THE UNIVERSITY OF MANITOBA

RULE FORMATION AND THE CONTROL OF BEHAVIOR IN HUMANS: AN ASSESSMENT OF THE ROLE OF AWARENESS IN OPERANT CONDITIONING

by

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Abstract

The accuracy of subjects' (n=50) self-generated rules describing the schedule of reinforcement they were responding under was experimentally manipulated by varying the accuracy of the instructions given each subject prior to the conditioning trial period. An examination of both the frequency of and cumulative responding of the subjects receiving erroneous VI_{60} or VR_{150} instructions indicated that subjects who were unaware of the administered FI_{60}/FI_{100} schedule responded as if under the control of the illusory rather than the administered contingencies. Awareness of the applied schedule appeared to be correlated to control by the applied schedule over the responding of subjects receiving erroneous instructions. However, there was some evidence to indicate that control by the FI_{60}/FI_{100} schedule could be exerted over the responding of subjects without the subject's awareness of the schedule. As such, there would seem to be some support for a more nonmediational approach to the role of awareness in the behavior change process. That is, although unaware conditioning is, at best, weak, it would appear that it can occur.

Evidence was also gathered in an attempt to validate a recognition threshold paradigm as an alternative to the more traditional questionnaire paradigm in the assessment of awareness. However, contrary to expectation, subjects who were aware of a particular schedule of reinforcement failed to re-
cognize completely a sentence describing that schedule of reinforcement at a lower level of stimulus clarity than did those subjects unaware of that schedule. The present evidence would not seem to support a recognition threshold paradigm as a viable alternative in the assessment of awareness.
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Front view of the conditioning apparatus

The cumulative record of the "off-quadrant" case.
A study by Kaufman, Baron, and Kopp (1966) has provided evidence to indicate that instructions play a significant role in the conditioning, or behavior change, process. Kaufman et al. provided their subjects with either complete or minimal information about the required operant response and either accurate or erroneous information concerning the schedule of reinforcement to be administered. Those subjects erroneously informed that their responding would be under either a fixed-interval (FI) or a variable-ratio (VR) schedule, when a variable-interval (VI) schedule of reinforcement was in fact administered, tended to respond as if their behavior was under the control of the illusory rather than the administered schedule of reinforcement. In light of evidence (Dawson & Biferno, 1973; Weinstein & Lawson, 1963) that a subject's awareness of learning contingencies may be altered by manipulating the accuracy of instructions describing those learning contingencies, the Kaufman et al. (1966) findings would seem to have important implications with respect to the role of awareness in conditioning. Before elaborating on these implications, however, a brief review of some of the issues confronted when considering the role of awareness in conditioning will be presented.
What Is Awareness?

In describing the process of operant conditioning, Skinner (1969) has suggested that three conditions must always be specified in order to provide an adequate formulation of the interaction between an organism and its environment: 1) the occasions upon which a response occurs, 2) the response itself, and 3) the reinforcing consequences. It is the associations between these three conditions that comprise, according to Skinner, the contingencies of reinforcement.

Numerous studies (DeNike, 1964; Dulany, 1961, 1962; Farber, 1963; Greenspoon, 1955; Holmes, 1967; Leventhal, 1959; Levin, 1961; Philbrick & Postman, 1955; Rosenfeld & Baer, 1969; Spielberger, 1962, 1965; Spielberger & DeNike, 1966; Thorndike, 1933; Thorndike & Rock, 1934) have attempted to establish whether the awareness of the contingencies of reinforcement is a prerequisite for conditioning to occur. In the majority - if not all - of these studies, awareness has been conceptualized as referring, in general, to the conscious experiences - that is, thoughts, ideas, and hypotheses - of the subject. Operationally defined, awareness has generally referred to the ability to correctly verbalize (or describe) one's response-reinforcement contingencies (Bandura, 1969).
A similar conceptualization of awareness will be adopted in this study; that is, awareness of the contingencies of reinforcement will refer to the formulation of a rule, or rules, accurately describing the contingencies of reinforcement. In turn, the subject's formulation of such rules will be inferred from the subject's ability to describe any associations between the occasions for the response, the response itself, and the reinforcing consequences.

The Assessment of Awareness

The principal technique that has been employed in assessing the awareness of subjects has been a postconditioning questionnaire, in which the subject is required to describe, by successive questions, the contingencies of reinforcement received. However, many investigators (DeNike, 1964; Levin, 1961) have found that the actual format of this assessment technique may affect results considerably, providing spuriously high, or low, estimates of awareness.

When employing such an instrument as a postconditioning questionnaire, one must be wary of the extent to which the continued questioning itself may facilitate awareness. That is, concern must focus on the extent to which a postconditioning questionnaire to assess awareness provides cues to verbalizations that would otherwise be nonexistent.

At the other extreme, one must consider the extent to
which results are due to the insensitivity of the instrument. That is, one must be conscious of the possibility that awareness, although present, may not be detected because of the nature or format of the technique used to assess awareness.

...because of insensitive interviewing procedures, failure to detect awareness has contributed to the positive results obtained in many investigations of verbal conditioning which have purported to demonstrate learning without awareness (Levin, 1961).

There are other criticisms of a postconditioning questionnaire technique that are unrelated to its specific format. For example, the establishment of a precise temporal relationship between awareness and conditioning is, at best, difficult when only a postconditioning questionnaire technique is employed. Since awareness is determined only at the conclusion of the conditioning period, it is impossible to ascertain, for those subjects inferred to be aware, at precisely what point during the trial period awareness was attained, and hence, whether any conditioning has occurred before awareness was attained (Dawson & Biferno, 1973).

Difficulty also arises when subjects who cannot verbalize the entire contingency relationship, but who can specify some of the components, are to be categorized. That is, the postconditioning questionnaire technique assumes awareness to be a dichotomous variable, either present or absent,
and as the following example from Eriksen and Kuethe (1956) so graphically illustrates, problems arise when a subject cannot be clearly assigned to either the aware or nonaware group.

There were another five Ss who could not be clearly placed in either the insight or the noninsight group. These subjects seemed to have a vague idea as to the reasons for shock and what they needed to do to avoid them, but their verbalizations were not definite enough to permit clear-cut decisions (p.204).

One means of eliminating such problems of categorization would be to reconceptualize awareness as falling along a continuum and, in turn, to develop some instrument that could quantify the degree of awareness of a subject.

Klein and Wiener (1966), in a preliminary attempt to develop such an instrument that could quantify the degree of awareness of a subject, have made use of what they refer to as a "recognition threshold paradigm". A sentence describing the contingency of reinforcement is reproduced at varying levels of stimulus clarity, with the least clear reproduction being presented to the subject first, and so on. The subject has to read each of these sentences, and it is assumed that the lower the level of stimulus clarity at which the sentence is recognized, the more aware the subject is of the contingency described. Klein and Wiener base the rationale for such a paradigm on the hypothesis that the greater the
the probability of emitting a response, all other factors being constant, the lower the threshold required for the controlling stimulus. Part of the present study will concentrate on establishing the validity - or lack of it - of such an assessment technique, and of the rationale on which it is based.¹

The Experimental Manipulation of Awareness

In attempting to circumvent the various difficulties encountered when using a postconditioning questionnaire to establish the awareness of a subject, several authors have investigated whether or not awareness can be systematically manipulated. For example, Weinstein and Lawson (1963), using the Greenspoon (1955) verbal operant conditioning paradigm, supplied varied information concerning the nature of the reinforcement, and then conducted postexperimental interviews to assess the degree of awareness of the different experimental groups of subjects. On the whole, subjects receiving full and accurate information showed a higher probability of being aware than those subjects receiving either minimal or no information. Similarly, Dawson and Biferno (1973) demonstrated that they could experimentally manipulate the probability that subjects would become aware of the relationship between the CS and the UCS - in a discrimination galvanic skin response (GSR) classical conditioning
paradigm - by means of varying the verbal instructions given each subject prior to the conditioning trial.

However, it is to be noted that such attempts at manipulating awareness are not without problems of their own. For example, within each of the above studies, one could not assume that a subject who had received a set of instructions correctly describing the learning contingencies was necessarily aware of those learning contingencies. As Weinstein and Lawson (1963) point out, even those subjects in the group having full and accurate instructions did not uniformly reveal complete awareness. ²

Theoretical Approaches to the Role of Awareness in Conditioning

Essentially, the point of contention between the various theoretical approaches attempting to account for the role of awareness within conditioning has centered on the temporal relationship between the formulation of accurate rules describing the contingencies of reinforcement (that is, awareness), and the change of behavior. Although Bandura (1969), in his review of the area, has referred to four theoretical approaches to the role of awareness in conditioning, it will be seen that only two of these four approaches - a nonmediational and a cognitive approach - are truly different or independent approaches to the problem.
Adherents of a nonmediational approach (Dollard & Miller, 1950; Goldiamond, 1973; Michael, 1970; Skinner, 1953, 1969; Thorndike, 1933) maintain that performance change or conditioning occurs independently of awareness.

... (We) know from laboratory studies of operant conditioning that if an experimenter defines and programs the contingencies appropriately, they will shape the behavior whether or not the subject is aware of the relationship... But once the contingencies are there, the behavior comes under their control whether or not one is aware of them (Goldiamond, 1973, p.98).

It is important to note that it is not the possible existence of awareness that is denied within a nonmediational interpretation, but rather its role as a necessary causal agent in behavior change (Terrace, 1971). Thus, while conditioning is postulated as occurring independently of awareness, it is not denied that the individual may eventually come to recognize (that is, develop awareness) the contingencies of reinforcement administered from the high output of correct responses. Awareness is thus viewed as being, temporally, a resultant or concomitant of, rather than a precondition or prerequisite for, behavior change.

