AUTO-SHAPING A SIMPLE OPERANT IN HUMANS USING SLIDE PRESENTATION AS A REINFORCER.

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ABSTRACT

Using slide presentation as a reinforcer a simple operant was auto-shaped in human subjects. The operant (bar tapping) was established, for most subjects, in an auto-shaping technique where a discriminative stimulus (S^D) was available. In this technique a response made in the presence of S^D was immediately reinforced. However, where no response was emitted in the presence of S^D the procedure was recycled, i.e. Chain FT 10-sec. (darkness) FT 10-sec. (S^D), with no reinforcement delivered.

Response-independent schedules (FT 10-sec.) were used
(i) for an analysis of superstitutious responding, and
(ii) for a control condition. Responding was not maintained under the non-contingent conditions but was re-established under the response-contingent (training) schedules.

The educational implications of auto-shaping are discussed.

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Introduction

The experimental analysis of behaviour has as its cornerstone the demand for objective interpretations constructed on operational definitions. Skinner (1969, p. 7) puts forward the contemporary position with regard to the analysis of behaviour. For Skinner "An adequate formulation of the interaction between an organism and its environment must always specify three things, 1) the occasion upon which the response occurs, 2) the response itself and, 3) the reinforcing consequences. The interrelationships between them are the 'contingencies of reinforcement'." For studies that use animals as subjects these specifications have been vigorously investigated. This intensity has not been of a similar magnitude with human subjects. The major disadvantage with human subjects is their non-exposure to rigid laboratory control. Human subjects cannot be controlled for breeding, complete environmental interaction or weight. Without using food deprivation schedules the main problem is in finding a suitable stimulus to use as a reinforcer, to which human subjects will respond. This study attempts to demonstrate the establishment and maintenance of a simple contingency-shaped operant in humans by using slide presentation as a reinforcer.

For Kish (1966) sensory reinforcement exists as a fifth category of reinforcement. To the existing, and classical position stemming from the needs-reduction background, the events capable of producing reinforcing effects such as primary (i) positive and (ii) negative reinforcement, secondary (iii) positive and (iv) negative reinforcement, has been added sensory reinforcement. In his article Kish states that

> "Sensory reinforcement will be used to refer to a primary reinforcement process resulting from the response-contingent presentation or removal of stimuli of moderate intensity which cannot be subsumed under classes i-iv (above). It is unlikely that such a category of reinforcers reflects a basic process different from the more traditional reinforcers." (p. 110)

Experimental evidence is cited in favour of a relationship between a response increment and the presentation of contingent sensory stimuli. It is towards the use of such response-contingent reinforcement with human subjects that the present experiment is directed.

Skinner (1954) reported one of the first experiments dealing with the analysis of human behaviour entitled: "A new Method for the Experimental Analysis of the Behavior of Psychotic Patients". A subsequent experiment reported by Lindsley (1956) went into much greater

detail of the experimental controls. After discussing the theoretical background Lindsley outlined operant procedures. Besides the usual type of modified vending machine for delivery of consumable or monetary goods[1] there are devices for presentation of musical, fluid or visual materials as reinforcing stimuli. Of particular interest is "an apparatus that presents colored slide images on the back of a translucent plexi-glass screeen on the wall of the room" (p. 127). It was reported that while most patients responded to contingent pictorial reinforcement, their rates of responding varied with the pictorial themes.

Apart from the consistent experimental work reported with light onset, offset, increment and decrement with animals during the 1950's. the most significant study with humans was that done by Antonitis and Barnes (1961). They used nursery school children as subjects in a free operant setting where two lever pressing devices were concurrently present in the school playing area. They found

> "that subject controlled onset or termination of a spot of light exercised a powerful reinforcing effect on the lever pressing behaviour of the groups, the effect diminishing in successive days. When pictorial stimuli were added, the results suggested that onset of light was more reinforcing than termination" (p. 110).

Their study cannot offer an analysis of individual performance under the various contingencies. It does indicate some measure of control over the lever-pulling response. Using movie cartoons Baer (1960, 1962) observed responding by nursery school children to a lever bar. By using TV viewing as a positive reinforcer Lindsley (1962) made the viewing contingent upon the emission of tapping responses. These studies are consistent in showing that pictorial stimuli can be made contingent upon operant responses. Each of the experiments discussed employs what Kish calls sensory reinforcement with human subjects. It is not possible to analyse the fine details of what are involved in the actual contingencies since each response involves: light onset, visual exploration, manipulatory behaviour, curiosity and kinesthetic feedback. It should be possible then, experimentally, to make slide-viewing contingent upon an operant with human subjects.

Skinner (1948) presented food on a fixed time schedule to pigeons, regardless of their behaviour. With six out of eight birds he observed

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1. The use of token reinforcement has its roots firmly planted in the experimental analysis of animal behaviour, as a direct extrapolation from infra-human to human subjects.

a regular, idiosyncratic, repetitive behavioural action by the bird between food presentations. In his experiment superstition refers to the behaviour when the delivery of food is entirely unconditional with regard to both the stimulus or the behaviour. In another experiment (Morse & Skinner, 1957) the delivery of food is made conditional on the behaviour but not with regard to the stimulus. The pigeon in this experiment engaged in sensory superstition when the change in rate of responding coincided with the discriminative stimulus. While tentative in their concluding statement these authors note that "it may at least be said that incidental stimuli adventitiously related to reinforcement may acquire marked discriminative functions" (p. 311).

An alternative to these experiments is for the delivery of food to be conditional on the stimulus but unconditional with regard to the responses. This is the approach taken by Brown and Jenkins (1968). For their experiment a standard pigeon key is illuminated for 8-sec. prior to the 4-sec. food tray presentation. The first key peck to the key was taken as the criterion. Their analysis focussed on conditions for arranging stimulus and food presentation. The authors state that "the emergence of the key peck may be characterised as a process of auto-shaping on which a direction is imposed by the species-specific tendency of the pigeon to peck at the things it looks at" (p.2). And later they note

> "our account..... relies on the shaping action of reinforcement and the acquisition of discriminative control over the shaped response as the result of the joint presence of the stimulus and the reinforced responses" (p. 7).

