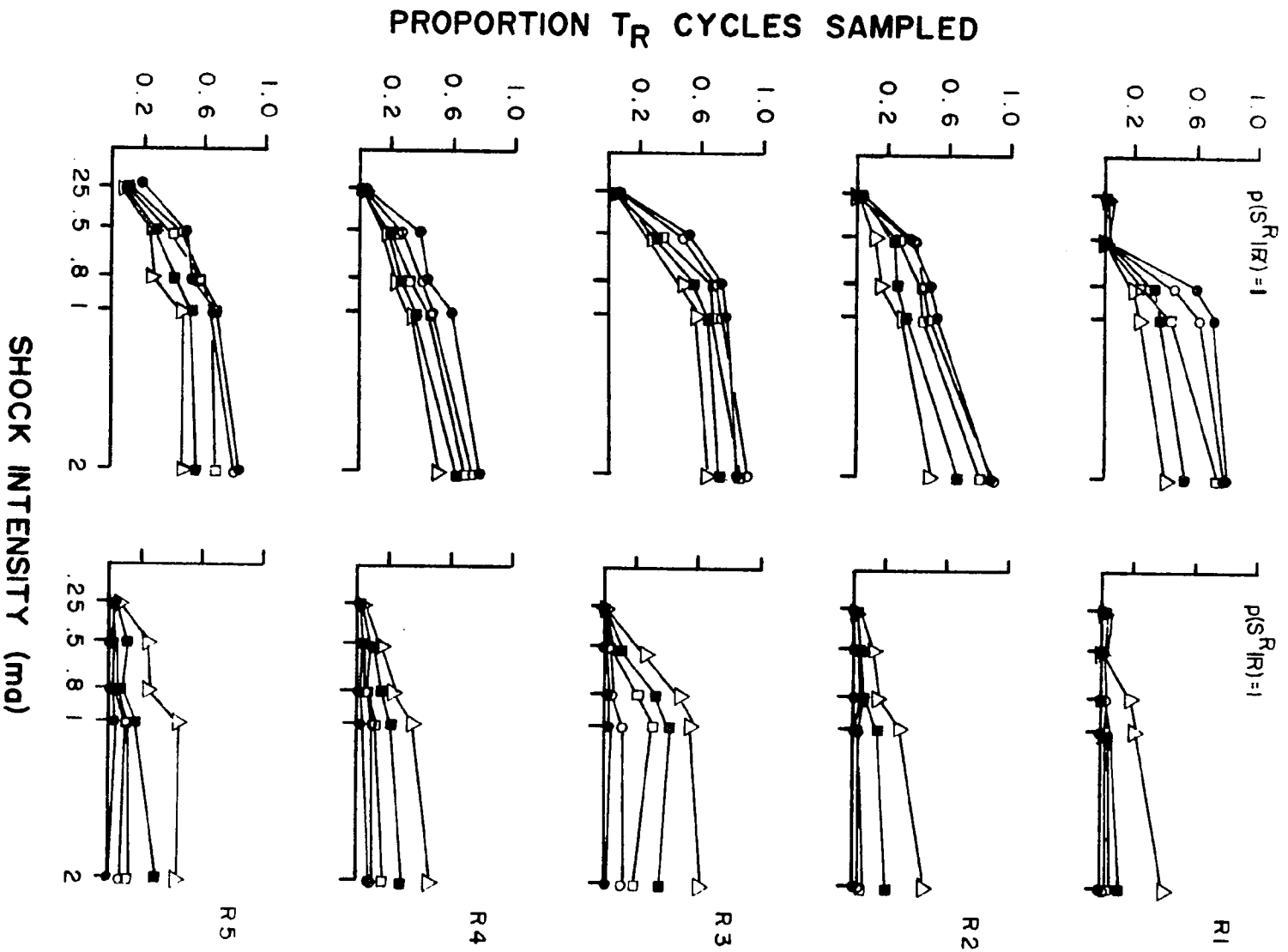
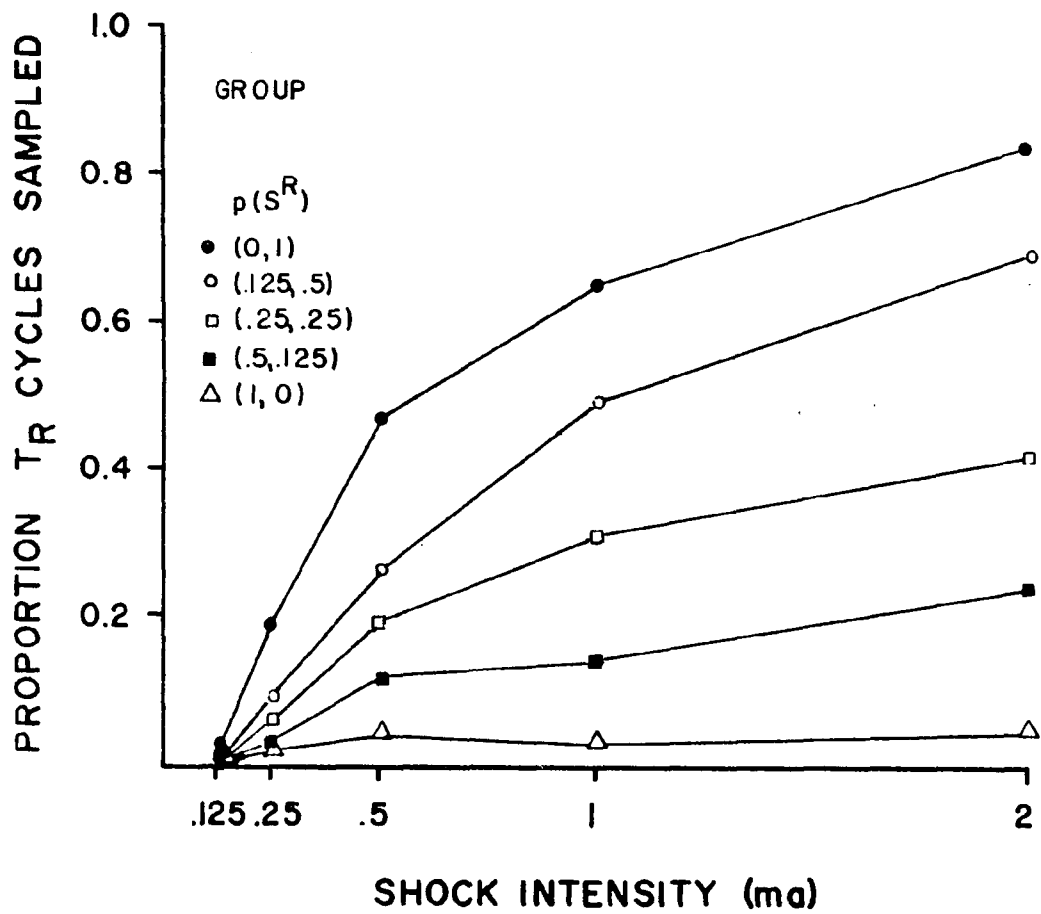


Figure 33

Figures 34 and 35: The proportion of T_R cycles sampled as a function of shock intensity in Experiment I.

Figures 34 and 35 show group and individual organism functions for the proportion of T_R cycles sampled as a function of shock intensity in Experiment I with probability of shock as a parameter. Shock probability was represented as follows: (0,1), closed circles, (.125,.5), open circles, (.25,.25), open rectangles, (.5,.125), closed rectangles, (1,0), open triangles. The legend for both figures is shown in Figure 34.