Similarly, within both the independent response systems theory (Verplanck, 1962) and the reciprocal interaction theory (Farber, 1963) the behavior change process is essentially conceptualized as occurring independently of awareness. For example, Verplanck (1962) conceptualizes awareness as a verbal
operant, and hence an independent response system, rather than as a factor that must precede - or in any way controls - behavior change. Automatic control is thus assumed to be exerted by the reinforcing stimuli over behavior, independent of the effects of these stimuli upon awareness. As in the nonmediational approach, awareness becomes, temporally, a concomitant of behavior change.

Parenthetically, it is interesting to note that the verbal "statements-of-rules", or hypotheses, (that is, the awareness of the subject) are conceptualized by Verplanck (1962) as being conditionable, as any other simple operant behavior.

Our habit of thinking of private events as causal agents of overt acts... have made it all but impossible to consider the possibility that private events are qualitatively similar to overt acts and that they are influenced by many of the same variables that influence overt acts (Terrace, 1971, p.6).

Conceptualized by Farber (1963) not as a theory but rather "as a framework within which a reasonable theory might be developed" the reciprocal interaction approach considers awareness to be both a consequence of and a precondition for behavior change. In support of his basic premises, Farber refers to Thorndike.

Unconscious learning is relatively undependable and slow... conscious awareness of the relation between response and rewards is enormously effective, if and when it occurs (Thorndike, 1933).
Farber (1963) thus postulates that learning can occur, to a limited extent, independently of the subject's understanding of the basis on which reinforcements are administered; however, in addition to making overt responses, subjects are also developing hypotheses about the response-reinforcement contingencies. These self-generated rules can then serve as discriminative stimuli for directing instrumental action; that is, accurate hypotheses are likely to be accompanied by correct overt responses, whereas erroneous hypotheses tend to coincide with inappropriate performances.

These self-generated rules are, in turn, selectively strengthened, maintained, or extinguished by the differential reinforcements administered for the overt behavior under their control. The correct hypotheses, once established, can result in a substantial increase of appropriate responding given adequate incentive conditions; that is, becoming aware of the contingencies of reinforcement increases the efficiency of performance.

A study by Philbrick and Postman (1955) may be seen as illustrating the contentions of Farber. They found that a group of subjects who remained unaware of the principle in a verbal conditioning task showed a significant amount of learning; however, their performance was consistently poorer than that
of a group of subjects who were able to verbalize the correct principle at some point in the learning series.

However, it should not be construed that the above approach of Farber (1955) is significantly different from the basic assumptions of the nonmediational approach, for even the staunchest of adherents of a nonmediational view do not deny the facilitative role that the formulation of correct rules describing the contingencies of reinforcement may play in the behavior change process.

Formal statements of contingencies, like instructions, have their effects, and if detailed enough may supply rules which function as prior stimuli to control behavior resembling that which would be generated by prolonged exposure to the contingencies themselves (Skinner, 1966, p.215).

In summary, all three of the theoretical approaches discussed above are essentially similar in that they basically contend that awareness, or the formulation of accurate rules describing the learning contingencies, does not need to temporally precede behavior change. That is, they all contend that awareness does not play a causal role in the conditioning process.

In sharp contrast, adherents of a cognitive view (e.g. Spielberger & DeNite, 1966) contend that awareness of the contingencies of reinforcement is an absolute prerequisite or precondition for behavior change. It is assumed that in the course of observing the differential consequences as-
associated with different types of responses emitted individuals test various hypotheses about the required response class, and "eventually figure out what they are supposed to do (Bandura, 1969, p. 566)". In a similar context, Mischel (1973) proposes that "on the basis of direct experience, instructions, and observational learning, people develop expectancies about environmental contingencies".

This acquired information, in turn, gives rise to "intentions", or "self-instructions" (self-generated rules), to produce the correct response. As Dulany (1961) points out, "subjects may hypothesize what is expected of them and instruct themselves accordingly".

The strength of this tendency to produce the correct responses depends upon the subject's valuation of the contingent incentives; thus, the magnitude of performance change becomes a function of both the accuracy of the guiding hypotheses, or self-generated rules, and also the incentive value, for each subject, of the consequences contingent upon the required behavior (Bandura, 1969; Mischel, 1973; Spielberger, 1965). As Holmes (1967) points out, "while awareness must precede improved performance, improved performance need not necessarily follow awareness (p. 289)".

In summary, from a brief survey of the theoretical approaches that have attempted to account for the role of aware-
ness in conditioning, it would appear that the issue in dispute is whether awareness is a necessary precondition in the behavior change process, or merely a resultant, or concomitant, of any behavior change that does occur. Unfortunately, current empirical evidence does little to resolve this controversy.

**Studies of Awareness and Conditioning**

*Verbal operant conditioning studies.* Attempts to empirically resolve the controversy surrounding the role of awareness in conditioning, and in operant conditioning in particular, have relied mainly upon a verbal operant paradigm. The majority of these studies, in turn, have employed one of two procedures: 1) The Greenspoon (1955) word naming task, which involves the emission of a single brief consequence by the experimenter to one class of the words produced one at a time by the subject, and 2) the Taffel (1955) process, in which sentences employing specific subject pronouns are followed by some kind of reinforcing stimulus (that is, the sentences in which the designated pronoun appears are selectively, or differentially, reinforced).

Evidence in support of a nonmediational approach has been provided from studies employing a verbal conditioning paradigm. Specifically, these studies (Leventhal, 1959; Levin & Sterner, 1966; Philbrick & Postman, 1955; Rosenfeld & Baer,
1969; Silver, Saltz, & Modigliani, 1970; Thorndike & Rock, 1934) claim to have demonstrated that subjects who do not report awareness of the contingencies of reinforcement nevertheless show significant conditioning effects.

Bandura (1969), however, points out that much of the above evidence is dismissed by adherents of a cognitive persuasion as probably due to either the insensitive methods used to gauge awareness, or the operation of partially correct hypotheses in those subjects assessed as unaware. Levin (1961), for example, maintains that when a more extensive interview technique is used postexperimentally, the evidence for conditioning without awareness disappears.

Employing what they purport to be a "more extensive" procedure to assess awareness, a number of studies (DeNite, 1964; Dulany, 1962; Holmes, 1967; Levin, 1961; Mondy, 1965; Spielberger, 1962, 1965; Weinstein & Lawson, 1963) claim that their results support a cognitive position. Specifically, they claim that the data shows an invariant relationship between the presence of awareness and behavior change. In addition, the studies by Holmes (1967), Mondy (1968), and Spielberger, Bernstein, and Ratcliff (1966) demonstrate how the subject's valuation of the contingent incentives plays an important role in whether or not the aware subject's behavior changes appropriately.
In critically evaluating the above studies, and their claims of providing evidence in support of a cognitive position, it is important to remember that as the questionnaire is made more extensive, the possibility that the questionnaire itself may be suggesting awareness to a nonaware subject also increases.

Even though it may not be possible to avoid suggesting awareness to some subjects when detailed postconditioning interviews are used, we will contend that such interviews are to be preferred to the superficial interviews generally employed in investigations of the operant conditioning of verbal behavior (Spielberger, 1962).

Thus, one must be cognizant of the possibility that the awareness demonstrated in those studies purporting to support a cognitive position may be an artifact of the "suggestive" format of the questionnaire used.

Additionally, as has been discussed previously, when using a postconditioning questionnaire technique as the only method from which awareness is inferred, it is difficult, if not impossible, to assess a precise temporal relationship between awareness and the onset of any behavior change. However, a study by DeNike (1964) has attempted to deal with this limitation of the postconditioning questionnaire technique. Utilizing an assessment procedure throughout the conditioning trial, the study provided data indicating that performance gains were found only for aware subjects. Furthermore, incre-
ments in performance first occurred in that block in which aware subjects first recorded the correct rules describing the contingencies of reinforcement.

Other, serious criticisms of the above studies supporting a cognitive view have been raised by Rosenfeld and Baer (1969). They contend that the use of the Greenspoon word naming task increases the probability of the subject questioning the purpose of the experiment; that is, when using such a paradigm, the subject becomes oriented towards the discovery of what sorts of words he should emit, and thus focuses on the occasions for the emissions of the experimenter's vocalization. Other authors (Dixon, 1966; Silver, Saltz, & Modigliani, 1970) have voiced a similar concern for the use of such a paradigm.

To control for the above sources of criticism, Rosenfeld and Baer (1969) employed a verbal conditioning task designed to be more representative of natural interpersonal events than was characteristic of other studies. To provide a more subtle form of reinforcement, and to avoid calling the subject's attention to the likelihood that someone was trying to change his verbal performance, Rosenfeld and Baer gave the subject the role of an interviewer whose goal was to condition certain responses of an interviewee. In fact, unknown to the subject, the interviewee attempted to condition
the "interviewer's" (the true subject) verbal behavior. In this way, Rosenfeld and Baer attempted to avoid giving the subject a simple problem-solving set with regard to the relationship of his verbal responses and those of the other person.

Using a single-organism design to prevent the obscuring of significant individual subject trends by grouped data, the results of the study indicate that the operant conditioning of verbal behavior can occur without awareness in some persons and that "a person may unknowingly let his verbal behavior be controlled by another person in order to himself gain control over certain aspects of the other's behavior (Rosenfeld & Baer, 1969, p.425)". The authors conclude that the success of the study suggested that "a major determinant of unaware verbal conditioning may be distraction of the subject from the manipulative motive of the persons with whom he is communicating (p. 431)".