Sidman and Fletcher (1968) demonstrated the procedure with monkeys and Gardner (1969) with quail. Sidman and Fletcher used three keys. A key was illuminated for 8-sec. prior to the food tray presentation. No response during the 8-sec. did not affect the scheduled food presentation. A response on the appropriate illuminated key was immediately reinforced. All other responses were non-contingent. The authors point out that "the success of the auto-shaping procedure does not require that the animal's responses to the key be the same as its responses to the reinforcer" (p. 308). It appears practicable to conceive of an experiment in which two different responses are required of a human subject; one, a tapping response to a bar, the other a visual scanning response of the reinforcer. It may be questioned whether the Sidman and Fletcher study could be included in the category

of auto-shaping. In a suitably designed experiment it could be shown that there is a distinct difference in the behaviour where reinforcement is immediately available and where it is delayed.

To date the auto-shaping procedure has proved successful with pigeons, monkeys and quail. No mention, as far as is known, has been made of the use of human subjects. Not only does the auto-shaping technique seem a useful way of obtaining an operant response when the subject has not been instructed, but it would be a useful way of testing the effectiveness of the reinforcer.[1]

The acquisition and maintenance of superstitious responding in pigeons has been reported by both Fenner (1969) and Neuringer (1970). Fenner reinforced the first key peck of pigeons in an auto-shaping procedure adopted from the Brown and Jenkins (1968) study. The first key peck emitted during the auto-shaping was reinforced. Throughout three sessions (each of about 200 reinforcements) responding was maintained. Neuringer explores the acquisition of a superstitious response and in particular asks whether a relatively few reinforcements are sufficient to establish a superstition. He notes that in most of the experiments on superstitious responding each subject has received hundreds or thousands of response-produced reinforcements for key pecking before responding superstitiously on the key. In his study Neuringer reinforced the first three key pecks made by food-deprived but naive pigeons and showed that responding can be maintained with only three reinforced responses. The Fenner experiment shows how effective one reinforced response can be in maintaining responding. This suggests the setting up of an experiment in which both of these conditions can be tested.

Herrnstein (1966) has presented a review in which a distinction is made between superstition as an explanation of (i) the laboratory phenomenon with animals and, (ii) aspects of human behaviour. He suggests that human superstitions in the non-laboratory setting are usually based on convention. As humans operate in a social context superstitions can be learned, they are specific to a particular society. The variability of human superstitious responding (e.g. not walking under a ladder, carrying a talisman) is less than that observed in the laboratory (Skinner's pigeons engaged in idiosyncratic non-instrumental aspects of instrumental behaviour). According to Herrnstein the

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1. See Implications for Education, page 21.

idiosyncratic aspects of human behaviour are referred to as style, taste or preference.

In the analysis of animal studies, emphasis has been placed on differences in responding as a result of accidental contingencies of reinforcement. For humans the analysis has been related to the ways in which persons carry out particular instrumental tasks. A study in which human behaviour is part of the contingencies of reinforcement would extend the studies that have been done with animal subjects.

Human superstitious behaviour has not been subjected to an experimental analysis in the naturalistic setting since the operating contingencies, or lack of them, have not been specified. The typical method for the study of human superstitious responding in the laboratory is through the use of two to four keys or buttons on which the subject responds. Where only one of the buttons is related to a schedule of reinforcement, presses on other irrelevant buttons is labelled superstitious, or collateral behaviour (Bruner and Revusky, 1961; Catania and Cutts, 1963; Randolph, 1965; Edwards and Dart, 1967). In each of these experiments there is evidence of responding not linked to the scheduled contact button.

It was proposed to set up an experiment to investigate human superstitious responding in a controlled laboratory environment. Extinction on a non-contingent schedule where free reinforcements are available will also be used as a control; it will enable a comparison to be made with response-contingent schedules. Rescorla and Skucy (1969) note that an extinction procedure which continues the reinforcer but makes its presentation independent of the response is a reasonable one because it yields extinction results as those usually obtained.

The recent and extensive article by Baron, Kaufman and Stauber (1969) deals specifically with the effects of instructions and reinforcement feedback with human subjects. The authors note that previous studies have shown that:

(i) when instructions about the desired response are omitted, substantial numbers of subjects may fail to acquire the response despite scheduling of reinforcing contingencies deemed favourable for the response;

(ii) additional instructions about the desired response result in rapid adoption of the response, and may induce inappropriately high rates, particularly on temporally-based schedules;

(iii) detailed instructions about reinforcing contingencies, as well as the response itself, typically produce rates of responding approximating the requirements of the reinforcement schedule, and

(iv) several studies have shown that instructions about the reinforcement schedule can produce behaviours more in accord with instructions than with actually scheduled reinforcement.

The Baron et al. experiment extended earlier work done with humans by an analysis of the instructional effects on fixed-interval schedules of reinforcement. Their conclusions come under two broad categories;

> "that instructions represent an external, observable determinant of behaviour whose influences, although complex can be investigated in a straightforward, objective manner, and instructions given to humans provide a means of evoking and controlling operant behaviors whose establishment in other ways would be impractical... (and) .... the use of instructional manipulations in the study of human behavior may be viewed as playing a role parallel to such manipulations as deprivation and drug administration in work with subhuman subjects; by increasing the probability in this way a means is provided whereby the controlling influences of reinforcement contingencies may be studied effectively" (p. 711).

In a newly designed experiment it would appear appropriate for the schedules to be simple, and without instructions since these would effectively change the responding in crucial ways. Specifically, to instruct the subject would contaminate both the auto-shaping procedure and the non-contingent schedules. The suggestion made by Skinner (1969) that verbal communication is not a substitute for the arrangement and manipulation of schedules seemed apposite to the developing research proposal.

Premack (1965) outlines what he calls the core assumptions of the traditional account of reinforcement. Firstly, the definition of a reinforcement as any stimulus that, given a certain relation to a response, produces a change in the frequency of that response. This fundamental division of the environment has not, according to Premack, been tested. Secondly, the claim that reinforcers are trans-situational e.g. 'food, it is said, reinforces all responses' has only been supported by a collection of empirical data that have been gathered in a post hoc fashion. Again this assumption has not been tested. The third and final

> "empirical claim is that there are two classes of responses, one that is reinforcing but not reinforceable, another that in reinforceible (sic.) but not reinforcing" (p. 130),

e.g. that eating and drinking are only used as reinforcing events but not as reinforceable events, the latter case requiring a reversal of the usual procedure. Premack notes that these assumptions

> "wear empirical masks which, when they are removed, reveal fairly common sensical assumptions. The assumptions were not tested; it had already been decided what kinds of events were reinforcing and what kind not" (p. 130).

To this rather confused state, in which empirical evidence for what is meant by a reinforcer is lacking Premack indicates that

> "reinforcement involves a relation, typically between two responses, one that is being reinforced and another that is responsible for the reinforcement" (p. 132).