Figure 34



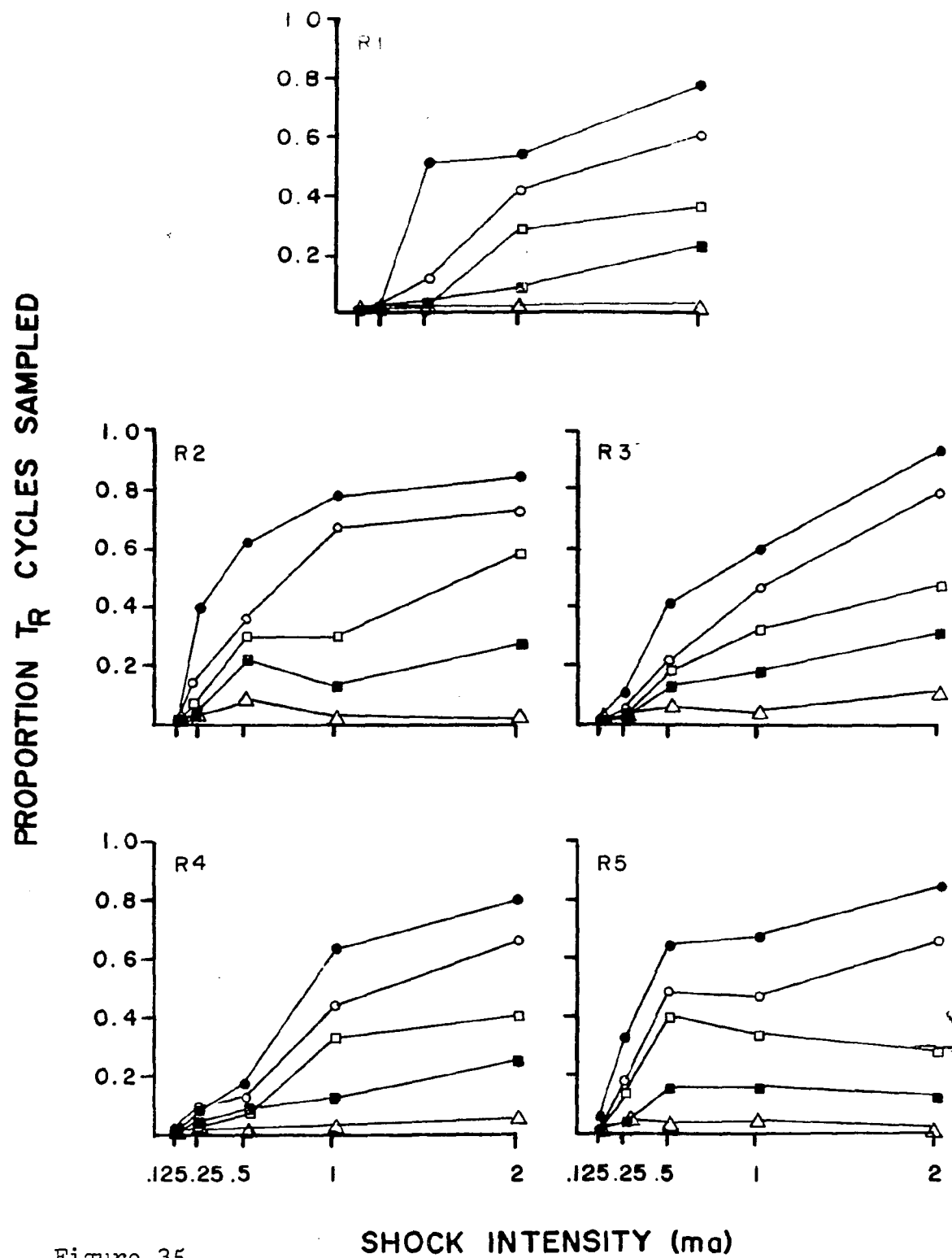


Figure 35

ance). Studies of shock intensity effects during avoidance learning generally show increases in responding with increases in shock intensity. Boren, Sidman and Herrnstein (1959) varied the intensity of electric shock from 0.10 to 3.70 ma in a Sidman avoidance procedure (S-S-R-S=20 sec). The function relating shock intensity to rate of avoidance was increasing and negatively accelerated. Riess (1970) similarly found a monotonic relationship across shock intensity values of 0.250 and 4.000 ma, with the regions of greatest effect of shock intensity found between 0.250 and 1.000 ma. When a shuttlebox avoidance response was measured, however, Moyer and Korn (1964) and Theios, Lynch and Lowe (1966) found that relatively intense electric shock interfered with the acquisition of avoidance responding, with maximal disruption occurring at 2.500 ma. Bolles and Warren (1965) reported an inverse relationship when the response selected for measurement was the bar press. Acquisition of avoidance improved when shock intensity decreased from 2.200 to 0.100 ma. An inverse relationship between avoidance responding and shock intensity was also obtained by D'Amato and Fazzaro (1966) when intensity was varied from 0.200 to 2.750 ma. Bolles and Warren (1965) attributed the discrepant findings to differences in the avoidance response selected for measurement and argued that, since the effect of increasing shock intensity was to increase the activity level of the animal, under conditions in which the bar press was selected, avoidance responding would decrease,

while under conditions in which running was selected, avoidance responding would increase. Powell (1970b), however, studied the effects of two shock intensities on the bar press response of rats maintained under a Sidman avoidance schedule (S-S=10 sec, R-S=20 sec) and found that higher shock intensities (2.000 ma) produced higher avoidance rates. While the results of the present paper confirm Powell's finding, the range of shock intensity values used does not permit an analysis of the disruptive effects of shock intensity values greater than 2.000 ma.

The effect of shock intensity has been most widely investigated under conditions in which electric shock is presented contingent upon a response. In general, the more intense the punishment, the lower the rate of responding, with response suppression most evident when electric shocks occur at high intensity and are scheduled to occur frequently (Appel, 1968; Appel & Peterson, 1965; Azrin, 1959, 1960). The function relating the amount of response suppression to the intensity of punishment was described by a decreasing exponential equation (Appel & Peterson, 1965). This same equation was found to describe the behavior of rats, pigeons and monkeys with different responses maintained on VI and FI food maintaining schedules when punishment was delivered after each response (Azrin, 1960), on a VI (Church, Raymond & Beauchamp, 1967; Filby & Appel, 1966) and an FI (Appel, 1968) schedule. Enhancement of response rates maintained under an FI schedule of electric shock presentation was

obtained by McKearney (1969), however, with response rates directly related to shock intensity when shock intensity assumed values from 0.300 to 5.600 ma. The present experiment replicated this finding when shock probability for responding exceeded that for not responding. Increasing shock intensity increased response rates at $p(S^R)=(.5,.125)$ (Experiment I), and at $p(S^R)=(1,.5)$, $(1,.25)$ and $(1,.125)$ (Experiment II). The animals in the present experiment were given an avoidance history. That the animals in McKearney's study were initially exposed to an avoidance schedule onto which the FI schedule of shock presentation was superimposed suggests the importance of the role of an animal's history in determining the effects of electric shock intensity. For example, Holz and Azrin (1962) demonstrated that low intensity response-produced shock which did not initially suppress responding, would do so subsequent to selective pairing with extinction. High intensity response-produced shock which initially suppressed responding later enhanced responding when selectively paired with food reinforcement.

That the effect of stimulus intensity is influenced by the schedule of reinforcement used to maintain responding was demonstrated by Powell (1970a). Pigeons were maintained on a two-component multiple VI,VR schedule of food reinforcement onto which a concurrent FR10 punishment schedule was superimposed. When electric shock intensity was first increased and then decreased, VR responding was sup-

pressed more and recovered less rapidly than VI responding. Powell and Morris (1969) demonstrated that the effects of the intensity of response-produced shocks on responding maintained by an avoidance schedule depended on the intensity of the electric shocks maintaining the avoidance response. Rats bar pressing under a Sidman avoidance schedule (S-S=R-S=20 sec) were punished following each response. When the intensity of the response-produced shock was one-quarter of the avoidance shock, reduced rates of responding occurred. When the intensity of the response-produced shock was one-half or equal to the avoidance shock, a marked suppression of the avoidance response was noted. Under both conditions of initial shock intensity, increases in punishment intensity produced a systematic decrease in avoidance rate, resulting in an increase in the number of avoidance shocks obtained. Similar effects were found (Bryant, 1972) when a visual CS followed by a 7.500 ma response-independent electric shock was superimposed onto responding maintained under a Sidman avoidance schedule (S-S=R-S=20 sec) with an avoidance shock equal to 1.500 ma. Avoidance responding was suppressed during the CS even though the avoidance schedule remained in effect. Suppression of responding was also reported by Roberts and Hurwitz (1970) when the concurrent shock avoidance schedule was suspended during CS presentation, and by Pomerleau (1970) under schedules in which a brief CS duration and a long interval of shock-free time were used. When stimulus

duration was long or the delay of shock brief, so that the occurrence of a response decrement during the CS resulted in the presentation of avoidable shocks, a high or "facilitated" response rate during the stimulus developed. Shimoff (1972) later demonstrated that the behavioral effects of the response-independent pairing of a neutral stimulus and a brief electric shock superimposed on avoidance responding was determined, in part, by the temporal properties of the individual stimuli and the temporal relationship between them. It is apparent from these studies that the effect of an electric shock stimulus is a joint function of several variables, including, among others, the intensity of the stimulus, the schedule of stimulus delivery, the reinforcement schedule maintaining ongoing behavior into which the shock stimulus is intruded, the response selected for measurement and the history of the organism.

Summary

In general, the data from both experiments in the present study indicated the following:

1. Increases in the probability of shock for a response class tend to produce decreases in the frequency of occurrence of behavior in that class. Proceeding from avoidance to punishment produced decreases in both response rates and the proportion of T_R cycles sampled.

2. In Experiment I, the proportion of the maximum shocks received was a biphasic function of the pairs of

probability values assigned to the response classes, with maximum shocks occurring at the point on the continuum between avoidance and punishment where shock frequency was independent of behavior. To the right of the maximum, most of the shock frequency reduction was attributable to a reduction in response-produced shocks, while to the left of the maximum, most of the reduction in shock frequency was attributable to a reduction in shocks presented for not responding. When the continuum from avoidance to punishment was examined by independently varying each of the two shock probabilities for responding and for not responding in Experiment II, while holding the other constant, the findings of Experiment I were confirmed.

3. For organisms with histories of responding on avoidance procedures, increases in the intensity of shock tend to produce an increase in the frequency of the avoidance response. In Experiment I, increases in shock intensity produced increases in both response rates and the proportion of T_R cycles sampled across all values of shock probability except those defining punishment, where the effect was minimal and unsystematic. The differential effect of shock intensity on the proportion of maximum shocks received was negligible on proceeding from response-independent shock to punishment. At the avoidance end of that continuum, there was a pronounced effect of shock intensity, with the greatest shock frequency reduction occurring under the highest shock intensities. Increases in

shock intensity produced increases in the proportion of shocks received for responding and decreases in the proportion of shocks received for not responding. The findings for the effect of shock intensity on response rate, the proportion of T_R cycles sampled and total shock frequency reduction were confirmed in Experiment II.

GENERAL DISCUSSION

A number of attempts have been made to explicate the apparent differences between positive reinforcement, avoidance and punishment procedures. In some cases, these differences have been attributed to intrinsic differences in the reinforcing stimulus. For example, Black, Walters and Webster (1972) suggested that,

... an important distinction among reinforcers is between those that consist of the presentation or termination of a salient stimulus as against those that do not consist of an abrupt change in the environment (Black, Walters & Webster, 1972, p. 80).