To summarize thus far, studies employing a verbal operant conditioning paradigm present equivocal evidence as to the role of awareness in conditioning. Nor, as we shall see, are the results of studies employing other conditioning paradigms any more successful in resolving the controversy.

Non-verbal operant conditioning studies. Although not as extensively used as a verbal operant conditioning paradigm,
there have been a number of studies that have employed a
task-oriented operant paradigm in attempting to establish
the role of awareness. Two studies by Hefferline and his as-
associates (Hefferline & Keenan, 1963; Hefferline, Keenan, &
Harford, 1959) demonstrated that unaware subjects still show-
ed significant conditioning of a "thumbtwitch" response. Uti-
lining an avoidance paradigm, Hefferline et al. (1959) re-
ported that an invisibly small "thumbtwitch" increased in rate
of occurrence when it served, via electromyographic amplifi-
cation, to terminate or postpone aversive noise stimulation.
Subjects, as assessed through the use of a general, nonspe-
cific, postconditioning technique, in general remained una-
ware of their behavior and its effects, unless they had re-
ceived pretrial instructions outlining the contingencies of
reinforcement in detail.³

In a subsequent study, Hefferline and Keenan (1963) used
monetary, or positive, reinforcement of the same "thumbtwitch"
response, again only detectable by the experimenter via electro-
myographic amplification. Results indicated that, although
none of the subjects could identify the response that pro-
duced the reinforcement (and hence could be presumed to be un-
aware of the contingencies of reinforcement), responses of the
chosen amplitude category increased substantially during re-
inforcement and declined abruptly when reinforcement was with-
drawn. Both of these studies purport to demonstrate, as pointed out by Skinner (1969), that "a subject can learn to respond without knowing that he has responded if the reinforced response is so subtle that he cannot perceive it (p. 245)."

A study by Ayllon and Azrin (1964), in which an operant procedure was employed to modify the eating behavior of mental patients, indirectly presents evidence that may be viewed as contradictory to the findings of the two above studies. It was found that the reinforcement of the desired behavior was not effective unless the reinforcement procedure was accompanied by instructions that specified the basis for the reinforcement (that is, until such time that it might be inferred that it was highly probable that the subjects were aware of the contingencies of reinforcement). That the failure to provide a statement of the relationship between the availability of the reinforcement and the subject's behavior appeared to constitute the essential factor in the failure of the subject's behavior to change in the desired direction may be interpreted as lending support to the cognitivists. If one interprets the differences in instructions as effecting differences in the awareness of the subjects, then awareness becomes, within this study, a precondition for behavior change. However, it must be acknowledged that this is not the only interpretation that can be made from the data, and as such, the above conclu-
sion must be dealt with cautiously.

**Studies employing other conditioning paradigms.** Although the primary focus of this study is on the functional role of awareness within operant conditioning, evidence from studies employing a classical conditioning paradigm shall not be ignored. Although an extensive review of the above literature is beyond the purview of this paper, a few of the studies will be discussed briefly. For example, two of the earlier studies (Diven, 1937; Haggard, 1943) demonstrated that a word may become a substitute stimulus for an electric shock, and evoke a galvanic skin response (GSR) that differentiates it from nonshock words, even though the subject may be unaware of the connection between the word and the electric shock.

In sharp contrast, a more recent study by Insko and Oakes (1966), in which the Staats and Staats procedure for classically conditioning attitudes toward nonsense syllables was employed, provides evidence demonstrating a correlation between the occurrence of learning and the awareness of the subject. Further, they provide evidence demonstrating that an interfering intertrial activity - color naming - significantly reduces both the awareness of the subject and the occurrence of conditioning.

Dawson and Biferno (1970) attempted to manipulate the probability that subjects would become aware of the relation-
ship between the CS and the UCS in a discrimination galvanic skin response (GSR) classical conditioning paradigm by altering, or varying, the pretrial instructions given to subjects. Subjects were also given a false rationale, or masking task, for the study. Dawson and Biferno reported three converging lines of evidence that seemed to suggest that, as in the Insko and Oakes (1966) study, awareness of the CS-UCS relationship was a necessary, but not necessarily sufficient, factor in human GSR discrimination classical conditioning. First, conditioning occurred among groups of aware (as inferred from a concurrent as well as postconditioning measure of awareness) subjects, but not among groups of unaware subjects. Furthermore, conditioning failed to occur when the probability of awareness was, through the instructions given, experimentally attenuated, but did occur when the probability of awareness was experimentally facilitated. Finally, conditioning occurred only at that point in the conditioning trial that awareness was first expressed.

**Summary and Statement of Purpose of the Study**

As has been seen, the evidence from numerous studies, employing a variety of conditioning paradigms, is equivocal in its support of a nonmediational and a cognitive approach to the role of awareness in conditioning. Further research is evidently required if a satisfactory resolution of the
issue is to be achieved.

The present study will focus on delineating the temporal relationship between the formulation by subjects of rules accurately describing the schedules of reinforcement administered in a non-verbal operant paradigm and the control of the operant response by those administered contingencies. As in the Kaufman et. al. (1966) study, subjects will be given pre-conditioning instructions varying in the accuracy of their description of the forthcoming schedule. Specifically, subjects will be either accurately informed that a variable-ratio (VR), variable-interval (VI), or fixed-interval (FI) schedule will be administered, or, they will be (mis)informed that a VI or VR schedule is to be administered when in actuality a FI schedule is applied.

If, as in the Kaufman et. al. (1966) study, subjects who are given erroneous information concerning the forthcoming schedule respond as if under the control of the schedule that is described rather than that which is administered than subjects who receive illusory VR instructions should produce a greater number of responses than subjects receiving illusory VI instructions. As well, both of these groups receiving the illusory instructions should produce a greater number of responses than subjects correctly informed of the FI schedule, and administered the FI schedule. Such would be the case if
subjects were actually administered a VR or VI schedule.

If these previous hypotheses are confirmed, concern will then focus on the explanation of why illusory instructions exert such control over behavior, and the relevance of such an explanation to resolving the controversy surrounding the role of awareness in conditioning. As discussed previously, varying the accuracy of pre-conditioning instructions describing the response-reinforcement contingencies given a subject has been shown to affect the subject's awareness of those contingencies (Dawson & Biferno, 1973; Weinstein & Lawson, 1963). In this study, those subjects receiving illusory VR or VI instructions may not have become aware of the administered FI contingency. If so, and if it can be further demonstrated that for those subjects awareness of the administered FI schedule must precede control by the FI schedule of the operant response, then the data will lend support to a cognitive rather than a nonmediational approach to the role of awareness in conditioning.

Keeping the above question in mind, an assessment will be made of the awareness of the FI schedule of those subjects receiving illusory or erroneous instructions. Next, concern will focus on the subjects' responding as a function of their assessed awareness of the FI schedule. If the FI schedule comes to shape, or control, the responding of subjects
only as they become aware of it, then those subjects receiving illusory instructions but who become aware of the FI schedule should respond more like those subjects correctly informed of the FI schedule than should those subjects given the same illusory instructions but who remain unaware of the FI schedule. As well, of those subjects receiving illusory instructions, only those subjects becoming aware of the FI schedule should show the "scalloping effect" of the FI schedule.

In summary, several predictions will be tested in this study:

(1) Subjects administered a VR schedule should produce more responses than those subjects administered a VI schedule, who in turn, should produce more responses than those subjects administered (and correctly informed of) a FI schedule.

(2) Subjects erroneously informed that a VR schedule will be administered should produce a greater number of responses than those subjects erroneously informed that a VI schedule is forthcoming, and both of these groups should produce more responses than subjects administered (and correctly informed of) a FI schedule.

(3) Subjects receiving illusory VI (or VR) instructions but who become aware of the FI schedule administered should produce fewer responses than those subjects who also receive
illusory VI (or VR) instructions but who remain unaware of the administered FI schedule.

(4) Of those subjects receiving illusory VR or VI instructions, only those subjects who become aware of the administered FI schedule should display the "scalloping effect" associated with the FI schedule.

In addition to the above issues, this study will attempt to provide data to assess the validity of a recognition threshold measure (Klein & Weiner, 1966) as an alternative to the questionnaire paradigm in the assessment of the awareness of the subject. To this effect, subjects will be presented with five sentences, each reproduced at ten levels of stimulus clarity. Each of the five groups of sentences will describe a different schedule of reinforcement. If the assumptive model of Klein and Weiner (1966) is correct, then subjects inferred from the questionnaires to be aware of the schedule of reinforcement applied to their behavior should come to recognize that sentence describing that schedule at a lower level of stimulus clarity than those subjects inferred to be unaware of that schedule of reinforcement. In particular, interest will be focused around those subjects receiving illusory instructions and their performance on the sentence describing the FI schedule as a function of their assessed awareness of the FI schedule.
CHAPTER II

METHOD

Subjects and Experimental Design

Fifty introductory psychology students from the University of Manitoba participated as experimental subjects as part of their course requirement. It is important to note that because of the incentive conditions used in this study all of these subjects needed three (or more) hours of experimental credit before participating in this study.

Five males and five females were randomly assigned to each of the five experimental groups. Instructions accurately describing the schedule of reinforcement that would be forthcoming were given to subjects in three of the experimental groups. Subjects in each of the other two experimental groups were given instructions describing a schedule of reinforcement other than that to be administered.