The basic tenet of the early (1959) experiments that Premack conducted was "any response A will reinforce any other response B, if and only if the dependent rate of A is greater than that of B" (p. 220). If responses are along a continuum with the least probable at one end and the most probable at the other, a type of response that falls at some point between these extremes will reinforce a response of less probability or itself be reinforceable by a response of greater probability. Using children as subjects, Premack (1959) showed that when both a Pin-ball machine and a Candy Dispenser were freely available, one was operated more frequently than the other. By locking the high probability machine (the one used more often when both were available) until the other machine was operated, Premack was able to make the former contingent upon the latter. The main point of his study was that "any stimulus to which the species responds can be used as a reinforcer, provided only that the rate of the response governed by the stimulus is greater than that of some other response" (p. 227).

Experimental evidence in support of Premack's theory of reinforcement has been reported with the study of non-human subjects (Premack, 1962, 1963a, 1963b, 1963c). Apart from the eating-manipulating behaviours the Premack principle has been experimentally employed with humans in other situations (Homme et al. 1963; Schaeffer et al. 1966; Fox 1966; Schaeffer 1967). The application of the Premack principle can be observed whenever behaviour can be explained in terms of response dominance. For example, Homme and Tosti (1965) used the principle with emphasis on the reinforcing response in their contingency management of motivation. These authors note that "the adaptive thing to do is to use, rather than be annoyed by, high probability behaviors. Use

them to reinforce other behaviors of lower probability in need of strengthening" (p. 149).

It seems possible however to use the Premack principle in another way. With two main responses available to the subject in a limited environment - pressing a lever, or visually scanning a complex visual stimulus in the form of a colour slide that is projected onto a screen - it is reasonable to assume that the visual-scanning response will be of a higher probability than the tapping response. If this assumption is correct (i.e. to increase tapping rate by making a higher probability visual response contingent upon it) it should be possible to make the scanning depend on the tapping (i.e. the viewing would positively reinforce the tapping). The extent to which this dependency can be shown as generally applicable to human subjects will be further evidence in support of Premack's theory.

Method

Subjects. For this experiment subjects were volunteers obtained from a local Teachers College. These volunteers signed a notice (see Appendix A) the wording of which was a modification of the Lippman and Meyer (1967) instructions. Subjects were from 1st and 2nd year classes, aged between 17 - 19 years, including males and females.

It was hoped to engage subjects who were not familiar with operant conditioning techniques. Until Friday 13th November, this was reasonably assured, but on that day students were exposed, independently by the College staff, to Skinner's introductory films on operant conditioning. There was no accompanying course reading. For the purposes of this experiment all subjects are considered naive.

Apparatus. The instrument used in this experiment has not been standardised, it was built specifically for the study. Essentially it consisted of an automatic changing slide projector, a back-projection screen, an electro-mechanical flag fitted in front of the projector lens which effectively blocked the slide from the screen except when operated, a modified morse key upon which the subject could respond by tapping, a postoffice stepper-relay which provided a feedback audio-click when the morse key circuit was completed, a small green light mounted on the morse key housing which was operated from the control room, a house-light and electric motor in the subject's room each wired to a variac (variable voltage device) operated from the control room,

and a stopwatch.

In the control room switches activated components of the apparatus. One switch was connected to the small green light (S^D). Another switch (S2) operated the solenoid which pulled the flag clear of the projector to throw the slide onto the screen. The flag remained clear of the slide projection as long as S2 maintained its circuit. Recording of the subject's responses was done by hand.

Procedure. A subject was contacted and an appointment made for an experimental session. The subject came to the building where the experiment was set up, and waited until called upon. The general written instructions were made available to the subject while in the waiting room (see Appendix B). When the subject indicated that the instructions had been read, the card was taken and the subject escorted to the door of the experimental room. When the experimenter opened the door the subject entered the room. At no time did the experimenter enter the room prior to the experiment. The slide 'THIS SLIDE IS FROM AN AUTOMATIC PROJECTOR' was shown for 90 seconds in experiments 1-4 but not in experiment 5. 30 seconds later the light and the masking noise were reduced by the variac, controlled by the experimenter. At this stage the experimental conditions were implemented. When the session terminated the experimenter took the question sheet into the experimental room. A foolscap page was headed with the question 'Briefly describe as clearly as possible, the conditions for getting slides in the present experiment'. This question was modified from the Lippman and Meyer (1967) study. When the subject indicated that the question had been answered, the written response was returned to the experimenter. The subject was required to (i) sign for receipt of the money, and (ii) read the final instructions (see Appendix C). The 50¢ was then paid.

The experimental combinations scheduled for the present study are outlined below. Each combination was labelled as an experimental condition. The conditions were arranged into experimental sessions. Guidance came from the shaping requirements. Another requirement was for the subject to be exposed twice to the response independent schedules (FT FT, i.e. condition III), once after shaping and once after training. Specific and constant training was part of each experimental session.

Table I

Combination of S^{Δ} and S^{D} arranged into Experimental Conditions

Combination[1] S^{Δ}	S^{D}	Condition
FT	FR1 1h10	I
FR1	FT	Ib
FR1	FR1	II
FT	FT	III

In the experimental sessions, outlined below, it can be noted that the training was the same for all sessions. An experimental session was made up of several conditions.

Table II

Combination of Conditions Constituting the Experimental Sessions

Experimental Session	Conditions Involved					
	shaping		response independent	training		response independent
1	I	II	III	I	II	III
2		II	III	I	II	III
3			III	I	II	III
4	Ib	II	III	I	II	III
5	I	II	III	I	II	III

Consecutive subjects were run through each session. This means that the first five subjects would take part in one each of the five sessions.

1. These are the combinations of S^{Δ} (the stimulus in the presence of which reinforcement is never available, darkness) and, S^{D} (the stimulus in the presence of which reinforcement could be delivered, green light) which are used in this study.

   FR1 indicates the occasion where the first response implements scheduled consequences.

   FR1 1h10, the occasion upon which the scheduled consequences depend on the emission of a single response in the limited time of ten seconds.

   FT the occasion where the scheduled effect is delivered independent of the subject's responding.

Results

While the operant framework provides a vehicle for the presentation of results in a completely descriptive manner, this experiment did not meet some of the basic requirements held by operant workers. For example, the non-reliable recording apparatus did not allow for an accurate codification of the behaviour. With electronic circuits it is possible to plot the behaviour directly against the time taken. When responses in time (response rates) are recorded, the presentation can proceed through descriptive techniques such as cumulative records. If statistical procedures were appropriate, analysis of group means would be relevant to the presentation of data. The data were analysed as if this were the case using t-tests. The results, not surprisingly, did not favour standard interpretation - no findings reaching a significant level of confidence. Bypassing the untoward effects of rounding data by inferential statistics, emphasis was redirected to a descriptive presentation.