Since reinforcement in the nondiscriminated avoidance case is conceived as the absence of shock or shock frequency reduction, and it is not signalled, the moment of reinforcement occurrence is less discriminable than with positive reinforcement or punishment. Because of the difference in the "salience" of the reinforcing stimulus, similar performances are not always maintained by the similar scheduling of different events. The differences in performance were found to depend upon, in part, the response selected for measurement. Bolles, Stokes and Younger (1966) suggested that responses (e.g., running in a wheel) which are "compatible with the rat's 'natural' defense reaction in fear-eliciting situations" (Bolles, Stokes & Younger, 1966, p. 203) could be acquired readily without the need for additional CS-termination and shock-

escape contingencies. Facilitation as a result of CS termination was said to be due to the provision of immediate "sensory feedback" to the animal. If, however, the response was not one of the animal's "species-specific defense reactions," the acquisition of the avoidance response could be facilitated by additional CS-termination and shock-escape contingencies. Supporting evidence for the difficulty in acquiring low probability avoidance responses (e.g., a bar pressing response for rats) was provided by Cole and Fantino (1966), Fantino, Sharp and Cole (1966), Meyer, Cho and Wesemann (1960) and Wahlsten, Cole, Sharp and Fantino (1968). Similar differences in the conditionability of different responses were reported by Anderson (1969), Bolles and Grossen (1969), Nakamura and Anderson (1964) and Theios and Lowe (1966). Bolles and Grossen (1969) stated that "... the amount, and kind, of stimulus change produced by [the avoidance response is] the most important factor in avoidance learning" (Bolles & Grossen, 1969, p. 90).

Rather than looking for differences in procedures and their behavioral effects, an alternative approach is to look for similarities. One point of commonality between the avoidance and punishment procedures and the behaviors they maintain is the delay of stimulus presentation produced by the occurrence of the response. In an avoidance experiment, the experimenter specifies a class of responses (R) which is not immediately followed by shock. Instead,

shock follows the response with some previously specified delay. In a Sidman avoidance schedule, for example, electric shock occurs at the end of the S-S interval if no response occurs. If a response occurs within the S-S interval, shock is delayed, with the minimum delay specified by the R-S interval. If no S-S interval is sampled, shock occurs immediately following the termination of the S-S interval. In the punishment case, the response class which is successful in avoiding electric shock ($\bar{R}$) is unspecified, while the punished response class (R) is clearly defined. In a punishment schedule, the experimenter follows each response occurrence (in the continuous punishment case) with the delivery of shock. Shock never immediately follows the occurrence of $\bar{R}$. Camp, Paymond and Church (1967) varied the temporal relationship between a response and shock to determine the extent to which the effects of punishment depended on the temporal relationship between responding and shock. Response suppression was a decreasing function of delay of shock, with the greatest suppression occurring when shock occurred immediately after a response.

As early as 1953, Sidman (1953b) had found a biphasic function describing the relation between the R-S interval and response rates in temporal avoidance. He attributed the falling off of response rates to the left of the maximum to a delay of punishment gradient operating on the avoidance response to depress the rate of avoidance at short R-S intervals and a distribution of punishment gradient

operating to depress nonavoidance behavior at longer R-S intervals. The rising limb of the function was replicated by Verhave (1959a) using long R-S intervals (20 to 300 sec) and a constant S-S interval (30 sec) and by Clark and Hull (1966) and Verhave (1959b) when rate of avoidance was measured with simultaneous and equal variations in the S-S and R-S intervals. Thus, while Dinsmoor (1954) explained punishment as a special case of avoidance, Sidman (1953b) saw avoidance as a special case of punishment.

Rather than giving separate names to variations in procedures and positing different underlying processes to explain these procedures, a search for similarities in both the procedures and variables controlling the behavior maintained under them would be far more profitable. According to Schoenfeld, Cole, Lang and Mankoff,

... if the concept of reinforcement is broadened to include all stimuli, and if 'contingency' is dropped from the lexicon of learning theory, then emphasis moves to the temporal relations among the occurrences of R and the intrusions of S (the 'reinforcements') into the behavior stream.... Reinforcement schedules, and systems like $t-\tau$ which undertook to order them, become 'stimulus schedules' in which a stimulus sheds its inferred 'functions' and reverts to what it is, namely, an energy input function describable in terms of its physical and its scheduling parameters alone (Schoenfeld, Cole, Lang & Mankoff, 1973, p. 160-161).

When viewed this way, any stimulus may conceivably increase, maintain or decrease responding, with the effects of the stimulus determined by its physical properties, its schedule of presentation, and the history of the or-

ganism (cf. Kadden, 1973). Once response-inferred definitions of stimulus functions are abolished, paradoxical results such as reports of response-produced increases in shock presentation or response-produced decrements in food presentation are no longer paradoxical. When the emphasis is placed on procedural and behavioral continuities instead of merely assigning positive and negative properties to stimuli, behavior theorists can begin to cut across categories previously restricted to either conditioning with positive reinforcers or aversive stimuli and can shed many of the logical fallacies constructed to help fit data to theory.

By eliminating the restrictions arbitrarily imposed by a discrete trials procedure (Sidman, 1953a) and by permitting the continuous observation of behavior (Schoenfeld & Farmer, 1970), parametric continuities in procedures have been observed. The organizational properties of the $t-\tau$ systems have permitted the unification of reinforcement schedules which in the past were seen as procedurally unrelated, with aversive control procedures seen as identical to positive reinforcement schedules "... save for the sense modality and/or physical properties of the stimulus that is presented" (Schoenfeld & Farmer, 1970, p. 104). The classification of reinforcement as positive or negative lacks empirical significance.

Avoidance behavior has been attributed to response-produced shock frequency reduction. The distribution of

responses in time is attributed to the temporal distribution of shocks. This of course must be true. It is also true, however, that the distribution of shocks in time in these procedures is at least partially determined by the distribution of responses in time. It seems of little value to assign a major determining role to shock frequency reduction when that in turn is dependent upon the behavior that it is assumed to be controlling. Clearly then, neither the temporal distribution of shocks nor the responses is independent of the other. Rather, both are dependent variables and are determined by the parameters of the schedule of stimulus intrusion (cf. Schoenfeld & Cole, 1972; Schoenfeld & Farmer, 1970; Schoenfeld, Cole, Lang & Mankoff, 1973; Shamow, 1979) and the nature of the intruded stimuli. It is the schedule variables and the physical parameters of the intruded stimuli, either of which may modulate the effects of the other, that are the true independent variables.

Table 3

Response rates in Component 1 of Experiment II

Shock intensities are in milliamperes. Response rates are in responses per second. Response rates in Component 1 at $p(S^R)=(0,1)$ over nine successive days are shown under the corresponding $p(S^R)$ value assigned to Component 2. Subject numbers are shown in the left-most column.

S	I	$p(S^R)$ in Component 2								
		(0,1)	(.125,1)	(.25,1)	(.5,1)	(1,1)	(1,.5)	(1,.25)	(1,.125)	(1,0)
S1	2.000	.41	.39	.38	.34	.34	.36	.40	.39	.40
	1.000	.25	.23	.21	.17	.30	.30	.33	.32	.30
	0.800	.26	.28	.22	.15	.21	.22	.21	.20	.24
	0.500	.05	.00	.00	.01	.00	.00	.01	.02	.01
	0.250	.00	.00	.00	.00	.00	.00	.00	.00	.00
S2	2.000	.63	.63	.49	.44	.54	.49	.49	.48	.41
	1.000	.33	.24	.30	.25	.43	.43	.42	.37	.42
	0.800	.24	.30	.29	.15	.20	.16	.23	.39	.43
	0.500	.16	.29	.10	.28	.18	.15	.29	.28	.42
	0.250	.03	.01	.01	.00	.00	.00	.00	.00	.00
S3	2.000	.54	.57	.52	.40	.43	.39	.42	.52	.49
	1.000	.39	.41	.41	.41	.45	.44	.45	.45	.47
	0.800	.42	.42	.37	.39	.38	.39	.39	.39	.40
	0.500	.17	.27	.10	.19	.16	.08	.15	.17	.25
	0.250	.10	.04	.04	.01	.01	.00	.02	.02	.02
S4	2.000	.43	.46	.41	.29	.30	.29	.39	.41	.40
	1.000	.18	.25	.31	.17	.34	.28	.28	.32	.40
	0.800	.21	.22	.16	.15	.15	.20	.20	.14	.25
	0.500	.20	.11	.06	.08	.07	.08	.07	.09	.08
	0.250	.02	.01	.01	.01	.01	.01	.01	.01	.02

Table 3 (continued)

Response rates in Component 1 of Experiment II

 $p(S^R)$ in Component 2

S	I	(0,1)	(.125,1)	(.25,1)	(.5,1)	(1,1)	(1,.5)	(1,.25)	(1,.125)	(1,0)
S5	2.000	.57	.53	.49	.54	.46	.47	.45	.44	.45
	1.000	.38	.38	.40	.32	.35	.34	.35	.32	.21
	0.800	.28	.26	.32	.30	.28	.23	.24	.27	.30
	0.500	.17	.20	.14	.13	.10	.14	.09	.10	.12
	0.250	.09	.04	.04	.04	.04	.03	.02	.02	.03
GROUP										
	2.000	.52	.51	.46	.40	.41	.40	.43	.45	.43
	1.000	.30	.30	.33	.27	.37	.36	.36	.36	.36
	0.800	.29	.30	.27	.23	.25	.24	.24	.29	.33
	0.500	.15	.17	.08	.14	.10	.09	.12	.13	.18
	0.250	.05	.02	.02	.01	.01	.01	.01	.01	.02

Table 4

Response rates in Component 1 of Experiment I

Shock intensities are in milliamperes. Response rates are in responses per second. Response rates in Component 1 at $p(S^R)=(0,1)$ over five successive days are shown under the corresponding $p(S^R)$ value assigned to Component 2. Subject numbers are shown in the left-most column.