In addition, twenty volunteer subjects, male and female, were obtained from among the students enrolled in the introductory psychology course (Evening Session) at the University of Manitoba. Participation as experimental subjects was not, for these twenty subjects, part of their course requirement. These twenty subjects were used to obtain normative data for the recognition threshold task.

Apparatus

Two adjoining rooms, each measuring 8 x 10 feet (2.43 x
3.00 M), and connected by conduits, were used. One of the rooms, hereto designated the experimental room, contained two tables, placed at right-angles to each other, forming an L; the subject was seated at these tables throughout the experiment.

Located on the table directly in front of the subject was the conditioning apparatus (Fig. 2.1). The outer shell of the apparatus (hereafter referred to as the CONSOLE) was constructed of heavy cardboard - painted black - and measured 22 x 10 x 12 inches (.56 x .25 x .30 M). Encased within the CONSOLE were an electromechanical digital counter (Hunter, model 140A) and a Unimax microswitch.

On the adjoining table, to the right of the subject, were placed four 9 x 12 inch (.23 x .30 M) envelopes. In one of these envelopes was contained the instructions describing the schedule of reinforcement that would be forthcoming, while the other three envelopes contained the questionnaire comprising the concurrent measure of awareness.

In the adjoining room occupied by the experimenter were an electromechanical digital counter (Hunter, model 140A) connected in series to the CONSOLE microswitch, two Guardian Electric relays, and a cassette-recorder (Sony TC-60A).

Essentially, each lever press produced by the subject was recorded on the electromechanical counter in the adjoin-
Front view of the conditioning apparatus (\(\frac{1}{4}\) scale)
Stimulus Lamps
Lever
Ready Button
Electro-mechanical digital counter
Openings for reset and off/on switches of counter
ing (that is, the experimenter's) room. The scheduling of points on the counter before the subject was controlled by opening the relay circuit; when the relay circuit was opened, the next lever-press by the subject both registered a point on the electromechanical counter contained within the CONSOLE, and simultaneously reclosed the circuit.

The Conditioning Task

Points, recorded on the electromechanical digital counter located in front of the subject, could be earned contingent upon the subject pressing the lever. These points were administered on either a fixed-interval (FI), variable-interval (VI) or variable-ratio (VR) schedule of reinforcement. These points acted as secondary reinforcers in that they could be exchanged for up to three extra hours of experimental credit needed by subjects to complete their course requirements. That is, the more points earned the greater the number of credit hours obtained by a subject for participating in the study.

Procedure

Upon entering the experimental room, each subject was required to remove all metallic objects (that is, rings, watches, etc.) from both hands on the pretext that the metallic content of the object might interfere with the normal functioning of the electrical equipment.
All subsequent instructions, unless otherwise noted, were presented in written form, thus minimizing the verbal interaction between the experimenter and the subject.

The experimental manipulation of awareness. In order to maximize the opportunities for obtaining learning without awareness, each subject was misinformed as to the nature, or intent, of the experiment. That is, the initial instructions that each subject received attempted to provide the subject with a rationale - albeit an erroneous one - for the experiment.

IT IS IMPORTANT THAT YOU UNDERSTAND THE FOLLOWING INSTRUCTIONS THOROUGHLY. THUS, PLEASE READ THE FOLLOWING INSTRUCTIONS AS MANY TIMES AS YOU MAY REQUIRE TO FULLY COMPREHEND THEM.

A recent study claims to have demonstrated that subjects, when given written instructions describing different schedules of reinforcement, and then allowed to respond under those schedules of reinforcement, experience different degrees of distortion in their ability to later describe what these schedules were. However, it is the feeling of this experimenter that the results of that particular study are questionable, and that they may in fact be the result of artifact. It is felt by this experimenter that different schedules of reinforcement should in no way have any effect on an individual's ability to later describe them. Thus, this experiment is being conducted with the aim of settling this question.

Before continuing with the specific instructions to be followed in this experiment, there are several terms which first need to be explained:

(A) The Response: Whenever the term RESPONSE appears in this study, it refers to the pressing of the LEVER to be found on the CONSOLE.

(B) The Reinforcement: By pressing the LEVER, "points" can be earned; these "points" will register on the COUNTER, also to be found on the CONSOLE. These points may then be used to "purchase" up to two (2) extra credit
hours for this experiment. That is, the more points earned (that is, registered on the COUNTER) the greater are your chances of being able to obtain, in exchange for these points, up to three hours of credit for participating in this experiment. However, if you do not earn very many points, you will receive only the one hour of credit normally assigned for participating in an experiment. Thus, the more points registered on the COUNTER, the more hours of credit that can be obtained for participating in this experiment.

It is important to note that keeping the LEVER pressed down without letting it return to its "resting" position is recorded, by the equipment, as only one (1) response, and as such, the number of points that you can earn is reduced drastically.

(C) The Schedule of Reinforcement: In ENVELOPE A, to be found on the table beside you, is contained instructions describing the schedule of reinforcement under which you will be responding. These instructions will describe to you the relationship that exists between the pressing of the LEVER (the response) and the earning of points (the reinforcement). By following the instructions concerning the schedule of reinforcement, you will be able to obtain the points you need without having to make too many "wasted", or unreinforced, responses.

The Procedure to be Followed in this Experiment: In order that we may assess the ability of individuals to describe the different schedules of reinforcement after having responded under them for various periods of time, three "breaks" will occur at ten (10) minute intervals during the experiment. Each of these "breaks" will be indicated by the RED LIGHT going on; during these periods when the RED LIGHT is on, the equipment becomes inoperative, so that no points can be earned for pressing the LEVER.

Your task during these three periods when the RED LIGHT is on is to answer the two questions contained in each of the envelopes labelled 1, 2, and 3. That is, during the first "break", you are to answer the two questions in ENVELOPE 1, during the second "break" the two questions in ENVELOPE 2, and during the third, and final, "break" the two questions in ENVELOPE 3. Upon completion of each of the sets of questions contained within each of the envelopes, you are to return the question sheets to the envelope and seal it.

After you have completed the two questions in each of the "breaks", press the READY button to indicate that you are ready to begin responding again. When the RED LIGHT goes off, the equipment is again operative, and
you may begin responding again to earn points. When you feel that you understand the above instructions completely, only then remove the set of instructions from ENVELiOPE A (found on the table beside you); read these instructions carefully and as many times as needed. When you feel that you understand both the instructions on these pages and those contained within ENVELiOPE A (describing the schedule of reinforcement), press the READY button to indicate that you are ready to begin responding. The RED LIGHT will go out to indicate when you may begin to respond to earn the points needed to obtain the extra credit hours.

After reading the above instructions, each subject then referred to the set of instructions contained in ENVELiOPE A. This set of instructions described either a variable-ratio (VR), fixed-interval (FI), or variable-interval (VI) schedule of reinforcement.

**VR Instructions:**

The schedule of reinforcement that you will be responding under is referred to as a VARIABLE-RATIO schedule of reinforcement. When responding under a RATIO schedule of reinforcement, a prespecified number of responses must be produced for each reinforcement. The number of responses required for each reinforcement is referred to as the RATIO; that is, there will be a ratio of "N" responses for each reinforcer.

When responding under a VARIABLE-RATIO schedule of reinforcement, the number, or ratio, of responses required to earn a reinforcement varies randomly; that is, the number of unreinforced responses between reinforcements is variable. In this experiment, in which the schedule of reinforcement is a VARIABLE-RATIO SCHEDULE of 150 responses, the mean, or average, number of responses required for each reinforcement is 150. Specifically, this means that the counter will register a point (designating a reinforcement) for each 150 responses, on the average, produced. That is, at times, the counter may register a point for only a few responses produced after a previous reinforcement, while at other times the counter may not register a point until considerably more than 150 responses are produced after a previous reinforcement.
But, ON THE AVERAGE, the number of responses required to earn each point, or reinforcer, will be 150. Thus, the more responses produced, the greater the probability that you will maximize your reinforcements.

**FI Instructions:**

The schedule of reinforcement that you will be responding under is referred to as a FIXED-INTERVAL schedule of reinforcement. When responding under an INTERVAL schedule of reinforcement, a prespecified length, or interval, of time must elapse from a previous reinforcement (or start of the trial period) before a response can again earn a reinforcement. That is, a response made BEFORE the specified interval of time has passed from the previous reinforcement CANNOT earn any further reinforcement; only that response occurring AFTER the specified period of time has passed from the previous reinforcement CAN earn another reinforcement.

When responding under a FIXED-INTERVAL schedule of reinforcement, the length of time needed to elapse from a previous reinforcement before a response can again earn a reinforcement is constant, or fixed. In this experiment, in which the schedule of reinforcement is a combination of a FIXED-INTERVAL SCHEDULE of 60 seconds and a FIXED-INTERVAL SCHEDULE of 100 seconds, the length of these intervals is 60 seconds and 100 seconds respectively. Specifically, this means that when the FIXED-INTERVAL of 60 seconds is in effect (this period will be denoted by the BLUE LIGHT in front of you going on — that is, when the BLUE LIGHT is on, the schedule of reinforcement is FIXED-INTERVAL of 60 seconds, while when the BLUE LIGHT is off, the schedule of reinforcement is FIXED-INTERVAL of 100 seconds) the counter can register a point (designating a reinforcement) for a response produced only after 60 seconds has elapsed from a previous reinforcement. If you press the lever before 60 seconds have passed from the previous time the counter registered a point, nothing will happen.