The results shown in Table III indicate the number of subjects involved in each experiment.

Table III

The number of subjects in each experimental session. Showing the distribution of subjects as; those used in the experimental sessions who responded and came under stimulus control; those who maintained responding on condition IIIa (the first response-independent schedule) labelled No Stimulus Control, and; those who did not respond labelled No Responding.

Experiments	1	2	3	4	5	
Subjects Used	8	8	8	8	8	
No Stimulus Control	2	0	2	1	4	
No Responding	2	10	5	4	3	
Total	12	18	15	13	15	Total 73

The main results are shown in Figs. 1 - 3. All Figures refer to data collected over the first ten trials in each experimental condition.

In Fig. 1 the proportion of subjects responding on different trials are presented. These proportions have been calculated by adding together the number of subjects responding on one trial and dividing this sum by the total number of subjects in that experimental session.

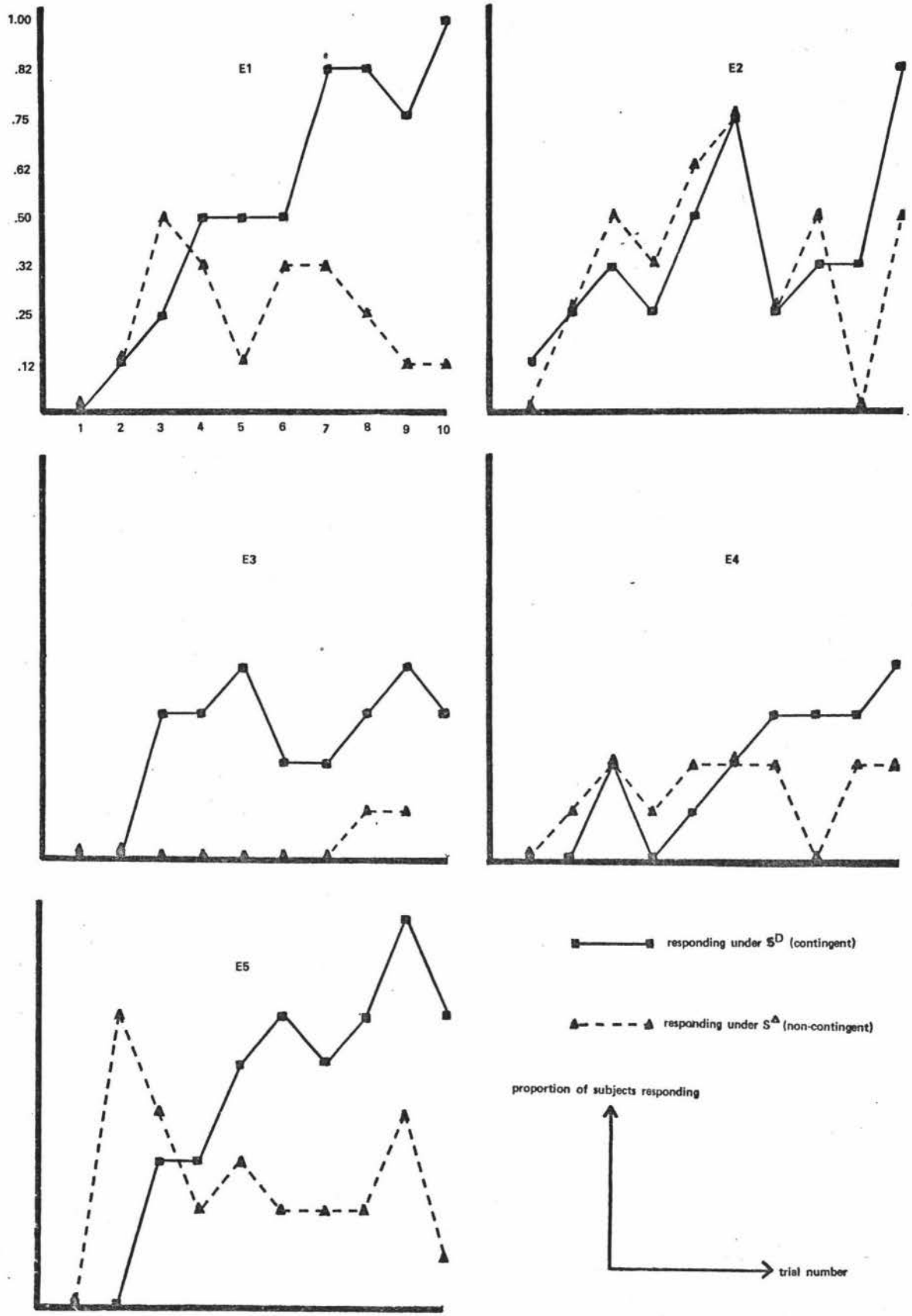

Fig. 1. Proportion of subjects responding on each trial (for first ten trials) under condition Ib i.e. Fixed Time 10 sec (S^{Δ} broken line) Fixed Ratio 1 (S^{D} unbroken line), for all experiments. (N=8.)

