PROJECTOR SLIDE CHANGING AND FOCUSING AS OPERANT REINFORCERS¹

RICHARD G. BENTON² AND ROY B. MEFFERD, JR.³

VETERANS ADMINISTRATION HOSPITAL, HOUSTON

Uninstructed subjects choose to view, in sharp focus where possible, projected visual images in preference to various simpler auditory and visual stimuli (*e.g.*, buzzers of flashing lights). The rate of responding on the lever rapidly increased above the operant level (projector inoperative) even though the stimuli were nonsense syllables. When focusing also was made contingent on responses, the subjects promptly started sharpening the focus of legible but blurred nonsense syllables. When the visual material was colored landscape scenes, the rates of slide-changing generally decreased, because of increased viewing time relative to the nonsense syllables, at the same time that the latencies of focusing decreased. Both the sharpness of focus and the total time spent with the image in sharp focus increased greatly with the colored slides, establishing that the subjects were under control of the stimulus events. Extinction of both responses occurred very rapidly when the controls became inoperative.

Lindsley (1962) used brightness of a television screen as a reinforcer for humans, and Israel (1960) successfully used focusing of blurred words as a prompting technique. Butler (1961) demonstrated with the rhesus monkey that a motion picture can serve as a reinforcer in operant conditioning. The present study examined human subjects' responses when they were presented a variety of switches, buttons, and levers that activated buzzers, clicking metronomes, flashing lights, and a slide projector. The purpose of the experiment was disguised. As soon as a subject learned to operate the projector, he operated it thereafter to the virtual exclusion of the other devices, even when only nonsense syllables were shown. Both the changing and focusing of visual images were found to act as reinforcers.

METHOD

Subjects

Six males, 21 to 26 years of age, volunteered to test a new physiological electrode.

Apparatus

The subject was seated near the rear of a 5.5-m square, dimly lighted room cluttered with equipment. A variety of switches, buttons, and levers were mounted on the chair arms. Mounted on the left arm were an electric metronome that emitted clicks and light flashes when activated by means of a 10-position selector switch, and three panel-

mounted switches that clicked but activated nothing; one was a two-position toggle switch, another a six-position selector switch, and the other a spring-return push-button switch. On the right arm of the chair were two levers, one cork-tipped that activated a buzzer, and the other one metal (5-mm square by 5.5-cm long) that activated a remote projector. Both levers could be moved forward and back with uniform force being required at any position to move them. Neither was spring-loaded and they remained in any position in which they were placed. Before each session both levers were placed in the rearmost position toward the subject. The projector lever was the activator examined in the experiment. It was programmed through a servo-actuator to activate the slide changer and/or the focusing mechanism of a modified Kodak Carousel 800 projector⁴ located on a stand (along with several other items of equipment) behind and

¹Reprints may be obtained from Roy B. Mefferd, Jr., Psychiatric and Psychosomatic Research Laboratory, VA Hospital, 2002 Holcombe Blvd., Houston, Texas 77031. We wish to express appreciation to Dr. Betty A. Wieland of this laboratory and the Department of Psychology, University of Houston, Houston, Texas, for her valuable suggestions.

²Post-doctoral Fellow of the Vocational Rehabilitation Administration; presently with the Psychology Department, University of Texas Medical Branch, Galveston, Texas.

³Also, departments of Physiology and Psychiatry, Baylor University College of Medicine, Houston, Texas.

at the subject's left. This projected slides onto a small screen 2.5-m in front and to the left of the subject. In addition to the screen, several other items (e.g., an unused recorder, an oscilloscope, and a portable table) were in the subject's foreground so that the screen was not isolated. The relationship between the lever travel and lens movement was linear and positive with the program used. Continuous recording of lever position, lens position, slide changes, and time intervals were made on a polygraph located in an adjacent room. The nature of the responses and the time intervals involved were determined from the polygraph recordings.

The stimuli were a series of lantern slides programmed to become sequentially available as discussed below. Eighty of the slides were of three-letter nonsense syllables that had zero associative meaning (Glaze, 1928), and 40 were of landscape scenes in color.

