REINFORCEMENT VALUES OF VISUAL PATTERNS COMPARED THROUGH CONCURRENT PERFORMANCES¹

D. E. BERLYNE

UNIVERSITY OF TORONTO

Use of concurrent variable-interval performances confirms that more-complex visual patterns have greater reinforcement value for human subjects than less-complex patterns. The findings tally with verbal evaluative ratings and with results of previous experiments using a discrete-trial binary-choice technique.

The power of visual patterns to reinforce instrumental responses or operants in human beings was first demonstrated by Ivanov-Smolenski (1927). Since then, it has been confirmed in numerous experiments (see Berlyne, 1960, 1966; Kish, 1966). The most striking examples come from aesthetic behavior (see Berlyne, 1971a), where contact with appropriately composed visual patterns apparently reinforces the efforts of the creative artist and all the activities through which the appreciator gains access to works of art.

Experimental aesthetics, ever since it was founded by Fechner over a hundred years ago, has relied predominantly on verbal judgments of "preference", "liking", *etc.* It is desirable to supplement these with nonverbal measures of preferential or hedonic reaction to visual and auditory structures. Measures of reinforcement value are among those that suggest themselves most readily.

The three pairs of patterns shown in Figure 1, each consisting of a more-complex and less-complex member, have been used in previous experiments (Berlyne and Crozier, 1971, Berlyne, 1971b) with an equivalent for human subjects of a T-maze technique. Each trial was signalled by a buzzer, whereupon the subject had to press either a key exposing the more-complex (MC) pattern of a pair or another key exposing the less-complex (LC) pattern. It was found repeatedly that the response exposing the MC pattern was more likely to be

performed, provided that the subject had relatively impoverished stimulation immediately before each choice.

Using the same stimulus patterns, it was decided to find out whether Catania's (1963) technique could provide a means of comparing their reinforcement values. Catania made available two keys, associated with independent variable-interval (VI) schedules, and found the rates of pecking at the two to be directly proportional to the magnitude of reinforcement. His subjects were pigeons, and he manipulated the magnitude of reinforcement by varying the duration of access to food. In the present experiment, the technique was adapted for human beings with visual patterns of differing complexity as the reinforcing conditions.

METHOD

Subjects

Five male and 19 female undergraduates taking a first-year psychology course served.

Apparatus

The subject sat in front of a 24 by 36 in. (61 by 91 cm) black plywood board, placed on a table top and bearing two telegraph keys mounted 10 in. (25 cm) apart. A screen was placed in front of the table, 47 in. (120 cm) from the subject. An adjoining room contained the scheduling and recording equipment and a three-channel Polymetric Tachisto-Projector, Model V-1459-3, which projected on to the screen through a window. The size of an image on the screen was 22 by 15 in. (56 by 38 cm). A Gerbrands Model 2A tape puller maintained the VI schedules.

¹This investigation was supported by research grant A-73 from the National Research Council of Canada. The data were collected by Mary Louise King. Reprints may be obtained from the author, Dept. of Psychology, Univ. of Toronto, Toronto 181, Canada.

Fig. 1. The three stimulus pairs, with the less-complex (LC) patterns on the left and the more-complex (MC) patterns on the right.

Procedure

Every subject went through three successive phases, each lasting 10 min. A different pair of patterns from Figure 1 was used in every phase. Each of the six possible permutations of stimulus pairs among phases was assigned to a group of four subjects. For two subjects in each group, the MC pattern corresponded to the right, left, and right keys in successive phases, whereas the remaining two subjects were exposed to the opposite arrangement.

To disguise the purpose of the experiment, a GSR electrode was attached to the subject's left hand, and he was told that "physiological responses to some visual stimuli" were going to be measured. He was then given the following instructions:

There are two telegraph keys in front of you. If you press the left key, some but not all of your key presses will produce a slide; this will always be the same slide. The same is true of the right key; if you press it, some but not all of your key presses will produce a slide, which will always be the same one. There are two slides involved, one of which is only on the left key, and the other only on the right. Your task is to press the keys whenever you wish, in any order you wish, and as often as you wish, as long as you do not press both keys at once. As soon as a slide appears, please stop pressing the keys, and look at the slide. This, of course, is because we want your physiological reactions to the slide. When the slide disappears you may start pressing the keys again.

There will be three sections to the experiment. During section one, the same two slides will be appearing, one on the left key and one on the right. The slides will be changed before section two and again before section three. The signal for you to start pressing the keys will be a single buzzer. At the end of a section I'll press the buzzer twice as a signal for you to stop, then once more when it is time to start again.

There was a 1-min pause between phases to enable the slide magazine to be changed and the apparatus to be reset. A buzzer sound sig-

nified the start of a phase, and two buzzer sounds the end.

Each key was independently scheduled to produce reinforcers (5-sec exposures of the corresponding slide) according to a VI 20-sec schedule. The minimum interval elapsing between one reinforcement and the time when depression of the same key could produce the next reinforcement ranged from 5 sec to 35 sec in multiples of 5 sec, with a mean of 20 sec. In addition, to discourage alternation, neither key could produce reinforcement for 5 sec following the end of a slide exposure, and a key could not produce reinforcement for 3 sec after a response on the other key.

After this part of the experiment was completed, the GSR electrode was removed, and the subject was required to rate each of the six slides on each of four seven-point scales. The ends of the scales were labelled "uninteresting-interesting", "displeasing-pleasing", "no pleasure at all—extreme pleasure", and "no discomfort at all—extreme discomfort". Each slide appeared for 5 sec, followed by a 5-sec interval during which a judgment was recorded. The orders in which the scales and the slides were presented were counterbalanced among subjects. Six slides were presented successively in connection with the first scale and then once again in connection with each of the other scales.