S	I	$p(S^R)$ in Component 2				
		(0,1)	(.125,.5)	(.25,.25)	(.5,.125)	(1,0)
S1	2.000	.32	.36	.33	.29	.29
	1.000	.25	.25	.27	.28	.27
	0.500	.21	.09	.03	.09	.20
	0.250	.00	.01	.00	.00	.01
	0.125	.00	.01	.00	.01	.00
S2	2.000	.45	.48	.45	.49	.54
	1.000	.54	.51	.50	.39	.30
	0.500	.41	.24	.30	.27	.25
	0.250	.16	.11	.07	.03	.04
	0.125	.01	.01	.04	.04	.01
S3	2.000	.29	.34	.43	.38	.41
	1.000	.31	.32	.34	.27	.26
	0.500	.03	.15	.15	.19	.17
	0.250	.01	.05	.05	.03	.03
	0.125	.01	.01	.01	.00	.01
S4	2.000	.36	.44	.36	.36	.35
	1.000	.26	.27	.26	.27	.21
	0.500	.00	.05	.06	.07	.08
	0.250	.02	.03	.02	.03	.03
	0.125	.00	.01	.01	.00	.01

Table 4 (continued)

Response rates in Component 1 of Experiment I

S	I	$p(S^R)$				
		(0,1)	(.125,.5)	(.25,.25)	(.5,.125)	(1,0)
S5	2.000	.33	.34	.25	.26	.30
	1.000	.27	.25	.27	.25	.27
	0.500	.26	.26	.24	.22	.28
	0.250	.11	.07	.08	.06	.07
	0.125	.02	.01	.00	.03	.03
GROUP						
2.000	$\bar{X}=$	.35	.39	.36	.36	.38
	$SD=$	.06	.06	.08	.09	.10
1.000	$\bar{X}=$	.33	.32	.33	.29	.26
	$SD=$	.12	.11	.10	.06	.03
0.500	$\bar{X}=$	.18	.16	.16	.17	.20
	$SD=$	.17	.09	.12	.09	.08
0.250	$\bar{X}=$	.06	.05	.04	.03	.04
	$SD=$	.07	.04	.03	.02	.02
0.125	$\bar{X}=$	.01	.01	.01	.02	.01
	$SD=$	.01	.00	.02	.02	.01

Table 5

Response rates in Component 2 of Experiment II

Shock intensities are in milliamperes. Response rates are in responses per second. Subject numbers are shown in the left-most column.

S	I	$p(S^R)$								
		(0,1)	(.125,1)	(.25,1)	(.5,1)	(1,1)	(1,.5)	(1,.25)	(1,.125)	(1,0)
S1	2.000	.42	.47	.45	.33	.31	.09	.02	.01	.00
	1.000	.22	.17	.16	.11	.09	.02	.01	.00	.00
	0.800	.26	.21	.11	.12	.10	.01	.00	.00	.00
	0.500	.00	.00	.00	.00	.00	.00	.00	.00	.00
	0.250	.00	.00	.00	.00	.00	.00	.00	.00	.00
S2	2.000	.58	.69	.53	.38	.35	.15	.01	.01	.00
	1.000	.25	.34	.27	.24	.22	.11	.01	.00	.00
	0.800	.19	.30	.20	.13	.07	.03	.03	.02	.00
	0.500	.10	.18	.08	.07	.06	.02	.01	.00	.00
	0.250	.01	.00	.00	.00	.00	.00	.00	.00	.00
S3	2.000	.53	.67	.59	.43	.37	.25	.16	.11	.00
	1.000	.43	.48	.47	.41	.38	.28	.20	.09	.01
	0.800	.39	.42	.37	.36	.34	.20	.16	.05	.01
	0.500	.18	.22	.15	.15	.12	.04	.02	.01	.00
	0.250	.04	.03	.02	.03	.02	.02	.00	.00	.00
S4	2.000	.47	.54	.47	.34	.27	.15	.15	.08	.03
	1.000	.31	.35	.32	.17	.25	.16	.09	.08	.01
	0.800	.14	.17	.10	.10	.13	.07	.03	.02	.00
	0.500	.12	.14	.09	.06	.05	.04	.01	.02	.07
	0.250	.01	.00	.01	.01	.01	.00	.00	.00	.00

Table 5 (continued)

Response rates in Component 2 of Experiment II

S	I	$p(S^R)$								
		(0,1)	(.125,1)	(.25,1)	(.5,1)	(1,1)	(1,.5)	(1,.25)	(1,.125)	(1,0)
S5	2.000	.57	.56	.45	.36	.22	.14	.07	.04	.00
	1.000	.36	.38	.35	.28	.23	.07	.05	.04	.02
	0.800	.24	.29	.28	.22	.11	.03	.02	.01	.00
	0.500	.13	.19	.18	.11	.09	.03	.01	.01	.01
	0.250	.07	.05	.03	.04	.03	.01	.01	.01	.01
GROUP										
2.000	$\bar{X}=$	.51	.59	.50	.37	.30	.16	.08	.05	.01
	$S^D=$	.07	.09	.06	.04	.06	.06	.07	.05	.01
1.000	$\bar{X}=$	.31	.24	.31	.24	.23	.13	.07	.05	.01
	$S^D=$	.08	.11	.11	.11	.10	.10	.08	.04	.01
0.800	$\bar{X}=$	.24	.28	.21	.19	.15	.07	.05	.02	.00
	$S^D=$	.10	.10	.11	.11	.11	.08	.06	.02	.00
0.500	$\bar{X}=$	.11	.14	.10	.08	.06	.03	.01	.01	.00
	$S^D=$	.07	.09	.07	.06	.05	.02	.01	.01	.00
0.250	$\bar{X}=$	.03	.02	.01	.02	.01	.01	.00	.00	.00
	$S^D=$	.03	.02	.01	.02	.01	.01	.00	.01	.00

Table 6

Response rates in Component 2 of Experiment I

Shock intensities are in milliamperes. Response rates are in responses per second. Response rate values in parentheses are recovery values at $p(S^R)=(0,1)$. Subject numbers are shown in the left-most column.

S	I	$p(S^R)$				
		(0,1)	(.125,.5)	(.25,.25)	(.5,.125)	(1,0)
S1	2.000	.40 (.35)	.33	.20	.15	.01
	1.000	.22 (.28)	.20	.15	.06	.01
	0.500	.21 (.27)	.04	.00	.02	.00
	0.250	.01 (.00)	.00	.00	.00	.00
	0.125	.00 (.00)	.00	.00	.01	.00
S2	2.000	.46 (.54)	.42	.40	.21	.03
	1.000	.57 (.64)	.43	.23	.08	.01
	0.500	.38 (.42)	.17	.17	.11	.05
	0.250	.15 (.03)	.06	.02	.01	.00
	0.125	.00 (.00)	.00	.00	.00	.00

Table 6 (continued)

Response rates in Component 2 of Experiment I

S	I	$p(S^R)$				
		(0,1)	(.125,.5)	(.25,.25)	(.5,.125)	(1,0)
S3	2.000	.34 (.43)	.35	.27	.18	.08
	1.000	.29 (.47)	.23	.17	.08	.02
	0.500	.15 (.23)	.09	.06	.05	.03
	0.250	.04 (.04)	.02	.01	.01	.01
	0.125	.01 (.00)	.00	.00	.00	.01
S4	2.000	.48 (.38)	.41	.22	.15	.05
	1.000	.27 (.40)	.19	.13	.06	.00
	0.500	.05 (.00)	.03	.02	.02	.00
	0.250	.02 (.00)	.03	.01	.01	.01
	0.125	.00 (.00)	.01	.01	.00	.00

Table 6 (continued)

Response rates in Component 2 of Experiment I

		p(S ^R)					
S	I	(0,1)	(.125,.5)	(.25,.25)	(.5,.125)	(1,0)	
GROUP	2.000	$\bar{X}=$	.43	.37	.24	.15	.04
		S ^D =	.06	.04	.10	.06	.03
	1.000	$\bar{X}=$	.33	.24	.17	.07	.01
		S ^D =	.14	.10	.04	.01	.01
	0.500	$\bar{X}=$	.21	.10	.09	.05	.02
		S ^D =	.12	.07	.08	.04	.02
	0.250	$\bar{X}=$	.07	.03	.02	.01	.01
		S ^D =	.06	.03	.02	.01	.01
	0.125	$\bar{X}=$	.01	.00	.00	.00	.00
		S ^D =	.01	.00	.00	.00	.00

Table 7

Proportion of T_R cycles sampled in Component 2 of Experiment II

Shock intensities are in milliamperes. Subject numbers are shown in the left-most column. Shock probability values in parentheses represent values for R and $\bar{R}$, respectively.