The procedures were designed to reflect the changes that occur in operant rates of slide changing and focusing under the contingencies specified below. The order of the procedures was sequential, I to III, with extinctions occurring after Procedures II and III. On the first day, the subject was seated and a dummy electrode was attached to his arm. The instructions were casual: "We are testing a new electrode that we hope to use in our next physiological experiment. We hope it will allow our subjects more freedom of movement and still give us good quality records. It will take me some time to calibrate the recorder in the next room, so make yourself comfortable. While you wait you can just sit and relax, but please don't go to sleep. All these switches on the arms of the chair will be used later in the experiment, so since you don't have to sit still, feel free to try any of the switches you desire. It will not disrupt anything. I will let you know when we are about to start the experiment and at that time I will tell you what I would like for you to do."

After the operant-level data on the assorted inoperative and silent switches and levers had been collected for 20 min (i.e., Procedure I), the subject was informed: "I am sorry but we must make a few modifications in the electrode before it will work. Could you please come

back again tomorrow? If everything is working then, we will proceed with the experiment."

Next day these comments were repeated, but this time Procedure II, slide changing of nonsense syllables, was operative. Data were collected until the 80 slides in the slide carrier had been projected. (The longest time required for this was 16.3 min). The slide-changing response was then extinguished (i.e., Extinction, Procedure II), and the same apology given.

On the third occasion, with Procedure III operative, very meager instructions, similar to the above, were given with a resigned, apologetic air. After the last slide of Procedure III, the focusing response, and then the slide-changing response, was extinguished (i.e., Extinction, Procedure III (focus) and (slide changing), respectively).

Procedure I: Operant levels. On the first day, all switches and levers were silent and inoperative and the subject's manipulation of them did not set the occasion for, or result in, any systematic set of stimulus events.

Procedure II: Initial slide presentation and subsequent changing of nonsense syllables contingent on differentiated lever positioning operants (FR 1). On the second day, the first time the subject moved the lever from its initial back position all the way forward and then returned it all the way back to its initial position, the projector was turned on and a slide was projected. Thereafter, each time he made this response the projector changed to a new slide on a fixed-ratio schedule (FR 1) until all 80 slides had been presented. This number of slides was not critical, since the circular slide carrier would continue through another cycle without a pause so long as the subject made the lever responses. The projector was preset to present all the slides in sharp focus.

Extinction, Procedure II: No slide changing. In this 10-min period immediately following Procedure II, the lever was remotely disconnected from the projector without interruption in the subject's responses, and a response no longer changed the last slide.

Procedure III: Slide changing and focusing contingent on differentiated lever positioning operants (FR 1). On the third day, the slide-changing condition of Procedure II was reinstated, but, in addition, the focus of the projector was adjusted so that when the projector lever was in the full back or forward position,

⁴The circuitry can be obtained from the junior author at the address in Footnote 1.

the letters of the nonsense syllables were legible but not in sharp focus. As the subject moved the lever forward, the letters became sharp at the halfway point; as he moved the lever farther forward, the sharpness of the focus decreased again. Thus, to change a slide and focus it sharply, the subject had to push the lever all the way forward, return it all the way back, and finally push it halfway forward. For the next slide, he had to pull it all the way back and then repeat the above movements. The first 40 slides were nonsense syllables, and the second 40 were the colored landscape scenes (III_n and III_c, respectively, of Fig. 1 and 2).

Extinction, Procedure III (focus): No focusing. Starting with slide 21 of the colored scenes, the slides continued to be changed each time the subject made a slide-changing response, but now he could no longer obtain sharp focus by any technique.

Extinction, Procedure III (slide changing): No focusing or slide changing. This 10-min period was similar to Extinction, Procedure II, except that it followed Extinction, Procedure III (focus). In it the subject could neither change nor obtain sharp focus of the last slide.

RESULTS

During the 20 min of the first session (Procedure I: operant levels), when the equipment was inoperative, all the subjects operated most of the levers and switches several times. The mean number of manipulations per subject ranged from 1.1 for the push-button selector switch to 4.0 for the metronome switch. The mean for the projector lever was 3.0. Thus, the projector lever was operated several times by each subject, but it was not the most popular of the devices, *i.e.*, it held no special attraction for any of the subjects.

In the second session, Procedure II was operative with the slides all appearing in sharp focus (*i.e.*, the slide changes were made contingent on the subject's moving the lever all the way forward and all the way back). The first full lever response (with the lever initially in the back position) occurred in from 1.5 to 10.5 min for the six subjects, at which time the projector was turned on and the first nonsense syllable was projected. Thereafter, the operant rates increased promptly for all the subjects

except P (who made two responses, paused for 58 sec while he operated several of the other devices, made another lever response, paused, then rapidly increased his response rate). Every subject continued responding (with occasional pauses and/or operation of other devices) until all 80 slides were changed. This required from 7.0 to 16.3 min for the six subjects, including the time required for the first response. The mean rates of responding after the first response ranged from 2.1 to 8.1 sec per response with an overall mean of 5.2 sec per response. The data for Subject T, with a rate of 4.2 sec per response, were selected for graphical presentation (Fig. 1) as being typical of the group.