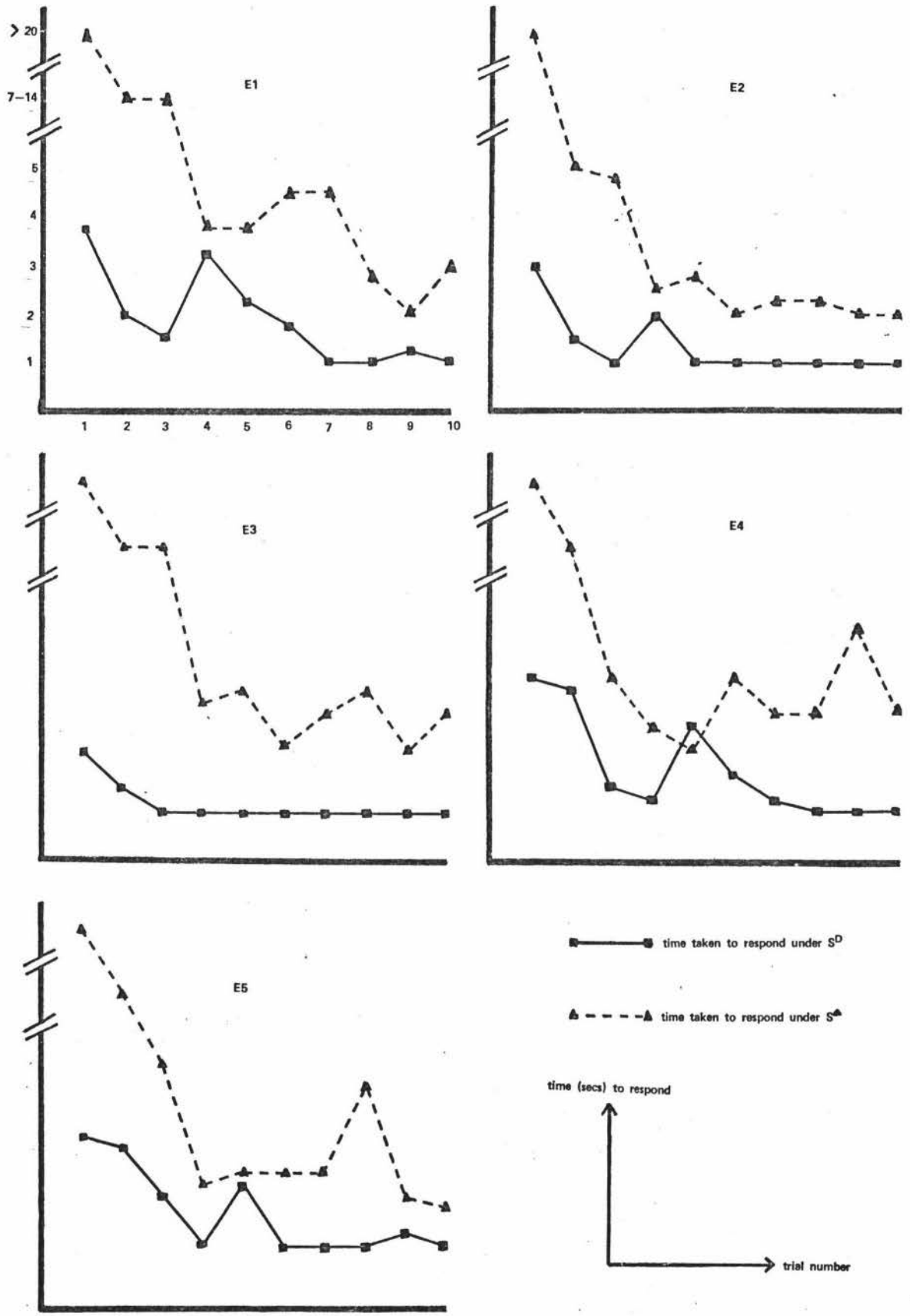

Fig. 2. Mean time taken to respond on each trial (for first ten trials) under condition IIb i.e. FR1 (S^{Δ} broken line) and FR 1 (S^{D} unbroken line), for all experiments. (N=8.)

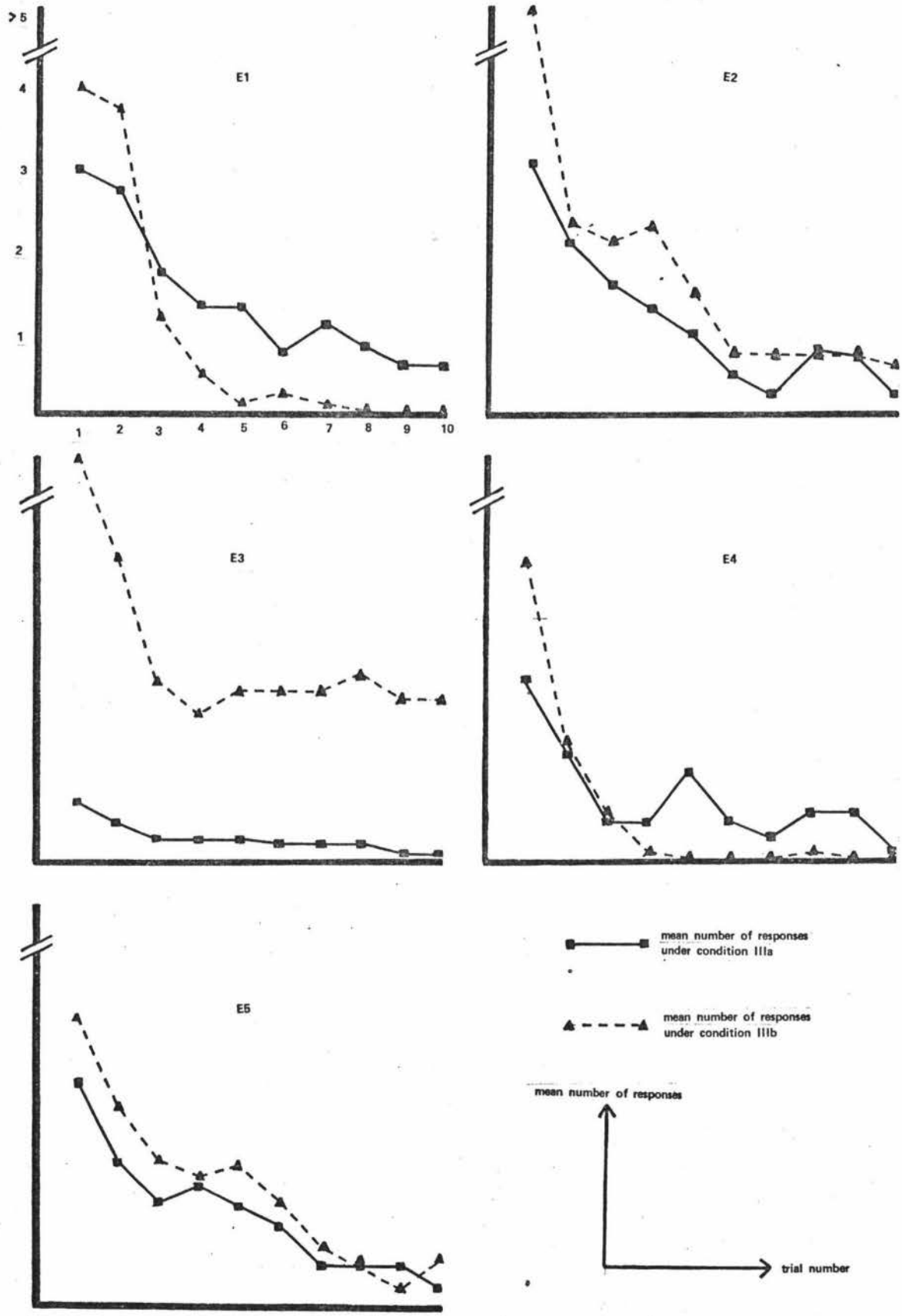

Fig. 3. Mean number of responses emitted by subjects (for first ten trials) under conditions IIIa i.e. FT 10sec. FT 10 sec (unbroken line), and IIIb i.e. FT 10sec. FT 10 sec. (broken line) for all experiments. (N=8.)