However, when the FIXED-INTERVAL SCHEDULE of 100 seconds is in effect (remember, this period will be denoted by the BLUE LIGHT being off), the counter can register a point only for a response produced only after 100 seconds has elapsed from the previous reinforcement, or point registered on the counter. During this period, if you press the lever before 100 seconds have passed from the previous time the counter registered a point, nothing will happen. Thus, it is important for you to
watch whether the BLUE LIGHT is on or off, thus signifying whether the schedule of reinforcement is FIXED-INTERVAL of 60 seconds, or FIXED-INTERVAL of 100 seconds. Also, remember, that if you press the lever before the counter is ready to register, nothing will happen. Of course, if you do not press the lever when the counter is ready to register again, you will be losing valuable time when you could be earning reinforcements.

VI Instructions:

The schedule of reinforcement that you will be responding under is referred to as a VARIABLE-INTERVAL schedule of reinforcement. When responding under an INTERVAL schedule of reinforcement, a prespecified length, or interval, of time must elapse from a previous reinforcement (or start of the trial period) before a response can again earn a reinforcement. That is, a response made BEFORE the specified interval of time has passed from the previous reinforcement CANNOT earn any further reinforcements; only that response occurring AFTER the specified period of time has passed from the previous reinforcement CAN earn another reinforcement.

When responding under a VARIABLE-INTERVAL schedule of reinforcement, the length of time needed to elapse from a previous reinforcement before a response can again earn a reinforcement varies randomly. In this experiment, in which the schedule of reinforcement is a VARIABLE-INTERVAL of 60 seconds, the mean, or average, length of these intervals is 60 seconds. Specifically, this means that the counter can register a point (designating a reinforcement) for a response only once each 60 seconds, on the average. That is, sometimes the counter will be ready to register another point for a response only a few seconds after the last time it registered a point, while at other times the counter will be ready to register again only after more than 60 seconds have passed following the last time it registered. If you press the lever before the counter is ready to register, nothing will happen. Of course, if you do not press the lever when the counter is ready to register again, you will be losing valuable time when you could be earning reinforcements.

As noted before, for two of the experimental groups the instructions given did not accurately describe the schedule of reinforcement to be administered, while for the other three
groups it did.

It should be noted that, although the instructions given may have differed, and the schedule administered was not constant across all subjects, for all subjects the sequencing of the BLUE LIGHT on/off phases was the same. That is, for all subjects, the blue stimulus lamp was on for the first and third ten-minute intervals of the conditioning trial period, and off for the other two ten-minute segments.

The Assessment of Awareness

The rules describing the contingencies of reinforcement formulated by each subject were inferred from their responses to questionnaires given both during and at the conclusion of the conditioning trial period.

The concurrent questionnaire. This questionnaire (Appendix 1) was administered, at ten-minute intervals, during the conditioning trial period itself. Each presentation of the questionnaire consisted of the same two questions (it should be noted here that the experimenter was not present when the subject completed the concurrent questionnaire). Upon completing the questionnaire, the subject returned it to the envelope provided, and sealed the envelope.

Evaluation of the responses given to the concurrent questionnaire was undertaken by three raters who were uninformed about the specific group assignments of the subjects. A more detailed analysis of the rating procedure employed will be dis-
cussed in the following chapter.

The postconditioning questionnaire. A written questionnaire, comprised of open-ended questions (Appendix 2), was administered to each subject at the conclusion of the forty minute conditioning trial period. Each of these questions was presented separately to the subject, and the subject returned the answer to each question to the experimenter before receiving another question.

Evaluation and categorization of these responses was also conducted by the aforementioned three raters who were blind to the group assignments of the subjects. This rating procedure is also discussed more fully in the next chapter.

The recognition threshold task. The stimulus material for this task consisted of five groups of sentences; within each group, ten successive carbon copies (20 bond paper) were produced of the same sentence.

Each group of sentences described a different schedule of reinforcement. The schedules described by these sentences included a variable-interval (VI), fixed-interval (FI), variable-ratio (VR), fixed-ratio (FR), and continuous (CRF) schedule of reinforcement (see Appendix 3).

The order of presentation across subjects of the five groups of sentences was randomized. However, within each group of sentences, the order of presentation of the ten carbon copies
of the sentence ran from the least clear copy (that is, the tenth carbon copy) to the clearest copy (that is, the original). Each subject, both in the five experimental groups and in the standardization group, was asked to read aloud as many words of each of the carbon copies of each sentence as possible, until full recognition of the sentence was achieved. The following instructions were read to each subject prior to responding on the recognition threshold task.

In the folder before you are five (5) groups of sentences. Within each group, there are ten carbon copies of each sentence; the copies of each sentence progressively get clearer, the first copy being the least clear, and so on. Your task is to try to read each of the sentences. You are to read aloud as many of the words of each copy of each sentence that you can recognize. Do not worry about guessing; guessing is permitted. There is no time limit to this task. However, do not go on to the next copy of the sentence until you are told to do so.

To establish the norms for complete recognition of each of the sentences, twenty "naive" subjects were used as a standardization group. These subjects, given no other information except for the above instructions and not having actually responded under a schedule of reinforcement, were assumed to be unaware of any of the schedules of reinforcement described by the sentences. In contrast, subjects in the five experimental groups were not administered the recognition threshold task until they had completed the post-conditioning questionnaire.
CHAPTER III
RESULTS
Response Frequency and Instructions

A comparison of the median number of lever presses produced by subjects administered (and correctly informed of) either a VR$^{150}$, VI$^{60}$, or PI$^{60}$/FI$^{100}$ schedule of reinforcement is summarized in Table 3.1. A listing of the number of responses produced by each subject in each of these three experimental groups is presented in Appendix 4.

As predicted, subjects administered a VR$^{150}$ schedule produced a greater number of responses than did those subjects administered a VI$^{60}$ schedule, who in turn produced a greater number of responses than did those subjects administered (and correctly informed of) the PI$^{60}$/FI$^{100}$ schedule. A Kruskall-Wallis one-way analysis of variance by ranks adjusted for directionality of prediction$^5$ was significant at the .001 level, $H(2)=16.2$.

Of much greater importance is the comparison of the median number of responses produced by subjects receiving illusory VR$^{150}$ and VI$^{60}$ instructions (see Table 3.2). Again, as pre-
TABLE 3.1
The Median Number of Lever-Presses Produced By Subjects Receiving Accurate Instructions As a Function of the Schedule of Reinforcement Administered

<table>
<thead>
<tr>
<th>Schedule Administered</th>
<th>$\text{FI}<em>{60}/\text{FI}</em>{100}$</th>
<th>$\text{VI}_{60}$</th>
<th>$\text{VR}_{150}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.5</td>
<td>394.5</td>
<td>4540</td>
<td></td>
</tr>
</tbody>
</table>
TABLE 3.2
The Median Number of Lever-Presses Produced By Subjects Receiving Illusory Instructions As Compared to the Median Number of Responses Produced By Subjects Accurately Informed of the \( \text{FI}_{60}/\text{FI}_{100} \) Schedule of Reinforcement

<table>
<thead>
<tr>
<th>Instructions</th>
<th>Accurate Instructions</th>
<th>Illusory Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{FI}<em>{60}/\text{FI}</em>{100} )</td>
<td>( \text{VR}_{150} )</td>
<td>( \text{VI}_{60} )</td>
</tr>
<tr>
<td>61.5</td>
<td>6233</td>
<td>528.5</td>
</tr>
</tbody>
</table>
dicted, a Kruskall-Wallis one-way analysis of variance by ranks, adjusted for a directional prediction, showed those subjects receiving illusory VR\textsubscript{150} instructions to have produced significantly more responses than did those subjects receiving illusory VI\textsubscript{60} instructions, who in turn produced a greater number of responses than did those subjects administered (and correctly informed of) a FI\textsubscript{60}/FI\textsubscript{100} schedule, \( H(2) = 20.2, p < 0.001 \). (Appendix 4 should be referred to for a listing of the number of responses made by each subject.) It is thus apparent that subjects receiving illusory instructions tended to respond as would be expected if the schedule erroneously described to them had actually been administered.

The Awareness of Subjects Receiving Illusory Instructions

Three raters, "blind" to the specific group assignments of subjects but aware of the intent and procedure of the study, assessed the responses of those twenty subjects receiving illusory instructions to both the Concurrent and the Postconditioning Questionnaires. At this stage, an attempt was made to come to some joint decision concerning the nature of the rule formulated by each subject describing the relationship between their responding and the accumulation of points on the counter. Decisions were made for two points in time: (a) the rule that subjects had formulated by at least the conclusion of the third interval of the conditioning trial per-
iod was inferred from their responses to the Concurrent Questionnaire, while (b) the rule that they had formulated by at least the conclusion of the fourth interval was assessed from their responses to the Postconditioning Questionnaire.

A subject was then categorized as aware of the FI₆₀/FI₁₀₀ schedule if they were assessed to have formulated a rule in some way related to the FI₆₀/FI₁₀₀ schedule. It should be noted that only those subjects assessed to have formulated a rule describing a schedule other than the FI₆₀/FI₁₀₀ contingency were categorized as unaware of the FI₆₀/FI₁₀₀ schedule. That is, those subjects whose responses provided insufficient data from which any specific schedule could be discerned were excluded from further analysis. Table 3.3 summarizes the categorization of these twenty subjects with respect to their awareness of the FI₆₀/FI₁₀₀ schedule.