Immediately after the 80th slide, the lever was disconnected remotely so that the subject could produce no more slides during Extinction, Procedure II. After a few seconds, the operant rates decreased and responses had virtually stopped within 1 to 2 min for all subjects except P (his rate decreased sharply within 3 min). Thereafter, the subjects' responses became erratic. Occasionally they manipulated first one, then another of the non-contingent devices, but they repeatedly returned to the non-operative projector lever. All subjects experimented with other types of lever responses, the most common of which was to make a regular response, then a short burst of very rapid full and partial responses. By about 7 min, the subjects had returned to operant-level response rates with all devices.

At this point we could not be sure whether the subject was just working the controls, or whether he was looking at the slides; *i.e.*, was he under the control of the stimulus events? To answer this, in the third session, Procedure III, both slide changing and focusing were made contingent on the subject's responses. Immediately after the electrodes were placed and the preliminaries were completed, all the subjects started operating the projector almost immediately to the virtual exclusion of the other devices. The longest latency in doing this was 23-sec for T. On the second response, three of the subjects discovered the focusing contingency. Thereafter, these subjects focused the images of nonsense syllables fairly consistently, except for brief intermittent periods in which they made only rapid slide changes (note that the syllables were legible even in their blurred state when the lever was either in its full back or forward position). Subject

Fig. 1. Cumulative curves of the projector lever responses made by Subject T during the various procedures. Vertical bars indicate the end of a given procedure. II were slide-changing responses of nonsense syllables; in III, focusing responses were superimposed first with nonsense syllables (III_n), then with colored slides (III_c); in III Extinction (focus), focusing of the colored slides was extinguished, and in III Extinction (slide changing), focusing and slide changing were extinguished.

G had the longest latency (1 min) in starting to focus systematically. This would suggest strongly that the subjects were, in fact, looking at the slides and accordingly were under the control of the stimulus events of slide changing and focusing. (On interrogation after the experiment, the subjects reported that they preferred looking at the projected images in lieu of the other stimuli, that they kept changing the nonsense syllables thinking they would see something more interesting, and that they focused just because they would rather look at a sharp than a blurred image.) The means for the 40 lever responses for slide changing of the nonsense syllables ranged from 3.2 to 14.2 sec per response. Starting with slide 41, landscape scenes in color were projected and the means for the next 40 lever responses ranged from 6.5 to 30.2 sec per response. With the colored slides, all subjects soon (1 to 4 min) focused rapidly, precisely, and regularly each time they changed a colored slide. One result of these rapid focusing responses was that the images were in reasonably sharp focus for most of the period between slide changes. The first 20 responses (or those made during the first 3 min) are shown for all subjects in Fig. 2. The important things to note from this figure are the bars above the cumulative response rec-

ords. These show the period for each slide in which the subject placed the lever near its central position (*i.e.*, when he kept the image in reasonably sharp focus). Comparison of III_n and III_c in Fig. 2 shows the increase in this period of sharp focus when the slides were colored landscape scenes.

Responses made late in any of the procedures tended for a given subject to become quite systematic and to be made with single, smooth movements. Using the last 10 responses of each of the two phases of Procedure III (*i.e.*, nonsense syllables and colored landscape scenes) the complex multiple responses of slide changing and focusing of this procedure become clear. The means and standard deviations of the separate components of these last 10 responses are presented in Table 1. The first column, Change, contains the mean duration of the slide-changing response starting with the lever in the central focus position and continuing until it had been pushed forward and pulled all the way back. Most subjects made this part of the response rapidly in one smooth movement. The next part of the response, Pre-Focus, consisted of the time interval in which the lever was left in the back position before the subject started pushing it forward to focus the new slide. During much of

Fig. 2. Cumulative curves of the projector lever responses made at the start of Procedure III by each of the six subjects to effect slide changes and to obtain sharp focus of the slightly blurred images. The periods in which the focus was kept reasonably sharp are shown by the bars lying above the cumulative response curves. The ordinates indicate the scale used for the number of responses.

this time the automatic slide-changing mechanism of the projector was operating, and most of the subjects paused until this was completed. Three of the subjects made the change movement faster with the landscape scenes than with the nonsense syllables; four subjects were faster during prefocus. Focusing, once started, was effected rapidly and usually with a single movement. With the landscape scenes, four subjects focused more rapidly, and all subjects obtained sharper focus than with the nonsense syllables. The most significant difference between the two phases of Procedure III was in the period of time that the slide was left in the focused position (View). With the land-

scape scenes, this time at least doubled for all subjects.