Fig. 2 shows the mean time taken, for subjects in all sessions, until the first response is emitted on a trial under condition IIb. The ordinate, showing time taken in seconds, has been broken at two points to enable a complete presentation of data. It can be noted that the minimum time possible for all sessions is two seconds for S^{Δ} and one second for S^{D}. This is the time taken by the projector to advance the magazine and change the slide.

The calculated means for the number of responses made by subjects during the different experimental sessions under the response-independent schedule of reinforcement are shown in Fig. 3. The first occasion is indicated by the broken line (IIIa), and the final condition indicated by the unbroken line (IIIb). The ordinate, showing the mean number of responses is non-continuous, to enable presentation of all the available information.

The results obtained from an inspection of the open-ended question, completed by subjects after the experiment, are presented. Table IV shows the number of subjects in each experiment who discriminated condition IIIa, the first response-independent schedule.

Table IV

Number of subjects in each experiment who indicated condition IIIa on the open-ended question

Experiment	1	2	3	4	5
N in experiments	8	8	8	8	8
N discriminating IIIa	7	6	4	8	6

Some of the non-relevant (superstitious) discriminations, selected from each experiment, are given below (E = experiment).

E1 "by moving hand immediately over light it immediately went off, by moving hand into another position the light went on";

E2 "tap, light, tap, slide, tap, off, tap, light";

E3 "it seemed quicker after a while to use two taps";

E4 "in this later case one first press caused the slide to disappear";

E5 "once it was on, the number of presses required for a slide to appear varied".

The following was a response from a non-respondent (i.e. No Responding, Table III) on E3: "Warm conditions in the room plus a certain amount of concentration must send some sort of electric impulse through the

black-box thing on the chair".

The availability of most subjects' scores (38 of 40) on a standardised intelligence test (ACER B. 40) enabled a comparison to be made between subjects' performance on schedules and their intelligence scores. To compare intelligence scores to schedule performance, various measures were taken. Specifically, the number of responses given on each of the non-contingent schedules, the number of trials to the criterion for condition Ib and, the total time on condition IIb. Each of the four schedule values were converted to T-scores. This was done for each group of subjects in each experiment on each of the measures. Altogether there were 144 T-scores. For each subject the experimental T-scores were summed and their mean calculated. This gave one value for each subject for schedule performance. The lower the value the more quickly the subject matched the schedule requirements and completed the experiment. Time, then, is the variable against which all subjects were compared.

The Pearson Product Moment Correlation was computed across subjects in each group. These results are presented in Table V.

Table V

Pearson Product Moment Correlation between
(i) mean sum of T-scores for experimental conditions IIIa, Ib, IIb, IIIb, and
(ii) intelligence scores from the B 40.

Experiment	1	2	3	4	5
r	-0.505*	-0.065	0.382	-0.043	-0.560*
p * $<$ .05					

Discussion

The assumption that the responses of visual scanning and tapping (by human subjects) would respectively constitute high and low probability behaviours was supported in the present study. This claim underpins and is strengthened by the subsequent discussion. Table III indicates the three subjects for whom the slide viewing was not a high probability response - these subjects were exposed to several slides but did not respond (by tapping) for further slides when the viewing was made contingent on their tapping (i.e. responding was not established). These subjects were all from experiment 3. Sixteen subjects were not presented with any slides during their experimental sessions.

Reinforcement contingent upon tapping was established for the remaining 54 subjects.

In Fig. 1 the acquisition of the contingent responding for the first ten trials is shown. The differences between contingent and non-contingent responding are evidenced in this presentation. It is assertained here that the different shaping conditions account for this observed difference. For instance, experiment 3 (no shaping) indicates less responding to S^{Δ}. It is important (in terms of response probabilities) that responding was re-established under condition Ib for all subjects.

In Fig. 2 the time taken until the first response is indicated. The second link of IIb (unbroken line, Fig. 2) is similar to the second link in Ib (unbroken line, Fig. 1), where the first response to S^{D} is reinforced. (The difference between these links is in the absence of the limited hold for IIb.) This similarity can be seen in the representation of the maintained responding to S^{D} in Fig. 2. While responding to S^{Δ} was extinguished, it was maintained to S^{D} (Fig. 1), evidence of stimulus discrimination. The initial responding to S^{Δ} took longer than the initial responding to S^{D} in condition IIb. This difference can be observed in the responding to S^{Δ} and S^{D} in the first trial for all experiments (Fig. 2). The experimental control of the two discriminative stimuli over the subjects' responding becomes clear in the rapid (10 trial) matching of the schedules under this condition. When taking the last two trials the largest differences, between responding under S^{Δ} and S^{D}, are observed in experiments 3 and 4. It is possible (except for experiment 2) that this difference is another reflection of the shaping conditions used at the start of the experimental sessions.

Not all subjects under the Brown and Jenkins (1968) auto-shaping method (used in experiment 3) emitted the operant response. Where responding was established it was not maintained (Fig. 3). Consistent establishment of the operant was obtained through both the Neuringer (1970) and the Sidman and Fletcher (1968) auto-shaping methods. Neuringer reinforced the first three responses made by the subject and then switched to a response-independent schedule with variable times between reinforcements. Subjects in experiments 2 and 4 (Fig. 3) established responding in a similar procedure but this responding was not maintained. In the Sidman and Fletcher method the first response was consistently reinforced during S^{D} (no response during S^{D} to the

appropriate key turned off the house light and blocked reinforcement). A similar procedure was adopted in this study for experiments 1 and 5 (Fig. 3). Responding was established but not maintained.

In his auto-shaping experiment Fenner (1969) notes that responding was maintained when the response-independent schedule had variable times between reinforcements, but was not maintained when the inter-reinforcement intervals were fixed. Maintenance, in the present experiment, was not stable with fixed time intervals. It would be interesting to repeat the present experiment with variable time intervals.

While there is some difference between the shaping techniques used in this study, it has been consistently shown that a simple human operant can be established without instructions. The most reliable method was that which paralleled the Sidman and Fletcher technique (i.e. in experiments 1 and 5).