Insert Table 3.3 about here

Response Frequency and the Awareness of Subjects

A comparison of the median number of responses produced during the fourth interval of the conditioning trial period by subjects receiving illusory VI₆₀ instructions as a function of their awareness of the applied FI₆₀/FI₁₀₀ sche-
<table>
<thead>
<tr>
<th>Awareness</th>
<th>( V_{I_{60}} )</th>
<th>( V_{R_{150}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aware ( F_{I_{60}}/F_{I_{100}} )</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Unaware ( F_{I_{60}}/F_{I_{100}} )</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

*Note. Figures represent number of cases in each cell.*
dual is summarized in Table 3.4. A similar comparison for

Insert Table 3.4 about here

those subjects receiving illusory VR_{150} instructions is summarized in Table 3.5. A more complete account of the perfor-

Insert Table 3.5 about here

mance of subjects receiving illusory instructions as a function of their awareness of the applied FI_{60}/FI_{100} schedule is given in Appendix 4.

As predicted, a Mann-Whitney U-test (Kirk, 1968) showed that those subjects who had received illusory VI_{60} instructions but who had become aware of the FI_{60}/FI_{100} schedule produced significantly fewer responses than did those subjects receiving the same illusory VI_{60} instructions but who had remained unaware of the FI_{60}/FI_{100} schedule, U'(4,4)=1, p<.05.

However, a Mann-Whitney U-test failed to support the prediction that those subjects receiving illusory VR_{150} instructions and who remained unaware of the FI_{60}/FI_{100} schedule would produce significantly more responses than would those subjects receiving the same illusory VR_{150} instructions but who had become aware of the FI_{60}/FI_{100} schedule, U'(2,4)=3,
TABLE 3.4
The Median Number of Lever-Presses Produced During the Fourth Interval of the Conditioning Trial Period By Subjects Receiving Illusory VI_{60} Instructions As a Function of Their Assessed Rule-Formation

<table>
<thead>
<tr>
<th>Assessed Rule-Formation</th>
<th>( F_{100}/F_{100} ) Related</th>
<th>Other(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>576</td>
</tr>
<tr>
<td></td>
<td>(4)</td>
<td>(4)</td>
</tr>
</tbody>
</table>

Note. Number of subjects is given in parentheses ( ).
a. All four subjects in this group were assessed to have developed a rule describing a VI schedule.
TABLE 3.5
The Median Number of Lever-Presses Produced During the
Fourth Interval of the Conditioning Trial Period
By Subjects Receiving Illusory $VR_{150}$
Instructions as a Function
of Their Assessed Rule-Formation

<table>
<thead>
<tr>
<th>Assessed Rule-Formation</th>
<th>$FI_{60}/FI_{100}$ Related</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1408.5</td>
<td>1986.5</td>
</tr>
<tr>
<td></td>
<td>(2)</td>
<td>(4)</td>
</tr>
</tbody>
</table>

Note. Number of subjects is given in parentheses ( ).
.05. It must not be overlooked that this lack of statistical significance could have been due to the extremely small n of the sample.

The Pattern of Responding and the Awareness of Subjects Receiving Illusory Instructions

Cumulative records of responding were graphed for the fourth interval or segment of the conditioning trial period for each of the twenty subjects receiving illusory VR<sub>150</sub> or VI<sub>60</sub> instructions. A rater, experienced in the interpretation of cumulative records and "blind" to the specific group assignments of subjects, attempted to predict from the respective cumulative record the schedule of reinforcement that the subject's pattern of behavior indicated was being applied. A second rater, similarly "blind" to the specific group assignments of subjects, similarly assessed the cumulative records of response; inter-rater agreement was high (.90) on the classification of the cumulative records.

A decision was then made from the first rater's predictions on whether the subject appeared to be responding as if under a FI schedule. Table 3.6 indicates that those subjects

______________________________
Insert Table 3.6 about here
______________________________

who received illusory instructions and who were assessed to
TABLE 3.6
The Pattern of Responding During the Fourth Interval
By Subjects Given Illusory Instructions
As a Function of Their Assessed Rule-Formation

<table>
<thead>
<tr>
<th>Pattern of Response</th>
<th>( \text{FI}<em>{60}/\text{FI}</em>{100} ) Related</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>FI Related Pattern</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>7</td>
</tr>
</tbody>
</table>

Note. Figures in each cell represent the number of subjects observed in each of the four conditions
a. At the conclusion of the fourth interval of the conditioning trial period
be aware of the FI\textsubscript{60}/FI\textsubscript{100} schedule tended to be more frequently seen as displaying a pattern of responding seemingly under the control of, or being shaped by, the FI schedule than did those subjects receiving illusory instructions but who remained unaware of the FI\textsubscript{60}/FI\textsubscript{100} schedule (a test for the significance of the difference between two independent proportions was significant beyond the .0007 level). However, it is perhaps of greater significance to note the "off-quadrant" occurrence of a subject whose pattern of response indicated control by the FI schedule eventhough he was assessed to be unaware of the FI\textsubscript{60}/FI\textsubscript{100} schedule (see Figure 3.1). That is, for this particular subject, the FI schedule would seem to have come to shape, or control, the subject's behavior eventhough the subject was reportedly unaware of the FI schedule.

Performance on the Recognition Threshold Task and the Awareness of Subjects

Normative data collected for each of the five groups of sentences of the Recognition Threshold Task (see Appendix 5) shows there to be an increase in stimulus clarity as one progresses from the first to the tenth copy of each of the five sentences. Tables 3.7 and 3.8 give the median level of

Insert Tables 3.7 & 3.8 about here
The cumulative record of the "off-quadrant" case
$\sum R_3$

- Time (secs.)

O. DESIGNATES $S_{R^+}$
TABLE 3.7

The Median Level of Recognition of the Sentence of the Recognition Threshold Task Describing the FI\textsubscript{60}/FI\textsubscript{100} Schedule By Subjects Receiving Illusory VR\textsubscript{150} Instructions As a Function of Their Awareness of the FI\textsubscript{60}/FI\textsubscript{100} Schedule

<table>
<thead>
<tr>
<th>Awareness of Subject</th>
<th>Aware FI\textsubscript{60}/FI\textsubscript{100}</th>
<th>Unaware FI\textsubscript{60}/FI\textsubscript{100}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

Note. The lower the value, the lower the level of stimulus clarity at which the sentence was completely recognized
TABLE 3.8
The Median Level of Recognition of the Sentence of the Recognition Threshold Task Describing the $FI_{60}/FI_{100}$ Schedule By Subjects Receiving Illusory $VI_{60}$ Instructions As a Function of Their Awareness of the $FI_{60}/FI_{100}$ Schedule

<table>
<thead>
<tr>
<th>Awareness of Subject</th>
<th>Aware $FI_{60}/FI_{100}$</th>
<th>Unaware $FI_{60}/FI_{100}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.5</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Note. The lower the value, the lower the level of stimulus clarity at which the sentence was completely recognized.
complete recognition of the sentence of the Recognition Threshold Task describing the FI\textsubscript{60}/FI\textsubscript{100} schedule of reinforcement for subjects receiving illusory VR\textsubscript{150} and VI\textsubscript{60} instructions, respectively, as a function of their assessed awareness of the FI\textsubscript{60}/FI\textsubscript{100} schedule. In both cases, contrary to expectation, unaware subjects come to recognize the sentence of the Recognition Threshold Task at a lower level of stimulus clarity than do those subjects aware of the FI\textsubscript{60}/FI\textsubscript{100} schedule (a Mann-Whitney U-test does not indicate, however, these differences to be significant: for subjects receiving illusory VR\textsubscript{150} instructions, U(2,4)=2.5, \( p > .05 \), while for those subjects receiving erroneous VI\textsubscript{60} instructions, U(4,4)=5.5, \( p > .05 \)). From the data it would seem that performance on a Recognition Threshold Task is not a valid indicator of the subject's awareness of the FI\textsubscript{60}/FI\textsubscript{100} schedule of reinforcement.
CHAPTER IV
DISCUSSION

The present study would seem to support the contention that when a subject's beliefs concerning the nature of the response-reinforcement contingencies differ from actuality, the subject's behavior comes, at best, weakly under the control of the actual contingencies until continued experience instills more realistic beliefs (Bandura, 1971; Kaufman et al., 1966). The data do not seem to support, however, the cognitivist's view that behavior is not shaped by its response-reinforcement contingencies unless the subject is aware of them.

Subjects receiving illusory instructions describing a schedule other than that to be administered responded as if their behavior was under the control of the illusory rather than the administered contingencies (schedule). Subjects receiving erroneous VR₁₅₀ instructions produced a greater number of responses than did those subjects receiving erroneous VI₆₀ instructions, who in turn produced a greater number of responses than did those subjects administered (and accurately preinformed of) the FI₆₀/FI₁₀₀ schedule. But it should not be construed that the instructions themselves directly influenced the responding of subjects. Rather, giving subjects erroneous instructions tended to produce in subjects erroneous beliefs concerning the applied schedule.
In turn, the accuracy of these beliefs concerning the applied schedule moderated the performance of subjects receiving illusory instructions. That is, subjects receiving illusory VI\textsubscript{60} instructions but who became aware of the FI\textsubscript{60}/FI\textsubscript{100} schedule tended to respond as if under greater control of the FI\textsubscript{60}/FI\textsubscript{100} schedule than did those subjects receiving the same illusory instructions but who did not become aware of the FI\textsubscript{60}/FI\textsubscript{100} schedule. Subjects in the former group produced significantly fewer responses than did those subjects in the latter group.