S	I	$p(S^R)$								
		(0,1)	(.125,1)	(.25,1)	(.5,1)	(1,1)	(1,.5)	(1,.25)	(1,.125)	(1,0)
S1	2.000	.80	.78	.71	.52	.42	.11	.02	.01	.00
	1.000	.73	.62	.45	.36	.24	.03	.01	.00	.00
	0.800	.61	.46	.25	.31	.19	.01	.00	.01	.00
	0.500	.01	.00	.00	.00	.00	.00	.00	.00	.00
	0.250	.00	.00	.00	.00	.01	.00	.01	.00	.00
S2	2.000	.88	.90	.81	.66	.47	.24	.03	.01	.00
	1.000	.53	.47	.43	.32	.31	.18	.02	.01	.00
	0.800	.49	.45	.43	.26	.15	.07	.06	.05	.00
	0.500	.36	.38	.28	.23	.13	.06	.03	.00	.00
	0.250	.04	.01	.01	.01	.00	.00	.01	.00	.00
S3	2.000	.84	.91	.86	.71	.62	.35	.28	.11	.00
	1.000	.76	.73	.69	.66	.57	.43	.32	.11	.01
	0.800	.74	.70	.69	.57	.50	.34	.22	.06	.01
	0.500	.53	.48	.37	.34	.29	.12	.04	.03	.00
	0.250	.09	.06	.05	.03	.02	.01	.00	.00	.00
S4	2.000	.78	.74	.67	.61	.52	.30	.18	.09	.07
	1.000	.59	.47	.46	.38	.36	.23	.13	.10	.12
	0.800	.45	.41	.31	.26	.24	.15	.08	.05	.01
	0.500	.39	.28	.20	.22	.18	.13	.04	.07	.02
	0.250	.05	.01	.02	.02	.03	.01	.01	.01	.01

Table 7 (continued)

Proportion of T_R cycles sampled in Component 2 of Experiment II

S	I	$p(S^R)$								
		(0,1)	(.125,1)	(.25,1)	(.5,1)	(1,1)	(1,.5)	(1,.25)	(1,.125)	(1,0)
S5	2.000	.83	.80	.68	.53	.46	.30	.13	.09	.01
	1.000	.69	.67	.66	.52	.46	.18	.11	.11	.04
	0.800	.51	.56	.56	.41	.26	.08	.04	.02	.01
	0.500	.48	.47	.41	.31	.28	.10	.03	.02	.01
	0.250	.20	.12	.11	.10	.08	.04	.03	.03	.03
GROUP										
2.000	$\bar{X}=$	.83	.83	.74	.61	.50	.26	.11	.06	.02
	$SD=$	.04	.07	.08	.08	.08	.09	.08	.05	.03
1.000	$\bar{X}=$	.66	.59	.54	.45	.39	.21	.12	.07	.02
	$SD=$	.10	.12	.13	.14	.13	.14	.13	.06	.02
0.800	$\bar{X}=$	.56	.52	.45	.36	.27	.13	.08	.04	.01
	$SD=$	.11	.12	.18	.13	.14	.13	.09	.02	.01
0.500	$\bar{X}=$	.35	.32	.25	.22	.18	.08	.03	.03	.01
	$SD=$	.20	.20	.16	.13	.12	.05	.02	.03	.01
0.250	$\bar{X}=$	.08	.04	.04	.03	.03	.01	.01	.01	.01
	$SD=$	.07	.05	.04	.04	.03	.02	.01	.01	.01

Table 8

Proportion of T_R cycles sampled in Component 2 of Experiment I

Shock intensities are in milliamperes. Subject numbers are shown in the left-most column. Shock probability values in parentheses represent values of R and $\bar{R}$, respectively.

S	I	$p(S^R)$				
		(0,1)	(.125,.5)	(.25,.25)	(.5,.125)	(1,0)
S1	2.000	.78	.61	.37	.23	.02
	1.000	.54	.42	.29	.09	.01
	0.500	.52	.12	.01	.04	.01
	0.250	.02	.00	.01	.00	.00
	0.125	.01	.01	.01	.02	.01
S2	2.000	.84	.73	.58	.27	.02
	1.000	.77	.67	.30	.13	.02
	0.500	.63	.36	.30	.22	.08
	0.250	.40	.16	.07	.03	.01
	0.125	.01	.02	.00	.00	.01
S3	2.000	.93	.79	.47	.31	.10
	1.000	.60	.47	.32	.18	.04
	0.500	.41	.22	.18	.13	.06
	0.250	.11	.06	.04	.03	.02
	0.125	.02	.02	.01	.01	.02
S4	2.000	.80	.66	.40	.25	.05
	1.000	.64	.44	.31	.12	.01
	0.500	.17	.12	.07	.08	.01
	0.250	.08	.09	.02	.04	.02
	0.125	.01	.02	.02	.00	.00

Table 8 (continued)

Proportion of T_R cycles sampled in Component 2 of Experiment I

S	I	$p(S^R)$				
		(0,1)	(.125,.5)	(.25,.25)	(.5,.125)	(1,0)
S5	2.000	.86	.66	.28	.12	.01
	1.000	.68	.47	.34	.16	.04
	0.500	.65	.49	.40	.16	.04
	0.250	.34	.18	.16	.04	.05
	0.125	.13	.01	.02	.02	.01
GROUP						
2.000	$\bar{X}=$	.84	.69	.42	.24	.04
	$S_D=$	.06	.07	.11	.07	.04
1.000	$\bar{X}=$	.65	.49	.31	.14	.03
	$S_D=$	.09	.10	.02	.00	.00
0.500	$\bar{X}=$	.47	.26	.19	.13	.04
	$S_D=$	.19	.16	.16	.07	.03
0.250	$\bar{X}=$	.19	.10	.06	.03	.02
	$S_D=$	.02	.01	.01	.01	.01
0.125	$\bar{X}=$	.02	.01	.01	.01	.01
	$S_D=$	.02	.01	.01	.01	.01

Table 9

Proportion of shocks received in Component 2 of Experiment II

Shock intensities are in milliamperes. Subject numbers are in the left-most column. Shock probabilities in parentheses represent values of R and $\bar{R}$, respectively. The proportion of shocks received (S^R max) for $R + \bar{R}$, R and $\bar{R}$ are shown at each pair of shock probability values.

			p(S ^R)								
S	I		(0,1)	(.125,1)	(.25,1)	(.5,1)	(1,1)	(1,.5)	(1,.25)	(1,.125)	(1,0)
S1	2.000	R+ ~~R~~	.20	.34	.48	.74	.99	.58	.26	.13	.00
		R	*	.94	.76	.53	.42	.01	.02	.01	.00
		~~R~~	.20	.22	.29	.47	.58	.94	.92	1.00	*
	1.000	R+ ~~R~~	.27	.45	.65	.82	1.00	.52	.26	.14	.00
		R	*	.61	.45	.36	.24	.03	.01	.00	.00
		~~R~~	.27	.38	.54	.64	.76	.97	.99	1.00	*
	0.800	R+ ~~R~~	.38	.60	.81	.84	1.00	.51	.25	.12	.00
		R	*	.52	.27	.32	.19	.01	.00	.01	.00
		~~R~~	.38	.54	.74	.68	.81	.99	.99	.92	*
	0.500	R+ ~~R~~	.99	1.00	1.00	1.00	1.00	1.00	.24	.11	.00
		R	*	.00	.00	.00	.00	.00	.00	.00	.00
		~~R~~	.99	1.00	1.00	1.00	1.00	1.00	.95	.91	*
0.250	R+ ~~R~~	1.00	1.00	1.00	1.00	1.00	.49	.25	.12	.01	
	R	*	.00	.00	.00	.00	.00	.01	.00	.00	
	~~R~~	1.00	1.00	1.00	1.00	.99	.98	.96	.92	*	
S2	2.000	R+ ~~R~~	.12	.21	.39	.67	1.00	.64	.26	.12	.00
		R	*	.87	.81	.68	.47	.24	.03	.01	.00
		~~R~~	.11	.10	.19	.33	.53	.80	.91	.88	*
	1.000	R+ ~~R~~	.46	.58	.68	.84	.99	.59	.26	.13	.00
		R	*	.43	.45	.31	.31	.18	.02	.01	.00
		~~R~~	.46	.52	.57	.68	.68	.82	.96	1.00	*

Table 9 (continued)

Proportion of shocks received in Component 2 of Experiment II

S	I		p(S ^R)								
			(0,1)	(.125,1)	(.25,1)	(.5,1)	(1,1)	(1,.5)	(1,.25)	(1,.125)	(1,0)
S2	0.800	R+ ~~R~~	.51	.60	.68	.87	1.00	.54	.29	.16	.00
		R	*	.44	.43	.26	.15	.07	.06	.05	.00
		~~R~~	.51	.55	.57	.74	.85	.94	.93	.93	*
	0.500	R+ ~~R~~	.64	.66	.79	.88	1.00	.54	.24	.14	.00
		R	*	.37	.28	.23	.13	.06	.03	.00	.00
		~~R~~	.64	.62	.72	.76	.87	.96	.84	1.00	*
	0.250	R+ ~~R~~	.96	.99	.99	1.00	1.00	.50	.26	.11	.00
		R	*	.00	.00	.00	.00	.01	.00	.00	.00
		~~R~~	.96	.99	.99	.99	1.00	1.00	.99	.90	*
S3	2.000	R+ ~~R~~	.16	.20	.36	.67	1.00	.68	.41	.22	.00
		R	*	.92	.87	.78	.62	.35	.20	.11	.00
		~~R~~	.16	.09	.14	.28	.38	.67	.81	.91	*
	1.000	R+ ~~R~~	.24	.36	.48	.66	.99	.71	.49	.20	.01
		R	*	.71	.69	.66	.57	.43	.32	.11	.01
		~~R~~	.24	.27	.30	.33	.43	.56	.67	.76	*
	0.800	R+ ~~R~~	.25	.39	.47	.71	1.00	.67	.42	.18	.01
		R	*	.69	.68	.58	.50	.34	.22	.06	.01
		~~R~~	.25	.30	.30	.43	.50	.65	.79	.92	*
	0.500	R+ ~~R~~	.47	.56	.72	.84	1.00	.56	.28	.16	.00
		R	*	.38	.37	.35	.29	.12	.04	.03	.00
		~~R~~	.47	.52	.63	.66	.71	.88	.95	1.00	*
	0.250	R+ ~~R~~	.91	.95	.97	.99	1.00	.49	.25	.12	.00
		R	*	.07	.07	.04	.02	.01	.00	.00	.00
		~~R~~	.91	.94	.97	.97	.98	.98	.99	.92	*

Table 9 (continued)