Responding on each of the control conditions is shown in Fig. 3. These conditions have also been called the response-independent schedules; they are central to the discussion of superstitious behaviour. The control effects are indicated by Rescorla and Skucy (1969) who note that the

> "continued presentation of food during extinction possibly permits a more accurate assessment of the effects of eliminating the response-reinforcer relation in producing disruption of learned associations" (p. 389).

In a similar way the implementation of the response-independent schedules in this study after the shaping and training conditions serves as an extinction procedure. The re-establishment of responding (shown in Fig. 1) supports the theory of response probabilities. Fig. 3 shows the rapid reduction in responding under both response-independent conditions (except for experiment 3 under condition IIIb).

It was expected that responding by subjects to the second response-independent schedule would be similar across all experiments (Fig. 3). This expectation was based on the assumption that the same training used in all experiments would have a similar effect on subject responding. The results show that subjects differed across experiments. The training did not have the expected effect. For subjects who were exposed to several shaping procedures, the shaping and training fitted the expectation. However, where there were no shaping conditions prior to condition IIIa (in experiment 3), the training assumed the role of shaping. The shaping/training distinction is most illustrative in

responding under the response-independent conditions. There is a similarity between responding under IIIa (for experiments 1 and 5) and the responding under IIIb (for experiments 2 and 3). The maintenance of responding during the response-independent conditions is related to the number of schedule conditions to which the subject had been exposed. In this case the shaping/training distinction is replaced by the number of schedules used in the experiment.

Herrnstein (1966) notes a characteristic which favours the development of superstitious behaviour; less reinforcement may be required to maintain behaviour than to cause its acquisition. It has been shown in this study that responding under response-independent schedules was most persistent where the acquisition of the responding (experiment 3) was the longest, i.e. the training in this experiment was similar to shaping in other experiments. For human subjects (as with animals) there is an increased resistance to extinction once a response has been established. Contingent behaviour is emitted even when the consequences are non-contingent. For some subjects (those who did not come under stimulus control, from Table III) the maintenance of the responding under response-independent schedules continues 'as if' the behaviour had become functionally autonomous. What was once reinforceable behaviour has continued in the absence of contingent reinforcement. In the non-experimental setting a difficulty (with humans) is that reinforcements can be transferred from a specific behaviour to other, non-related behaviour. That is to say, a contingent reinforcement can be related to another behaviour which does not have any link with the reinforcement.

It was found that subjects who had many shaping conditions, discriminated the first response-independent schedule, in the open-ended question, more consistently than those with less shaping procedures. The discrimination of the response-independent condition was proportional to the number of shaping conditions. Amount of practice on schedules, it is suggested, is the main reason for the accurate discrimination (Table IV).

The effects of the instructional slide were different from those expected. The effects of this slide, prior to the study, were considered unimportant. The slide was used to instruct the subject that the projection-screen was not a one-way mirror. Although the slide was not shown in experiment 5, there were less subjects in this experiment who

came under schedule control under condition IIIa (Table III). It would appear that the procedure adopted in experiment 1, which (i) established and (ii) extinguished the responding on the response-independent schedule, is most useful in the preparation of subjects to be used on subsequent schedules.

It is expected that human performance on simple schedules in place of the training (Ib, IIb) used in this experiment, would produce cumulative records similar to those obtained with the study of animal subjects. The brief exposure to the auto-shaping technique (of experiment 1) and the fixed-time response-independent condition (IIIa) were shown to eliminate 'novel' responding. Records for subjects on training conditions in this experiment indicated that similar patterns of responding can arise on schedules which are introduced after the extinction on condition IIIa. All subjects who reached the criterion under condition IIIa (10 trials with no responding), responded under the training conditions (Figs. 1 & 2). A subject's performance upon reaching the criterion on condition IIIa is likened to food deprivation with animal subjects.

In two experiments (1 and 5, Table V) it was shown that a significant correlation existed between the subject's I.Q. score and performance on conditions during the experiment (this accounts for 25% variance). As mentioned, time is the crucial variable. A bright person matched the experimental requirements much quicker than a less bright person. Differences between experiments emerge from the correlations obtained. These are similar to, and give additional support of, the shaping/training distinction outlined above.

The final topic is concerned with response probabilities used to establish and maintain the operant in human subjects. An investigation of response probabilities offers an alternative to the unquestioned acceptance of monetary reinforcement. The current study has invoked Premack's (1965) theory of reinforcement which emphsises response probabilities. As suggested on page 7, if it is possible to rank all responses in terms of their probaility of emission for a given situation; any response of a higher probability could be made contingent upon any response that is of a lower probability. Responses can reinforce other responses.

It is suggested here that reinforcing stimuli and reinforcing responses merely reflect degrees of environmental control. The

reinforcing stimulus is effective because it has been learned in a social context; it works in many different situations. The reinforcing response is individualised, workable in a particular situation in which continuous comparions between responses are made. Homme and Tosti (1965) note;

> "It is true that such events (reinforcing stimuli) are not without response components of viewing or hearing, but it is mainly the stimulus attributions which make them easy to identify" (p. 149).

It is suggested, further, that in the final analysis, effective reinforcements can be explained in terms of reinforcing responses.

It is in moving from an explanation of reinforcement to a description of what can happen that this experiment is significant. Theoretically, all responses can be ranked in terms of their probability of occurrence (at a given time). Experimentally, the visual scanning response was assumed to be, and used, as a high probability response with human subjects. It depended on an emission of bar-tapping, a low probability response. The power of ranking the probability of these responses (for all subjects) is shown to be consistent in these results. The results favour the expected direction of ranking response probabilities (stimulus control was maintained when reinforcement was made contingent upon responding). This study is interpreted as being significant in showing that the visual-scanning response can be made dependent upon bar-tapping in human subjects. It has provided evidence of behaviour modification (auto-shaping an operant in human subjects) through ranking response probabilities.

When persons interested in behaviour modification (e.g. teachers, parents, politicians, police etc.) exchange their current reward system, that is largely based on reinforcing stimuli, for one that has as its foundation, reinforcing responses, wide reaching changes may be expected. All that is needed is a systematic and consistent application of the principles of behaviour modification. As shown in this study these principles are operationalised when contingencies of reinforcement are analysed. The study supports, in part, the claim made by Skinner (1958) when he says, "The new principles and methods of analysis which are emerging from the study of reinforcement may prove to be among the most productive social instruments of the twentieth century" (p. 99).

Implications

Tilton (1954) states that the most important thing for a teacher

to get from psychology is an understanding of and control over the learning process. If learning were defined as an observed change in the behaviour of an organism after it had been exposed to a particular situation, then operant psychology is concerned with control over the learning process. An understanding of behaviour has been obtained through the rigid control of the variables affecting it. While teachers cannot exercise the same degree of control over children in the classroom that operant psychologists can over their animal subjects in the laboratory, it is possible that the general framework used in the experimental analysis of behaviour will benefit behaviour modification in any setting (e.g. school, home or any other institution).