Although not statistically significant, the trend for subjects receiving illusory VR\textsubscript{150} instructions was in a similar direction. That is, subjects in this group who were assessed to be aware of the FI\textsubscript{60}/FI\textsubscript{100} schedule tended to produce fewer responses than did those subjects in the group who were unaware of the FI\textsubscript{60}/FI\textsubscript{100} schedule. As has been pointed out previously, the lack of statistical significance for this comparison may have been due to the extremely small sample size of the aware subgroup; it appears that it was more difficult for subjects receiving illusory VR\textsubscript{150} instructions to discern the FI\textsubscript{60}/FI\textsubscript{100} schedule than it was for subjects receiving erroneous VI\textsubscript{60} instructions.

Evidence presented thus far seems to indicate that awareness of the response-reinforcement contingencies is, if not
a necessary prerequisite, at least an important antecedent of the control of the behavior by those contingencies. However, the data relating the pattern of the subject's responding to the awareness of the subject of the \( \text{FI}_{60}^{/}/\text{FI}_{100} \) schedule would seem to indicate that awareness of the schedule need not necessarily precede control of the behavior by the schedule. That is, one of fourteen subjects demonstrated a response pattern that indicated control by the FI schedule even though that subject was not seen as being aware of the \( \text{FI}_{60}^{/}/\text{FI}_{100} \) schedule. If it is (or can be) assumed that the above was not a case of misclassification (that is, that either the awareness of the subject or the schedule predicted from the cumulative record of response were errors in classification by the judges) then we may conclude that although unaware conditioning is at best weak, it does occur.

Is the above example due to an error (or errors) of classification? It must be noted that, although the possibility that the awareness of the subject was misclassified cannot be completely discounted, care was taken in this study to prevent such mislabelling. As noted previously, the criteria used in assigning subjects to the unaware category were fairly stringent, with ambiguous cases being discarded from further analyses. Even with this conservative approach, it is conceivable that misclassification of the awareness of
subjects did occur. For example, it is conceivable that subjects, although aware of the FI$_{60}$/FI$_{100}$ schedule, may have been hesitant, or reluctant, to admit or give any indication of this awareness.

The accuracy of the prediction made from the cumulative record of the subject concerning the schedule of reinforcement it appeared his behavior was being shaped by may also be questioned. However, the reliability of such predictions was high, with inter-rater agreement being .90; further, both raters were in agreement on the classification of the schedule predicted for the "off-quadrant" subject.

In retrospect, the evidence from this study seems to best support the view of Farber (1963) and his reciprocal interaction approach to the role of awareness in conditioning. That is, although control by the response-reinforcement contingencies appears to be at best weak unless the subject is aware of them, control by the contingencies can occur without the awareness of the subject of the contingencies. Thus, the data would seem to lend support to the nonmediational faction in the controversy surrounding the role of awareness in conditioning.

What relevance do the above findings have for the more applied-oriented psychologist? Increasingly (e.g., Bowers, 1975) the call has come forth to increase the subtlety.
of the behavior change program, to decrease the awareness of the subject of the response-reinforcement contingencies to be manipulated, in order to facilitate the effectiveness of such change programs. It should be apparent that increasing the nonawareness of the subject of the response-reinforcement contingencies may have just the opposite effect of facilitating effective behavior change. If we assume that a subject's beliefs concerning the nature of the applied contingencies tend to diverge from reality or actuality as we make less and less explicit those contingencies, then are we not by increasing the subtlety of the change program also increasing the risk that the client's behavior will come under the control of, or be shaped by, the illusory, or erroneous, beliefs developed rather than the actual contingencies. Under such conditions, the behavior change program may become quite ineffective in achieving the desired changes in behavior.

Finally, we turn to the performance of subjects on the Recognition Threshold Task as a function of their awareness of the schedule described in the sentence of the Recognition Threshold Task. Evidence does not tend to support the contention of Klein and Weiner (1966) that subjects aware of a response-reinforcement relationship should come to recognize a sentence describing that relationship at a lower
level of stimulus clarity than would subjects who are not aware of that contingency. In fact, the trend of the data was in the opposite direction. Subjects receiving illusory instructions and who were assessed to be unaware of the FI₆₀/FI₁₀₀ schedule tended to recognize the sentence of the Recognition Threshold Task describing the FI₆₀/FI₁₀₀ schedule at a lower level of clarity than did those subjects assessed to be aware of the FI₆₀/FI₁₀₀ schedule. Again, it is possible that the above results are due to the misclassification of the subjects' awareness from the responses given to the Postconditioning Questionnaire. However, as previously argued, the conservative classification of a subject as unaware must be borne in mind.

It would thus seem that one must question the validity of a recognition threshold paradigm as an alternative to the questionnaire format in the assessment of awareness. Fault may lie at one, or both, of two points: (a) the initial assumption of Klein and Weiner (1966) that the more probable a response, all other factors being constant, the lower the threshold required for the controlling stimulus may be in error, or, (b) the further assumption by Klein and Weiner (1966) that increased awareness of a particular contingency necessarily increases the strength of the verbal response describing that contingency may be inappropriate.
Evidence from this study does not pinpoint which of the above (if not both) assumptions of Klein and Weiner (1966) is inaccurate. The lack of support for a recognition threshold paradigm found in this study may have been due to the lack of validity of either, or both, assumptions. That is, the results of the present study may have been but a particular example that even though a response (in this case a verbal response) was more probable, the threshold required for the controlling stimulus was not lowered, or, that though one can assume that an increase in probability of response will in general result in a decrease in the threshold required for the controlling stimulus, there is no basis on which to assume that an increase in awareness of a schedule produces a verbal response describing that schedule at a higher strength. The present data are insufficient to delineate at which point the deficiency occurs. However, regardless of the point of deficiency, what is apparent is the lack of validity, or utility, of a recognition threshold paradigm in assessing the awareness of subjects. Although alternatives to the questionnaire paradigm are sorely needed, we have no choice but to shelve a recognition threshold paradigm.
REFERENCES


Haggard, E.A. Experimental studies in affective processes: I. Some effects of cognitive structure and active participation on certain autonomic reactions during and following experi-


Klein, B., & Weiner, M. Awareness in the 'learning without awareness' paradigm. Journal of Experimental Research in


Thorndike, E.L., & Rock, R.T.  Learning without awareness of what is being learned or intent to learn it.  Journal of Experimental Psychology, 1934, 17, 1.


1. It is interesting that Klein and Weiner (1966) never attempted to validate their measure by comparing the estimate of the awareness of a subject using a recognition threshold paradigm with estimates made using other techniques.

2. It is conceivable that this result is merely an artifact of the insensitivity of the assessment technique used: that is, although the subject may have been made aware, the instrument may not have been sensitive enough to detect this awareness.

3. This finding provides further support that the subject's awareness of the learning contingencies may be manipulated by varying the instructions describing the contingencies.

4. "When an FI schedule of reinforcement is imposed on a subject, the behavior of the subject is progressively modified until, for the wide variety of species, responses, reinforcers, and parameters that have been studied, the pattern of cumulative responding comes to assume a characteristic form familiarly known as the scallop. The scallop is an upward concavity of the cumulative record of individual intervals, representing a generally increasing rate of responding through the interval (Dews, 1970)."

5. For a review of the use of the Kruskall-Wallis statistic in the testing of directional hypotheses in the multi-sample case, see Bradley (1968), pp. 134-138.
APPENDIX 1
The Two Questions Comprising the Concurrent Questionnaire
(1) Is there any systematic relationship between the pressing of LEVER A and the registering of points on the counter? (Circle the correct answer)

(a) No

(b) Yes

If your answer to the above is yes, describe that relationship.

(2) Which of the following five (5) statements best describes the degree of confidence or uncertainty that you have in the answer you have just given? (Circle your choice)

(a) I am completely certain my answer is correct

(b) I think my answer may be correct

(c) My answer was a guess

(d) I think my answer may be wrong

(e) I am completely certain my answer is wrong
APPENDIX 2

The Postconditioning Questionnaire
In interpreting the data from an experiment, the results become more meaningful when the subjects' understanding of, as well as their thoughts and ideas concerning the experiment are known. The questions on the following pages are meant to assess what your ideas and thoughts were about this experiment. Please answer each of the questions on the following pages as frankly and as completely as you can. Please answer them in their numbered order, and do not go on to the next question until you have answered the question preceding it, and given your answer for that question to the experimenter. Begin answering the questions after filling out the following information:

AGE
SEX

Thank you for your cooperation

(1) It is a common phenomenon for subjects of an experiment to form hypotheses concerning the intent, or objective, of the experiment. What do you think this experiment tried to demonstrate? Describe as fully as possible.

(1A) Which of the following five (5) statements best describes the degree of confidence or uncertainty that you have in the answer you have just given? (Circle your choice)
(a) I am completely certain my answer is correct
(b) I think my answer may be correct
(c) My answer was a guess
(d) I think my answer may be wrong
(e) I am completely certain my answer is wrong

An important consideration of any study is the subject's perception of and reaction to the experimental situation or setting. The following two questions deal specifically with your perception of the setting of this study.