RESULTS

Cumulative curves of mean responses on the two keys with each stimulus pair are displayed in Figure 2. Analysis of variance was applied to the numbers of responses per 10-min phase. The difference between keys producing MC and LC patterns over all three phases was significant at the 0.001 level: $F(1, 54) = 30.51$. The main effects and interactions involving stimulus pairs and phases were not significant. Over all three phases, 20 subjects out of 24 performed more responses on the key producing the more complex pattern: $p < 0.01$ according to the sign test.

Table 1 presents the mean ratings on the four scales for each slide.

DISCUSSION

It was confirmed that rate of responding is higher on a key producing a more-complex

Fig. 2. Cumulative curves of mean numbers of responses on keys producing, respectively, MC and LC patterns for the three stimulus pairs.

pattern than on a key producing a less-complex pattern, with the duration of exposure and other conditions held constant. It will be recalled that, for each subject, the more-complex pattern alternated between left and right keys from one phase to the next.

In a previous experiment using the binary-choice technique (Berlyne and Crozier, 1971, Experiment 1), the effect (*i.e.*, the difference

between the probabilities of the two alternatives responses) was significantly smaller with stimulus pair 2 than with the other two pairs. In the present experiment, it is interesting that, once again, the effect was smaller with stimulus pair 2 (see Figure 2), although the interaction was not significant.

It is sometimes suggested that the reinforcement value of an event can be judged from

Table 1
Mean Ratings

Stimulus Pair	Interestingness			Pleasingness			Pleasure			Discomfort		
	MC	LC	<i>t</i>	MC	LC	<i>t</i>	MC	LC	<i>t</i>	MC	LC	<i>t</i>
1	6.4	2.0	15.63*	5.9	3.1	7.15*	5.4	1.8	9.08*	1.8	2.5	n.s.
2	5.6	4.5	4.18*	4.1	4.2	n.s.	3.5	3.0	n.s.	3.3	2.2	n.s.
3	6.5	2.9	9.94*	4.6	4.2	2.82*	4.2	2.3	3.66*	3.2	3.8	n.s.

*—*p* < 0.01.
n.s.—not significant.

the frequency of a response that is producing the event. This is hazardous, as argued elsewhere (Berlyne, 1967, 1969). While the event is repeatedly occurring, it could increase response rate either by serving as a discriminative cue, making an immediate repetition of the response more likely, or by inducing a motivational or affective condition (*e.g.*, heightened arousal) that increases overall activity level. These two effects, being transient, must surely be distinguished from reinforcement, which is generally regarded as something that promotes learning, which in its turn is generally conceived as a lasting change in behavior (*e.g.*, Kimble, 1961). Observation of behavior hours or days after the last occurrence of a reinforcing event has been recommended (Berlyne, 1967, 1969) as a way of measuring reinforcement value without the risk of confusing it with the two transient effects just mentioned. The concurrent-performances technique that was used, following Catania's (1963) example, in the present experiment offers an alternative solution. Since the rates of two concurrent responses are compared, any difference between them cannot be due to an effect on overall activity level. The length of the inter-reinforcement interval excludes the possibility that response rate may reflect a heightened tendency to repeat a response immediately after the reinforcing event has occurred.

So, it seems safe enough to conclude that, in the present experiment, the frequencies of the concurrent responses reflected the relative reinforcement values of the visual patterns that the responses caused to appear. Moreover,

the results tally with observations of behavior in a discrete-trial binary-choice situation (Berlyne and Crozier, 1971) and with verbal evaluative ratings (Table 1).

REFERENCES

- Berlyne, D. E. *Conflict, arousal and curiosity*. New York: McGraw-Hill, 1960.
- Berlyne, D. E. Curiosity and exploration. *Science*, 1966, 153, 25-33.
- Berlyne, D. E. Arousal and reinforcement. In D. Levine (Ed.), *Nebraska Symposium on Motivation*, 1967. Lincoln, Neb.: University of Nebraska Press, 1967. Pp. 1-110.
- Berlyne, D. E. The reward value of indifferent stimulation. In J. T. Tapp (Ed.), *Reinforcement and behavior*. New York: Academic Press, 1969. Pp. 179-214.
- Berlyne, D. E. *Aesthetics and psychobiology*. New York: Appleton-Century-Crofts, 1971. (a)
- Berlyne, D. E. Effects of auditory prechoice stimulation on visual exploratory choice. *Psychonomic Science*, 1971, 25, 193-194. (b)
- Berlyne, D. E. and Crozier, J. B. Effects of complexity and prechoice stimulation on exploratory choice. *Perception and Psychophysics*, 1971, 10, 242-246.
- Catania, A. C. Concurrent performances: A baseline for the study of reinforcement magnitude. *Journal of the Experimental Analysis of Behavior*, 1963, 6, 299-300.
- Ivanov-Smolenski, A. G. [Studying the grasping reflex in children.] *Mediko-Biologicheskyy Zhurnal*, 1927, 2, 33-41.
- Kimble, G. A. *Hilgard and Marquis' conditioning and learning*. (2nd ed.). New York: Appleton-Century-Crofts, 1961.
- Kish, G. B. Studies of sensory reinforcement. In W. K. Honig (Ed.), *Operant behavior*. New York: Appleton-Century-Crofts, 1966. Pp. 109-159.

Received: 17 January 1972.

(Final acceptance: 30 May 1972.)