The rigid adherence to an analysis of schedules of reinforcement, developed in the 1950s, has not benefited teachers' understanding of or control over the learning process. The almost complete transfer from a legitimate study (experimental analysis of behaviour) to another setting (e.g. a school) by apostles of the new era (such as the exponents of programmed learning) has largely missed the mark. As an example, transference of a clarification of the all-important effects of a reinforcer has not occurred in many cases. It must be agreed that education cannot wait for complete empirical data regarding behaviour modification. To carry the above example a step further, consider the point made by Homme and Tosti (1965) when they suggest two discriminable divisions of the reinforcing event.

> "Under certain conditions, the reinforcing stimulus is the most appropriate consideration, while under others, it is the reinforcing response, without reference to any stimulus conditions, which is the most useful. In practical situations members of the first class are; compliments, verbal encouragements, thanks, gold stars, good grades, movies, and so on..... Other reinforcing events can best be characterised by their response characteristics and little emphasis need be placed on the stimulus properties" (p. 149).

Maehr (1968), in comparing studies of reinforcement in both animals and humans confuses the issue by not working with the division outlined above. Maehr (p. 109) states that an "objective definition and control of the reinforcement is not sufficient for directing and subsequently changing complex human behavior..... the subjective side of reinforcement cannot be overlooked". Reinforcement, for Maehr, refers to reinforcing stimuli not reinforcing responses. In the present study, reinforcing responses were used to establish and maintain a simple operant in humans. It is suggested that a similar usage of

reinforcing responses, in an appropriately designed experiment, could modify complex human behaviour.

When Skinner (1969) states that "lower organisms discriminate without responding verbally to essential properties... (man) simply discovered the additional value of constructing discriptive stimuli which improve his chance of success" (p. 138), he is discussing ways of constructing discriminative stimuli. Discriminative stimuli can be discovered by a person in two ways according to Skinner. Firstly, by experiencing (and constructing discriminative stimuli from) different situations, there is a certain probability that an organism will behave in a given way (providing the previous situations, responses and consequences have been specified). This behaviour is described as "Contingency-shaped". Secondly, "Rule-governed behaviour" is behaviour derived from the contingencies; it is of a different order from that which is contingency-shaped. Contingencies exist before the rules are established. The behaviour established by the contingencies is different from that established by rules. Skinner (ibid.) notes that "the golf player whose swing has been shaped by its effect on the ball is easily distinguished from the player who is merely imitating the coach" (p. 150).

The behaviour of a person who constructs discriminative stimuli through exposure to occasions, responses and consequences is different from that observed if he has been told what to do, when to do it, and informed of the possible effects. This distinction complements the difference that is frequently made between education and training. In this explanation, training is likened to rule-governed behaviour as this behaviour "is particularly effective when the contingencies would otherwise shape unwanted or wasteful behaviour" (Skinner, ibid., p. 168). Similarly, education can be likened to contingency-shaped behaviour, it is flexible and open-ended.

The distinction between rule-governed and contingency-shaped behaviour is clearest when one passes from one to the other. For example, a maxim (which is rule-governed) is followed because it has been taught. When a person constructs his own discriminative stimuli in relation to the maxim (discovers the truth) he will still do what he did before, but for different reasons. Central to this transition is an autonomous recognition of the effect of the operating contingencies. It is possible that a person crosses the boundary from training to

education in making personal observations of the effective contingencies. In a school situation, this means that education is fostered where the teacher arranges contingencies in which the student constructs his own discriminative stimuli. This study has shown that a simple operant can be established and maintained by auto-shaping techniques in human subjects. Auto-shaping is regarded as being similar to contingency-shaped behaviour, which is possible where the contingencies have been carefully arranged.

It would not be difficult to design and execute experiments in which human subjects of different ages are exposed to various schedules of reinforcement. These subjects could be auto-shaped to emit an operant and subsequently transferred onto more complex schedules. It is to be expected that the experimental analysis of behaviour with human subjects of different ages would provide an additional perspective for theoretical research contributing to the study of cognitive development.

APPENDIX A

Notice used to attract volunteer subjects.

A Departmental Demonstrator in the Education Department, Massey University, is undertaking some innovative research. The topic concerns human learning, investigating certain relationships of the learning process that are common to all people. The experiment is NOT concerned with emotional reactions, intelligence or personality. Participants will not be measured as in a 'psychological test'.

Between 50 - 70 students are required to act as subjects for one session each. A session will be up to but not over, an hour. Remuneration, on a cash basis, is 50¢ for a session.

Interested persons willing to act as subjects, either sign below or drop a note to John Kirkland, Education Department, Massey University.

As there is some urgency in obtaining data within this project potential subjects are urged to reply as soon as possible.

NAME (Mr., Miss., Mrs.)	PHONE or contact address	Day of the week and time suitable (evening and weekends included)

APPENDIX B

Instructions given to subjects prior to the experiment (mounted on a card, for subjects to read).

PLEASE READ CAREFULLY

You will be paid at the end of this session.

For the whole session you will be left in a room by yourself.

There is a bar heater in the room which will help maintain a comfortable temperature. The heater is controlled by a thermostat.

The whirring noise you will hear comes from a small electric motor. The noise is to help mask out other sounds. For example, you will probably hear the outside door slam and people walking down the passage. These sounds are not part of the experiment. The noise from the motor will help blot out these extra sounds.

The small projection screen on the wall is not a one-way mirror. As you know, to see through a one-way mirror the person being looked at has to be on the brightly lit side. In this case your room will be darkened out.

There will be a few minutes after your enter the room when the light will dim and the motor quieten to a gentle buzz. The experiment starts when this happens and will finish when the light and motor come on again.

It is not possible for any questions to be answered at this stage. You have enough information given above. What you are to do is part of your task.

If you are still unsure please read the card again.

If you understand, hand this card to the technician.

APPENDIX C

Instructions given to subjects following the experiment (mounted on a card, for subjects to read).

PLEASE READ CAREFULLY

It is not possible to reveal the purposes of the experiment at this stage.

You will realise that discussion about this experiment with others will make them produce false results. The experiment depends on non-informed subjects.

Your results are confidential, please respect this confidence by not discussing your experience in this session with anybody, whether they are coming or not as subjects.

If you understand, exchange this card for your 50¢.

Thank you for your cooperation.

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