(2) Were there any distractions or cues from the other room?
   No
   Yes (Please describe what these were)

(3) Was there anything in the experimental setting that hindered or helped you in any way in focusing on and manipulating the experimental apparatus?
   No
   Yes (Please describe what these were)

(4) Was there a systematic relationship between pressing LEVER A and the registering of points on the counter?
   No
   Yes (Please describe the relationship as completely as possible)
(4A) Which of the following five (5) sentences best describes the degree of confidence or uncertainty that you have in the answer you have just given? (Circle your choice)

(a) I am completely certain my answer is correct
(b) I think my answer may be correct
(c) My answer was a guess
(d) I think my answer may be wrong
(e) I am completely certain my answer is wrong

(5) Was there any relationship between the BLU£ LIGHT being either off or on, and the schedule of reinforcement that you received (that is, the recording of points on the counter for the pressing of LEVER A)?

NO

YES (Please describe this relationship as completely as possible)

(5A) Which of the following five (5) statements best describes the degree of confidence or uncertainty that you have in the answer you have just given? (Circle your choice)

(a) I am completely certain my answer is correct
(b) I think my answer may be correct
(c) My answer was a guess
(d) I think my answer may be wrong
(e) I am completely certain my answer is wrong

(6) Did the instructions you received accurately describe the schedule of reinforcement that you actually were responding under?

YES

NO (Please describe any inaccuracies in the instructions as completely as possible)

(6A) Which of the following five (5) statements best describes the degree of confidence or uncertainty that you have in the answer you have just given? (Circle your choice)

(a) I am completely certain my answer is correct
(b) I think my answer may be correct
(c) My answer was a guess
(d) I think my answer may be wrong
(e) I am completely certain my answer is wrong

(7) Had you heard about this experiment before participating in it today?

NO

YES (Please describe what you had been informed of)
(8) Do you really believe the instructions that extra credit hours can be earned in this experiment if a certain number of points, or reinforcements, are accumulated on the counter?
   YES________
   NO________

(9) If your answer to the preceding question was YES, rate your desire to earn those extra credit hours:
   HIGH________
   MODERATE____
   LOW________
   DON'T REALLY CARE____
APPENDIX 3

The Sentences of the Recognition Threshold Task
CRF Schedule:

A point registered on the counter for each response produced.

VI\textsubscript{60} Schedule:

The counter registered a point only for a response produced after 60 seconds, on the average, had passed from a previous reinforcement.

VR\textsubscript{150} Schedule:

On the average, 150 responses had to be produced for each point registered on the counter.

FR\textsubscript{150} Schedule:

150 responses had to be produced for each point registered on the counter.

FI\textsubscript{60}/FI\textsubscript{100} Schedule:

For half of the trial period, the counter registered a point only for a response produced after 60 seconds had passed from a previous reinforcement, while for the other half of the trial time the counter registered a point only for a response produced after 100 seconds had passed from a previous reinforcement.
APPENDIX 4
The Number of Responses Produced By Subjects During the Conditioning Trial Period as a Function of the Instructions Received Prior to the Conditioning Trial Period and the Assessed Awareness of these Subjects at the Conclusion of the Conditioning Trial Period
TABLE 1
The Number of Responses Produced By Each Subject During the Conditioning Trial Period as a Function of the Instructions Received Prior to the Conditioning Trial Period

Pre-Trial Instructions

<table>
<thead>
<tr>
<th>Accurate</th>
<th>Erroneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>FI\textsubscript{60}/FI\textsubscript{100}</td>
<td>VI\textsubscript{60}</td>
</tr>
<tr>
<td>31</td>
<td>1226</td>
</tr>
<tr>
<td>77</td>
<td>1430</td>
</tr>
<tr>
<td>36</td>
<td>390</td>
</tr>
<tr>
<td>44</td>
<td>191</td>
</tr>
<tr>
<td>164</td>
<td>54</td>
</tr>
<tr>
<td>65</td>
<td>238</td>
</tr>
<tr>
<td>58</td>
<td>465</td>
</tr>
<tr>
<td>562</td>
<td>459</td>
</tr>
<tr>
<td>32</td>
<td>395</td>
</tr>
<tr>
<td>367</td>
<td>56</td>
</tr>
</tbody>
</table>
TABLE 2
The Number of Responses Produced During the Fourth Interval By Subjects Receiving Illusory Instructions As a Function of Their Awareness of the Applied FI$_{60}$/FI$_{100}$ Schedule

<table>
<thead>
<tr>
<th>Illusory Instructions</th>
<th>VI$_{60}$</th>
<th>VR$_{150}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aware FI</td>
<td>11</td>
<td>704</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>2113</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>220</td>
<td></td>
</tr>
<tr>
<td>Unaware</td>
<td>643</td>
<td>3199</td>
</tr>
<tr>
<td></td>
<td>39</td>
<td>436</td>
</tr>
<tr>
<td></td>
<td>1355</td>
<td>1258</td>
</tr>
<tr>
<td></td>
<td>509</td>
<td>2715</td>
</tr>
</tbody>
</table>
APPENDIX 5
Norms for the Recognition
Threshold Task
TABLE 1
The Mean and Standard Deviation
for the Proportion of Words Recognized from
Each of the Ten Copies of
the Five Sentences

<table>
<thead>
<tr>
<th>Copy</th>
<th>CRF</th>
<th>PI</th>
<th>FR</th>
<th>VR</th>
<th>VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>.73</td>
<td>.5435</td>
<td>.3808</td>
<td>.3657</td>
<td>.3684</td>
</tr>
<tr>
<td>2</td>
<td>.78</td>
<td>.6655</td>
<td>.4077</td>
<td>.4688</td>
<td>.4980</td>
</tr>
<tr>
<td>3</td>
<td>.79</td>
<td>.8585</td>
<td>.4692</td>
<td>.5886</td>
<td>.6005</td>
</tr>
<tr>
<td>4</td>
<td>.815</td>
<td>.95</td>
<td>.65</td>
<td>.6875</td>
<td>.7051</td>
</tr>
<tr>
<td>5</td>
<td>.82</td>
<td>.9768</td>
<td>.7693</td>
<td>.8065</td>
<td>.7596</td>
</tr>
<tr>
<td>6</td>
<td>.945</td>
<td>.9963</td>
<td>.8808</td>
<td>.9188</td>
<td>.9460</td>
</tr>
<tr>
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<td>.98</td>
<td>1.000</td>
<td>.9577</td>
<td>.9907</td>
<td>.973</td>
</tr>
<tr>
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<td>.995</td>
<td>1.000</td>
<td>.9923</td>
<td>1.000</td>
<td>.9798</td>
</tr>
<tr>
<td>9</td>
<td>1.00</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
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<td>10</td>
<td>1.00</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>.2704</td>
<td>.2135</td>
<td>.3393</td>
<td>.2256</td>
<td>.2173</td>
</tr>
<tr>
<td>2</td>
<td>.2581</td>
<td>.2052</td>
<td>.3399</td>
<td>.3045</td>
<td>.2740</td>
</tr>
<tr>
<td>3</td>
<td>.2427</td>
<td>.1513</td>
<td>.3097</td>
<td>.2071</td>
<td>.2429</td>
</tr>
<tr>
<td>4</td>
<td>.2265</td>
<td>.0436</td>
<td>.3013</td>
<td>.2265</td>
<td>.1887</td>
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<tr>
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<td>.2205</td>
<td>.0346</td>
<td>.1929</td>
<td>.1786</td>
<td>.1691</td>
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<td>.1118</td>
<td>.0141</td>
<td>.1319</td>
<td>.1292</td>
<td>.0640</td>
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<td>.0600</td>
<td>.0000</td>
<td>.0854</td>
<td>.0173</td>
<td>.0500</td>
</tr>
<tr>
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<td>.0224</td>
<td>.0000</td>
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<td>.0000</td>
<td>.0361</td>
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<td>9 - 10</td>
<td>.0000</td>
<td>.0000</td>
<td>.0000</td>
<td>.0000</td>
<td>.0000</td>
</tr>
</tbody>
</table>
FIGURE 1
Graphical representation of the mean proportion of words recognized from each of the ten copies of the five sentences
TABLE 2
The Norms for the Level of Complete Recognition of Each of the Five Sentences of the Recognition Threshold Task

<table>
<thead>
<tr>
<th>Sentence</th>
<th>CRF</th>
<th>VR</th>
<th>VI</th>
<th>FR</th>
<th>FI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.2</td>
<td>6.45</td>
<td>6.8</td>
<td>6.1</td>
<td>4.9</td>
</tr>
<tr>
<td>St. Dev.</td>
<td>2.8</td>
<td>1.07</td>
<td>1.4</td>
<td>2.3</td>
<td>1.3</td>
</tr>
</tbody>
</table>
APPENDIX 6

The VI\textsubscript{60} Schedule of Reinforcement
### TABLE 1
The Time Intervals Between Reinforcements

<table>
<thead>
<tr>
<th>Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
</tr>
<tr>
<td>26</td>
</tr>
<tr>
<td>100</td>
</tr>
<tr>
<td>46</td>
</tr>
<tr>
<td>90</td>
</tr>
<tr>
<td>94</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>74</td>
</tr>
</tbody>
</table>

*Note. Read down columns.*
APPENDIX 7

The VR_{150} Schedule of Reinforcement
TABLE 1
The Cumulative Number of Responses Required for a Reinforcement

<table>
<thead>
<tr>
<th>Responses Produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>179</td>
</tr>
<tr>
<td>739</td>
</tr>
<tr>
<td>1335</td>
</tr>
<tr>
<td>2191</td>
</tr>
<tr>
<td>3035</td>
</tr>
<tr>
<td>3669</td>
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<td>4328</td>
</tr>
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<td>5412</td>
</tr>
<tr>
<td>6168</td>
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<tr>
<td>7067</td>
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</table>

Note. Read across columns