Proportion of shocks received in Component 2 of Experiment II

S	I		$p(S^R)$								
			(0,1)	(.125,1)	(.25,1)	(.5,1)	(1,1)	(1,.5)	(1,.25)	(1,.125)	(1,0)
S4	2.000	R+ ~~R~~	.20	.34	.48	.69	1.00	.65	.37	.20	.07
		R	*	.78	.69	.62	.52	.30	.18	.09	.07
		~~R~~	.20	.24	.31	.38	.48	.69	.76	.85	*
	1.000	R+ ~~R~~	.41	.58	.65	.82	1.00	.62	.34	.23	.02
		R	*	.46	.47	.40	.36	.23	.13	.10	.02
		~~R~~	.40	.53	.53	.61	.64	.77	.85	.97	*
	0.800	R+ ~~R~~	.54	.64	.76	.87	1.00	.58	.32	.17	.01
		R	*	.43	.31	.26	.24	.15	.08	.05	.01
		~~R~~	.54	.58	.68	.74	.76	.86	.94	.94	*
	0.500	R+ ~~R~~	.61	.76	.85	.89	1.00	.57	.29	.18	.02
		R	*	.32	.21	.23	.18	.13	.04	.07	.02
		~~R~~	.61	.72	.79	.78	.82	.89	1.00	.85	*
S5	2.000	R+ ~~R~~	.95	.97	.99	1.00	1.00	.50	.24	.13	.01
		R	*	.01	.03	.02	.03	.01	.01	.01	.01
		~~R~~	.95	.97	.98	.98	.97	.98	.93	.98	*
	1.000	R+ ~~R~~	.12	.29	.50	.74	.99	.63	.33	.20	.00
		R	*	.76	.75	.56	.46	.30	.13	.09	.00
		~~R~~	.12	.19	.31	.46	.54	.66	.77	.89	*
	0.800	R+ ~~R~~	.29	.40	.49	.74	1.00	.58	.33	.21	.04
		R	*	.67	.65	.52	.46	.18	.11	.11	.04
		~~R~~	.25	.32	.33	.47	.54	.80	.89	.82	*
	0.500	R+ ~~R~~	.48	.49	.58	.82	1.00	.53	.27	.12	.01
		R	*	.48	.56	.46	.26	.08	.04	.02	.01
		~~R~~	.48	.43	.43	.58	.74	.89	.92	.85	*

Table 9 (continued)

Proportion of shocks received in Component 2 of Experiment II

			p(S ^R)								
S	I		(0,1)	(.125,1)	(.25,1)	(.5,1)	(1,1)	(1,.5)	(1,.25)	(1,.125)	(1,0)
S5	0.500	R+ ~~X~~	.52	.58	.69	.84	1.00	.57	.25	.16	.01
		R	*	.47	.40	.31	.28	.10	.03	.02	.01
	0.250	~~X~~	.52	.52	.59	.68	.72	.95	.88	1.00	*
		R+ ~~X~~	.80	.89	.93	.96	1.00	.53	.28	.15	.03
		R	*	.09	.13	.20	.08	.04	.03	.03	.03
		~~X~~	.80	.88	.89	.90	.92	.99	.97	.93	*
GROUP											
2.000	R+ ~~X~~										
	~~X~~ =	.17	.28	.44	.70	1.00	.64	.32	.18	.02	
	S ~~D~~ =	.03	.07	.06	.04	.00	.04	.07	.04	.03	
	R										
	~~X~~ =	*	.86	.78	.64	.50	.24	.11	.06	.02	
	S ~~D~~ =	*	.08	.07	.10	.08	.13	.08	.05	.03	
	~~X~~										
	~~X~~ =	.17	.17	.25	.39	.50	.75	.84	.91	*	
	S ~~D~~ =	.03	.07	.08	.08	.08	.12	.08	.05	*	
	1.000	R+ ~~X~~									
		~~X~~ =	.33	.47	.59	.77	1.00	.60	.34	.18	.02
		S ~~D~~ =	.09	.10	.10	.08	.00	.07	.10	.04	.02
R											
~~X~~ =		*	.58	.54	.45	.39	.21	.12	.07	.02	
S ~~D~~ =		*	.13	.12	.14	.13	.14	.13	.06	.02	
~~X~~											
~~X~~ =		.33	.40	.46	.55	.61	.78	.87	.93	*	
S ~~D~~ =	.09	.12	.13	.15	.13	.15	.13	.11	*		

Table 9 (continued)

Proportion of shocks received in Component 2 of Experiment II

		p(S ^R)										
S	I	(0,1)	(.125,1)	(.25,1)	(.5,1)	(1,1)	(1,.5)	(1,.25)	(1,.125)	(1,0)		
0.800	R+ ~~X~~	~~X~~ =	.43	.54	.66	.82	1.00	.57	.31	.15	.01	
		S ~~D~~ =	.12	.11	.14	.07	.00	.06	.07	.03	.01	
		~~R~~										
		~~X~~ =	*	.51	.45	.38	.27	.15	.08	.04	.01	
		S ~~D~~ =	*	.11	.17	.14	.14	.13	.09	.02	.01	
		~~X~~										
	0.500	~~X~~ =	.43	.48	.55	.63	.73	.87	.91	.92	*	
		S ~~D~~ =	.12	.12	.18	.13	.14	.13	.08	.04	*	
		R+ ~~X~~	~~X~~ =	.65	.71	.81	.89	1.00	.65	.26	.15	.01
			S ~~D~~ =	.20	.18	.12	.07	.00	.20	.03	.02	.01
			~~R~~									
			~~X~~ =	*	.31	.25	.23	.18	.08	.03	.03	.01
S ~~D~~ =	*		.18	.16	.14	.12	.05	.02	.03	.01		
~~X~~												
0.250	R+ ~~X~~	~~X~~ =	.65	.68	.75	.78	.82	.94	.93	.03	*	
		S ~~D~~ =	.20	.20	.17	.13	.12	.05	.07	.07	*	
		~~X~~										
		~~X~~ =	.92	.96	.97	.99	1.00	.50	.26	.13	.01	
		S ~~D~~ =	.08	.04	.03	.02	.00	.02	.01	.01	.01	
		~~R~~										
	0.250	~~X~~ =	*	.03	.05	.05	.03	.01	.01	.01	.01	
		S ~~D~~ =	*	.04	.06	.08	.03	.02	.01	.01	.01	
		~~X~~										
		~~X~~ =	.92	.96	.97	.97	.97	.98	.97	.93	*	
		S ~~D~~ =	.08	.05	.04	.04	.04	.03	.01	.03	*	
		~~X~~										

Table 10

Proportion of shocks received in Component 2 of Experiment I

Shock intensities are in milliamperes. Subject numbers are in the left-most column. Shock probabilities in parentheses represent values of R and $\bar{R}$, respectively. The proportion of shocks received (S^R max) for $R + \bar{R}$, R and $\bar{R}$ are shown at each pair of shock probability values.

S	I		$p(S^R)$				
			(0,1)	(.125,.5)	(.25,.25)	(.5,.125)	(1,0)
S1	2.000	$R+\bar{R}$	.22	.54	1.00	.54	.02
		R	*	.71	.41	.24	.02
		$\bar{R}$	.22	.36	.59	1.00	*
	1.000	$R+\bar{R}$	.45	.70	1.00	.30	.02
		R	*	.48	.37	.11	.02
		$\bar{R}$	.45	.58	.74	.78	*
	0.500	$R+\bar{R}$	.47	.84	1.00	.29	.01
		R	*	.12	.01	.05	.01
		$\bar{R}$	.47	.81	1.00	.97	*
	0.250	$R+\bar{R}$	.99	.97	1.00	.25	.00
		R	*	.00	.00	.00	.00
		$\bar{R}$	.99	1.00	1.00	1.00	*
S2	2.000	$R+\bar{R}$	.99	1.00	1.00	.32	.00
		R	*	.02	.01	.02	.01
		$\bar{R}$	.99	1.00	1.00	1.00	*
	1.000	$R+\bar{R}$	.15	.43	1.00	.45	.02
		R	*	.75	.60	.28	.02
		$\bar{R}$	.15	.24	.43	.69	*
	0.500	$R+\bar{R}$	.23	.54	1.00	.31	.02
		R	*	.75	.36	.12	.02
		$\bar{R}$	.23	.36	.75	.76	*

Table 10 (continued)

Proportion of shocks received in Component 2 of Experiment I

S	I		$p(S^R)$				
			(0,1)	(.125,.5)	(.25,.25)	(.5,.125)	(1,0)
S2	0.500	R+ ~~R~~	.37	.67	.97	.39	.09
		R	*	.38	.32	.19	.09
		~~R~~	.37	.58	.65	.78	*
	0.250	R+ ~~R~~	.59	.89	1.00	.25	.01
		R	*	.16	.09	.02	.01
		~~R~~	.59	.85	.97	.91	*
	0.125	R+ ~~R~~	.99	.96	.95	.27	.01
		R	*	.01	.00	.00	.01
		~~R~~	.99	.96	.95	1.00	*
S3	2.000	R+ ~~R~~	.07	.46	1.00	.48	.10
		R	*	.97	.55	.31	.10
		~~R~~	.07	.21	.51	.66	*
	1.000	R+ ~~R~~	.39	.62	1.00	.36	.04
		R	*	.57	.38	.16	.04
		~~R~~	.39	.48	.63	.80	*
	0.500	R+ ~~R~~	.58	.78	1.00	.36	.06
		R	*	.22	.18	.14	.06
		~~R~~	.58	.73	.84	.86	*
	0.250	R+ ~~R~~	.89	.97	.97	.24	.02
		R	*	.05	.06	.03	.02
		~~R~~	.89	.96	.91	.84	*
	0.125	R+ ~~R~~	.98	.92	1.00	.22	.02
		R	*	.02	.01	.00	.02
		~~R~~	.98	.92	1.00	.87	*

Table 10 (continued)