Halfway through the colored slides, Extinction, Procedure III (focus) was initiated in which the subject could still change slides, but could no longer obtain sharp focus. In this period, all subjects promptly (1 to 6 slides) stopped their efforts to focus the colored slides; after each slide change, they left the lever in the back position until the next slide-changing response. Even though they continued to change the slightly blurred slides, their rates of slide changing now increased greatly (see Fig. 1). These mean rates of changing during the focus-extinction ranged from 3.4 to 5.2 sec

Table 1

Means and standard deviations (in parentheses) of the final 10 nonsense syllables and colored landscape scenes in Procedure III (slide changing and focusing contingent).

Subject	Change	Seconds per Response		View	Total
		Pre-Focus	Focus		
NONSENSE SYLLABLES					
B	0.5 (0.52)	0.6 (0.52)	0.5 (0.53)	3.3 (1.70)	4.9 (1.52)
G	1.8 (2.15)	1.7 (0.82)	1.0 (0.82)	1.4 (1.26)	5.9 (3.35)
P	1.0 (0.40)	2.8 (2.78)	1.5 (2.51)	2.1 (1.45)	7.5 (4.81)
R	1.1 (0.88)	1.7 (0.95)	0.2 (0.42)	1.0 (0.82)	4.0 (0.99)
D	0.5 (0.53)	0.7 (0.68)	1.0 (0.10)	3.0 (0.36)	4.9 (1.85)
T	0.4 (0.70)	4.4 (3.10)	1.1 (0.32)	2.1 (1.45)	7.9 (5.24)
COLORED LANDSCAPE SCENES					
B	1.5 (0.71)	2.0 (0.47)	0.4 (0.52)	6.4 (5.52)	10.3 (5.72)
G	0.5 (0.53)	0.6 (0.54)	0.5 (0.53)	15.5 (9.72)	16.9 (9.80)
P	0.7 (0.48)	0.8 (0.63)	0.3 (0.48)	8.3 (3.80)	10.1 (3.96)
R	0.5 (0.53)	0.5 (0.53)	0.5 (0.53)	5.1 (4.53)	6.9 (4.89)
D	1.4 (4.40)	1.9 (0.10)	1.7 (0.11)	19.0 (4.64)	24.0 (4.59)
T	0.6 (0.52)	0.8 (0.42)	0.6 (0.52)	7.0 (0.99)	9.0 (1.08)

per response. When the slide-changing contingency also was removed, so that the subject could neither obtain sharp focus of the last slide nor change it (Extinction, Procedure III: slide changing), the operant rate of lever responses decreased sharply, and ceased almost entirely within 90 sec. Only one subject, B, made any additional effort to focus in this final period.

Procedure II was repeated on a later occasion with all subjects and Procedure III was repeated with two of them. Except for decreased latencies of the initial response, these results were comparable to those obtained on the first occasion, and, therefore are not presented in detail.

DISCUSSION

The results demonstrate clearly that the operant rates increased markedly when they involved the operation of the projector and the changing of visual images, even when they were mere nonsense syllables. When focusing also was made contingent, the subjects quickly utilized this control to bring slightly blurred images into sharp focus. After a few of these double responses of slide changing and focusing, the duration between the manipulations required to change a slide and those required to focus it decreased sharply. When the slides were photographs of colored landscapes, the

double response became essentially a single one, and focusing became more rapid, regular, and precise than had occurred with the nonsense syllables. At the same time the operant rate of slide changing decreased as a result of increased viewing time. In view of these results, and of those cited in the introduction, there can be no doubt that when an individual is presented with an opportunity to view images, as opposed to simple flashing lights, or to the operation of simple buzzers, metronomes, clicking switches, and the like, he will choose to view an image even though it is only of a nonsense syllable. Furthermore, he will choose to view an image in as sharp detail as possible. This recalls Woodworth's (1947) comment that clarity of image may be the most powerful reinforcer of all.

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