Proportion of shocks received in Component 2 of Experiment I

S	I		$p(S^R)$				
			(0,1)	(.125,.5)	(.25,.25)	(.5,.125)	(1,0)
S4	2.000	R+ ~~R~~	.20	.50	1.00	.38	.05
		R	*	.63	.46	.24	.05
		~~R~~	.20	.35	.65	.60	*
	1.000	R+ ~~R~~	.33	.68	1.00	.31	.01
		R	*	.44	.38	.12	.01
		~~R~~	.33	.57	.68	.76	*
	0.500	R+ ~~R~~	.83	.85	.98	.28	.01
		R	*	.13	.05	.07	.01
		~~R~~	.83	.81	.93	.85	*
	0.250	R+ ~~R~~	.92	.98	1.00	.23	.02
		R	*	.12	.03	.03	.02
		~~R~~	.92	.95	1.00	.78	*
	0.125	R+ ~~R~~	.99	.96	1.00	.26	.00
		R	*	.02	.01	.00	.00
		~~R~~	.99	.96	1.00	1.00	*
S5	2.000	R+ ~~R~~	.15	.51	.97	.32	.01
		R	*	.71	.32	.12	.01
		~~R~~	.15	.34	.66	.83	*
	1.000	R+ ~~R~~	.31	.66	.96	.38	.04
		R	*	.50	.34	.18	.04
		~~R~~	.31	.54	.62	.81	*
	0.500	R+ ~~R~~	.35	.58	1.00	.35	.42
		R	*	.54	.44	.14	.04
		~~R~~	.35	.44	.65	.82	*
	0.250	R+ ~~R~~	.65	.89	1.00	.27	.05
		R	*	.18	.17	.04	.05
		~~R~~	.65	.84	.86	.91	*

Table 10 (continued)

Proportion of shocks received in Component 2 of Experiment I

			p(S ^R)					
S	I		(0,1)	(.125,.5)	(.25,.25)	(.5,.125)	(1,0)	
S5	0.125	R+ ~~R~~	.94	1.00	1.00	.23	.01	
		~~R~~	*	.02	.00	.02	.01	
		~~R~~	.94	1.00	1.00	.85	*	
GROUP								
2.000	R+ ~~R~~	~~X~~ =	.16	.49	1.00	.43	.04	
		S ~~D~~ =	.06	.04	.01	.08	.04	
		~~R~~						
		~~X~~ =	*	.75	.47	.24	.04	
		S ~~D~~ =	*	.13	.11	.07	.04	
		~~R~~						
	1.000	~~X~~ =	.16	.30	.57	.79	*	
		S ~~D~~ =	.06	.07	.10	.16	*	
		R+ ~~R~~	~~X~~ =	.34	.64	1.00	.33	.03
			S ~~D~~ =	.09	.06	.02	.04	.02
			~~R~~					
			~~X~~ =	*	.54	.37	.14	.03
S ~~D~~ =	*		.12	.02	.03	.01		
~~R~~								
0.500	~~X~~ =	.34	.51	.68	.78	*		
	S ~~D~~ =	.09	.09	.06	.02	*		
	R+ ~~R~~	~~X~~ =	.52	.75	1.00	.33	.04	
		S ~~D~~ =	.20	.12	.02	.05	.04	

Table 10 (continued)

Proportion of shocks received in Component 2 of Experiment I

S	I	p(S ^R)					
		(0,1)	(.125,.5)	(.25,.25)	(.5,.125)	(1,0)	
GROUP							
0.250	R+	$\bar{X} =$	*	.28	.20	.12	.04
		SD=	*	.18	.18	.06	.03
		$\bar{X} =$	.52	.68	.83	.86	*
		SD=	.20	.16	.07	.07	*
		$\bar{X} =$	.81	.94	1.00	.25	.02
		SD=	.18	.05	.01	.02	.02
		$\bar{X} =$	*	.07	.07	.03	.02
		SD=	*	.08	.07	.01	.02
		$\bar{X} =$	.81	.91	.96	.89	*
		SD=	.18	.06	.06	.08	*
		$\bar{X} =$	.98	.97	1.00	.26	.01
		SD=	.02	.03	.02	.04	.01
0.125	R	$\bar{X} =$	*	.02	.01	.01	.01
		SD=	*	.00	.01	.01	.01
		$\bar{X} =$	.98	.97	1.00	1.00	*
		SD=	.02	.03	.02	.08	*

Table 11

Total shocks received in Component 2 of Experiment II

Shock intensities are in milliamperes. Subject numbers are in the left-most column. Shock probabilities in parentheses represent values of R and $\bar{R}$, respectively. Total shocks received (Total SR) for R + $\bar{R}$, R and $\bar{R}$ are shown at each pair of shock probability values.

			p(S ^R)								
S	I		(0,1)	(.125,1)	(.25,1)	(.5,1)	(1,1)	(1,.5)	(1,.25)	(1,.125)	(1,0)
S1	2.000	R+ ~~R~~	177	302	430	665	894	522	230	120	2
		R	*	106	171	240	376	99	22	8	2
		~~R~~	177	196	259	425	518	423	208	112	*
	1.000	R+ ~~R~~	240	409	589	739	896	464	233	124	2
		R	*	69	101	161	214	29	10	3	2
		~~R~~	240	340	488	578	682	435	223	121	*
	0.800	R+ ~~R~~	342	543	726	754	900	449	229	110	2
		R	*	58	61	142	172	13	4	6	2
		~~R~~	342	485	665	612	728	446	223	104	*
	0.500	R+ ~~R~~	892	900	898	899	900	450	214	102	2
		R	*	0	0	2	0	0	0	0	2
		~~R~~	892	900	898	897	900	450	214	102	*
	0.250	R+ ~~R~~	896	898	897	898	900	442	224	104	2
		R	*	0	1	2	5	2	7	0	2
		~~R~~	897	898	896	896	895	440	217	104	*
S2	2.000	R+ ~~R~~	106	190	350	606	896	575	230	112	4
		R	*	98	183	307	423	217	25	13	4
		~~R~~	106	92	167	299	473	358	205	99	*
	1.000	R+ ~~R~~	413	519	610	753	894	531	231	118	2
		R	*	48	101	139	282	161	16	6	2
		~~R~~	413	471	509	614	612	370	215	112	*

Table 11 (continued)

Total shocks received in Component 2 of Experiment II

			p(S ^R)								
S	I		(0,1)	(.125,1)	(.25,1)	(.5,1)	(1,1)	(1,.5)	(1,.25)	(1,.125)	(1,0)
S2	0.800	R+ ~~R~~	455	544	610	782	900	485	262	149	4
		~~R~~	*	50	96	117	137	63	53	44	4
		~~R~~	455	494	514	665	763	422	209	105	*
	0.500	R+ ~~R~~	576	598	710	788	899	484	213	128	2
		~~R~~	*	42	62	104	117	54	25	4	2
		~~R~~	576	556	648	684	782	430	188	124	*
	0.250	R+ ~~R~~	576	598	710	788	899	484	213	128	2
		~~R~~	*	0	1	2	2	3	7	1	1
		~~R~~	866	889	892	895	898	448	223	101	*
S3	2.000	R+ ~~R~~	141	183	324	605	900	611	365	201	3
		~~R~~	*	104	195	353	557	311	182	99	3
		~~R~~	141	79	129	252	343	300	183	102	*
	1.000	R+ ~~R~~	214	322	429	592	895	637	441	184	7
		~~R~~	*	80	156	298	512	384	290	98	7
		~~R~~	214	242	273	294	383	253	151	86	*
	0.800	R+ ~~R~~	226	347	427	642	896	604	232	159	7
		~~R~~	*	78	153	259	447	310	202	55	7
		~~R~~	226	269	274	383	449	294	177	104	*
	0.500	R+ ~~R~~	426	508	647	752	897	500	249	143	3
		~~R~~	*	78	153	259	447	310	202	55	7
		~~R~~	426	465	564	593	638	394	214	115	*
	0.250	R+ ~~R~~	818	853	869	892	899	445	225	108	3
		~~R~~	*	8	16	16	17	6	3	4	3
		~~R~~	818	845	853	876	882	439	222	104	*

Table 11

Total shocks received in Component 2 of Experiment II

S	I		p(S ^R)								
			(0,1)	(.125,1)	(.25,1)	(.5,1)	(1,1)	(1,.5)	(1,.25)	(1,.125)	(1,0)
S4	2.000	R+ ~~X~~	183	303	436	620	897	581	333	180	64
		R	*	88	155	280	469	271	162	84	64
		~~X~~	183	215	281	340	428	310	171	96	*
	1.000	R+ ~~X~~	363	524	587	734	900	554	305	203	22
		R	*	52	106	181	324	209	113	94	22
		~~X~~	363	472	481	553	576	345	192	109	*
	0.800	R+ ~~X~~	490	573	685	783	900	526	285	149	8
		R	*	48	70	117	217	137	74	43	8
		~~X~~	490	525	615	666	683	389	211	106	*
	0.500	R+ ~~X~~	549	682	709	804	847	514	265	159	16
		R	*	36	47	104	164	114	38	63	16
		~~X~~	549	646	662	700	734	400	227	96	*
S5	2.000	R+ ~~X~~	853	872	888	892	900	449	219	115	5
		R	*	1	6	11	23	9	10	5	5
		~~X~~	853	871	882	881	877	440	209	110	*
	1.000	R+ ~~X~~	149	259	452	670	894	569	295	179	1
		R	*	86	169	252	410	273	121	79	1
		~~X~~	149	173	283	418	484	296	174	100	*
	0.800	R+ ~~X~~	265	361	442	662	897	521	299	190	39
		R	*	75	147	235	413	160	99	98	39
		~~X~~	265	286	295	427	484	361	200	92	*
	0.500	R+ ~~X~~	434	510	519	734	896	476	239	112	13
		R	*	54	125	209	234	75	33	16	13
		~~X~~	434	385	394	525	662	401	206	96	*
S5	2.000	R+ ~~X~~	464	558	617	755	899	517	222	140	13
		R	*	53	89	141	254	90	25	18	13
		~~X~~	464	469	528	614	645	427	197	122	*

Table 11

Total shocks received in Component 2 of Experiment II

			p(S ^R)								
S	I		(0,1)	(.125,1)	(.25,1)	(.5,1)	(1,1)	(1,.5)	(1,.25)	(1,.125)	(1,0)
S5	0.250	R+ $\bar{X}$	722	805	833	864	900	478	248	133	25
		R	*	10	30	55	70	34	29	28	25
		$\bar{X}$	722	795	803	809	830	444	219	105	*
GROUP											
2.000	1.000	R+ $\bar{X}$									
		$\bar{X}$ =	151	247	398	633	896	572	291	158	15
		SD=	31	58	57	32	2	32	61	40	28
		R									
		$\bar{X}$ =	*	96	175	286	447	234	102	57	15
		SD=	*	9	15	45	70	83	75	43	27
	0.800	$\bar{X}$									
		$\bar{X}$ =	151	151	224	347	449	337	188	102	*
		SD=	31	62	71	75	67	54	17	6	*
		R+ $\bar{X}$									
		$\bar{X}$ =	299	427	531	696	896	541	301	164	14
		SD=	85	92	88	68	2	63	85	40	16
1.000	0.600	R									
		$\bar{X}$ =	*	65	122	203	349	189	106	60	14
		SD=	*	14	27	64	116	128	113	50	16
		$\bar{X}$									
		$\bar{X}$ =	299	362	409	493	547	353	196	108	*
		SD=	85	106	115	132	113	65	28	14	*
	0.400	R+ $\bar{X}$									
		$\bar{X}$ =	389	503	593	739	898	510	249	136	7
		SD=	106	90	122	58	2	58	24	23	4
		R									
		$\bar{X}$ =	*	58	101	169	241	120	73	33	7
		SD=	*	12	38	65	121	115	77	21	4

Table 11 (continued)

Total shocks received in Component 2 of Experiment II

		p(S ^R)									
S	I	(0,1)	(.125,1)	(.25,1)	(.5,1)	(1,1)	(1,.5)	(1,.25)	(1,.125)	(1,0)	
GROUP	0.800	$\bar{X}$									
		$\bar{X}=$	389	432	492	570	657	390	205	103	*
	0.500	$SD=$	106	105	160	119	123	58	17	4	*
		$R+\bar{X}$									
		$\bar{X}=$	581	649	716	800	888	493	233	134	7
		$SD=$	184	154	109	60	23	27	23	21	7
		$\bar{R}$									
		$\bar{X}=$	*	35	56	102	159	73	25	23	7
		$SD=$	*	20	36	61	107	47	15	25	7
		$\bar{X}$									
	0.250	$\bar{X}=$	581	607	660	698	740	420	208	112	*
		$SD=$	184	180	144	120	108	23	15	12	*
		$R+\bar{X}$									
		$\bar{X}=$	831	863	876	889	900	453	229	112	7
		$SD=$	67	37	26	14	0	14	11	13	10
		$\bar{R}$									
		$\bar{X}=$	*	4	11	17	23	11	11	8	7
		$SD=$	*	5	12	22	27	13	10	12	10
		$\bar{X}$									
		$\bar{X}=$	381	860	865	871	876	442	218	104	*
		$SD=$	67	41	39	36	27	4	6	3	*

Table 12

Total shocks received in Component 2 of Experiment I

Shock intensities are in milliamperes. Subject numbers are in the left-most column. Shock probabilities in parentheses represent values of R and $\bar{R}$, respectively. Total shocks received (Total S^R) for $R + \bar{R}$, R and $\bar{R}$ are shown at each pair of shock probability values.

S	I		$p(S^R)$				
			(0,1)	(.125,.5)	(.25,.25)	(.5,.125)	(1,0)
S1	2.000	$R+\bar{R}$	201	241	225	241	14
		R	*	80	93	110	14
		$\bar{R}$	201	161	132	131	*
	1.000	$R+\bar{R}$	408	316	251	136	16
		R	*	54	84	48	16
		$\bar{R}$	408	262	167	88	*
	0.500	$R+\bar{R}$	425	379	248	132	6
		R	*	13	3	23	6
		$\bar{R}$	425	366	245	109	*
	0.250	$R+\bar{R}$	893	450	238	146	10
		R	*	0	0	0	0
		$\bar{R}$	893	435	234	113	*
	0.125	$R+\bar{R}$	888	450	238	146	10
		R	*	2	2	10	10
		$\bar{R}$	888	448	236	136	*
S2	2.000	$R+\bar{R}$	134	193	230	202	17
		R	*	84	134	124	17
		$\bar{R}$	134	109	96	78	*
	1.000	$R+\bar{R}$	206	244	250	138	14
		R	*	84	82	52	14
		$\bar{R}$	206	160	168	86	*

Table 12 (continued)

Total shocks received in Component 2 of Experiment I

S	J		p(S ^R)				
			(0,1)	(.125,.5)	(.25,.25)	(.5,.125)	(1,0)
S2	0.500	R+ ~~R~~	334	303	218	174	80
		R	*	43	71	86	80
		~~R~~	334	260	147	88	*
	0.250	R+ ~~R~~	534	399	238	111	8
		R	*	18	20	9	8
		~~R~~	534	381	218	102	*
	0.125	R+ ~~R~~	887	431	214	123	7
		R	*	1	1	1	7
		~~R~~	887	430	213	122	*
S3	2.000	R+ ~~R~~	63	205	238	215	89
		R	*	109	124	140	89
		~~R~~	63	96	114	75	*
	1.000	R+ ~~R~~	354	281	228	163	38
		R	*	64	86	73	38
		~~R~~	354	217	142	90	*
	0.500	R+ ~~R~~	526	352	228	160	58
		R	*	25	40	63	58
		~~R~~	526	327	188	97	*
	0.250	R+ ~~R~~	798	436	218	110	14
		R	*	6	14	15	14
		~~R~~	798	430	204	95	*
	0.125	R+ ~~R~~	883	414	248	100	17
		R	*	2	3	2	17
		~~R~~	883	412	245	98	*

Table 12 (continued)

Total shocks received in Component 2 of Experiment I

S	I		p(S ^R)				
			(0,1)	(.125,.5)	(.25,.25)	(.5,.125)	(1,0)
S4	2.000	R+ ~~X~~	170	227	250	173	49
		R	*	71	103	106	49
		~~X~~	179	151	147	67	*
	1.000	R+ ~~X~~	300	305	237	141	8
		R	*	49	85	56	8
		~~X~~	300	256	152	85	*
	0.500	R+ ~~X~~	746	381	220	126	11
		R	*	15	11	30	11
		~~X~~	746	366	209	96	*
	0.250	R+ ~~X~~	825	442	241	103	21
		R	*	13	7	15	21
		~~X~~	825	429	234	88	*
	0.125	R+ ~~X~~	889	433	227	116	3
		R	*	2	3	2	3
		~~X~~	889	431	224	114	*
S5	2.000	R+ ~~X~~	131	231	219	145	5
		R	*	80	71	52	5
		~~X~~	131	151	148	93	*
	1.000	R+ ~~X~~	282	298	216	170	38
		R	*	56	77	79	38
		~~X~~	282	242	139	91	*
	0.500	R+ ~~X~~	311	262	247	157	38
		R	*	61	100	64	38
		~~X~~	311	200	147	93	*
	0.250	R+ ~~X~~	582	399	233	121	43
		R	*	20	39	19	43
		~~X~~	582	379	194	102	*

Table 12 (continued)

Total shocks received in Component 2 of Experiment I

			p(S ^R)				
S	I		(0,1)	(.125,.5)	(.25,.25)	(.5,.125)	(1,0)
S5	0.125	R+ $\bar{X}$	842	454	232	103	11
		R	*	2	0	7	11
		$\bar{X}$	842	452	232	96	*
GROUP							
2.000	R+ $\bar{X}$	$\bar{X}=$	142	219	232	195	35
		SD=	53	20	12	37	35
		R					
		$\bar{X}=$	*	85	105	106	35
		SD=	*	14	25	33	35
	$\bar{X}$	$\bar{X}=$	142	135	127	89	*
		SD=	53	30	22	25	*
		R					
		$\bar{X}=$	*	61	83	62	23
		SD=	*	14	4	14	14
1.000	R+ $\bar{X}$	$\bar{X}=$	310	289	236	150	23
		SD=	76	28	15	16	14
		R					
		$\bar{X}=$	*	61	83	62	23
		SD=	*	14	4	14	14
	$\bar{X}$	$\bar{X}=$	310	227	154	88	*
		SD=	76	41	14	3	*
		R					
		$\bar{X}=$	468	335	232	150	39
		SD=	177	52	14	20	31
0.500	R+ $\bar{X}$	R					
		$\bar{X}=$	*	31	45	53	39
		SD=	*	20	41	26	31
		$\bar{X}=$	*	20	41	26	31

Table 12 (continued)

Total shocks received in Component 2 of Experiment I

S	I	$p(S^R)$				
		(0,1)	(.125,.5)	(.25,.25)	(.5,.125)	(1,0)
GROUP	0.500	$\bar{X}$				
		$\bar{X}= 468$	304	187	97	*
		$SD= 177$	72	42	7	*
		$\bar{X}$				
	0.250	$\bar{X}= 726$	422	233	112	17
		$SD= 158$	21	9	6	16
		$\bar{X}$				
		$\bar{X}= *$	11	16	12	17
		$SD= *$	8	15	7	16
		$\bar{X}$				
		$\bar{X}= 725$	411	217	100	*
		$SD= 158$	28	18	9	*
	0.125	$\bar{X}$				
		$\bar{X}= 878$	436	232	118	10
		$SD= 20$	16	13	18	5
		$\bar{X}$				
		$\bar{X}= *$	2	2	4	10
		$SD= *$	0	1	4	5
		$\bar{X}$				
		$\bar{X}= 878$	435	230	113	*
		$SD= 20$	16	12	17	*

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