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REINFORCEMENT VALUES OF VISUAL STIMULI AS A FUNCTION OF STIMULUS VARIETY

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This study tested the hypothesis that humans have a preferred or optimal amount of stimulus variety by means of reinforcement value. Four human subjects chose between pairs of sequences of visual patterns under two-operandum concurrent variable-interval schedules. The variety of visual sequence presented by pressing one button was constant, while the variety of visual sequence presented by pressing the other button was changed by manipulating the number of colors used in the stimulus. Choice proportions were measured in terms of number of responses and time spent responding. The results showed that the individual preference curves were not systematic and inconsistent across subjects.

Key words: stimulus variety, choice behavior, preference, concurrent variable-interval schedules, button press, humans.

INTRODUCTION

It is now widely accepted that sensory stimuli have reinforcing effect as food or water. Many kinds of sensory stimuli have been listed as reinforcers — light, sound, picture, and voice, for example. In many theories of curiosity, intrinsic motivation, or aesthetics, stimulus complexity is considered a major determinant of reinforcer value common to many sensory stimuli. And it is hypothesized that individual preference for stimulus complexity increases up to some moderate amount and then decline progressively (e.g., Berlyne, 1973, 1974; Dember & Earl, 1957; Fiske & Maddi, 1961; Walker, 1981). The purpose of the present study was to test this hypothesis.

Complexity is indeed a useful concept, but too ambiguous to experiment due to its multidimensionality (Kreitler, Zigler, & Kreitler 1974). Complexity was defined in various ways. Some investigators defined complexity as the number of sides in random polygons. But this definition can be applied only to polygons. Others used subjective complexity, or complexity judgment. However, this definition is circular, because subjective complexity is not a stimulus but a response of humans to stimulus in essence.

Instead of complexity, stimulus variety was used in the present experiment. Stimulus variety is also one dimension of complexity. It is defined as the number of discriminably dissimilar elements, so that it can be manipulated objectively. Further-

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more, it can be applied to stimuli in any modality.

There have been several experiments that examined preference in humans as a function of stimulus variety. In these experiment, the number of dissimilar elements presented simultaneously (e.g., Alberti & Witryol, 1990; Hare, 1974b) or successively (e.g., Bragg & Crozier, 1974; Crozier, 1974; Hare, 1974a, Normore, 1974; Vitz, 1966) was varied, then preference was measured. The obtained relationships between stimulus variety and preference were generally inverted U-shaped or monotonic functions. However, interpretation of the results is problematic because these experiments predominently relied on subject's verbal preference judgments. First, difference in wording make comparison among the results difficult. Second, sensory stimuli functioned as discriminative stimuli, not as reinforcers in these experiment, where preference was expressed after the presentation of sensory stimuli.

In the present experiment, the preference in humans for stimulus variety was invesigated by means of nonverbal measure, reinforcement value. Variety of the sequences of visual patterns was manipulated, then choice behavior between two buttons producing different visual sequences according to concurrent variable-interval (VI) schedules was measured.

METHOD

Subjects: Four undergraduate students, 2 females and 2 males, served as subjects.

Stimulus Material: The reinforcers used in this experiment were visual sequences. The sequence consisted of 18 presentations of visual patterns, appearing singly for .5 sec at intervals of .5 sec. Each pattern was a 6×6 matrix which was constructed by 36 colored circles (1 cm^2) spaced 2 cm apart center to center. Stimulus variety was varied by varying the number of circle colors per sequence in two ways. In Condition A, the number of colors per pattern was varied and the visual sequence

Table 1. Stimulus characteristics.

Position	Level	Number of colors	Color
RIGHT	1	1	BLUE
	2	2	plus PINK
	3	3	plus ORANGE
	4	6	plus LIGHT BLUE, PURPLE, RED
	5	9	plus YELLOW, GREEN, VIOLET
LEFT	1	1	RED

was repeated presentations of the identical pattern. In Condition B, the number of colors per pattern was held constant, that is, only one color was presented simultaneously. But the number of colors per sequence was varied across 18 presentations. Five pairs of visual sequences were used in each condition. Characteristics of the stimuli are specified in Table 1. In both conditions, the elements (colored circles) were randomly selected with the restriction that all colors appeared equally in each pattern and more various stimuli included all colors used for less various stimuli.

Apparatus: Each subject sat down at a desk surrounded on three sides by a black plywood board. The front board (60 by 90 cm) had a window (32 by 25 cm) 25 cm above the desk. Behind the window, a 14-in. color CRT display (EPSON, PC-286CD) was positioned for stimulus presentation. A 23 by 13 by 5 cm aluminium box with two buttons was mounted on the desk. Each button required a minimum force of approximately 2 N to operate. The experiment was controlled by a microcomputer (EPSON, PC-286V) with a timerboard (JAC, TIMERBOARD II) located behind the front board.

Procedure: The subjects were instructed as follows:

> There are two buttons in front of you. Sometimes when you press the left button, a sequence of patterns will be presented on the screen. This will always be the same sequence. The same is true of the right button. Sometimes when you press the right button, the other sequence of patterns, which will always be the same one, will be presented on the screen. In short, there are two kinds of sequences of patterns, one of which is presented only by the left button, and the other only by the right button. Your task is to press the two buttons whenever you wish, as often as you wish, and in any order you wish. But please do not press both buttons at once. As soon as a sequence of patterns is presented on the screen, please stop pressing the buttons, and look at the sequence of patterns. When the presentation of the sequence of patterns ends, you may start pressing the buttons again. In addition, please do not rise from your seat till the end of this experiment is showed.

Subjects then worked under the concurrent VI 20-sec VI 20-sec schedule after receiving the instruction. The distribution of interval values was constructed according to the Fleshler and Hoffman (1962) progression with $N=7$, and each interval was selected randomly without replacement. To prevent reinforcers for presses on one button from accidentally reinforcing changing over from the other button, a 3-sec period of non-reinforcement, called a changeover-delay, followed every changeover. The variety level of stimulus presented by the left button was held constant at Level 1 (red), while the variety levels of stimuli presented by the right button were varied. Five variety levels were studied and the order of changes in variety level was the same in each condition, 1-4-2-5-3. At each level, 10-min (excluding presentation of visual sequence) session was repeated until relative response rates and relative time allocations in three consecutive sessions differed by no more than 10% and showed no consistent trend. But the repetition was limited to ten. Subject HT and Subject MI

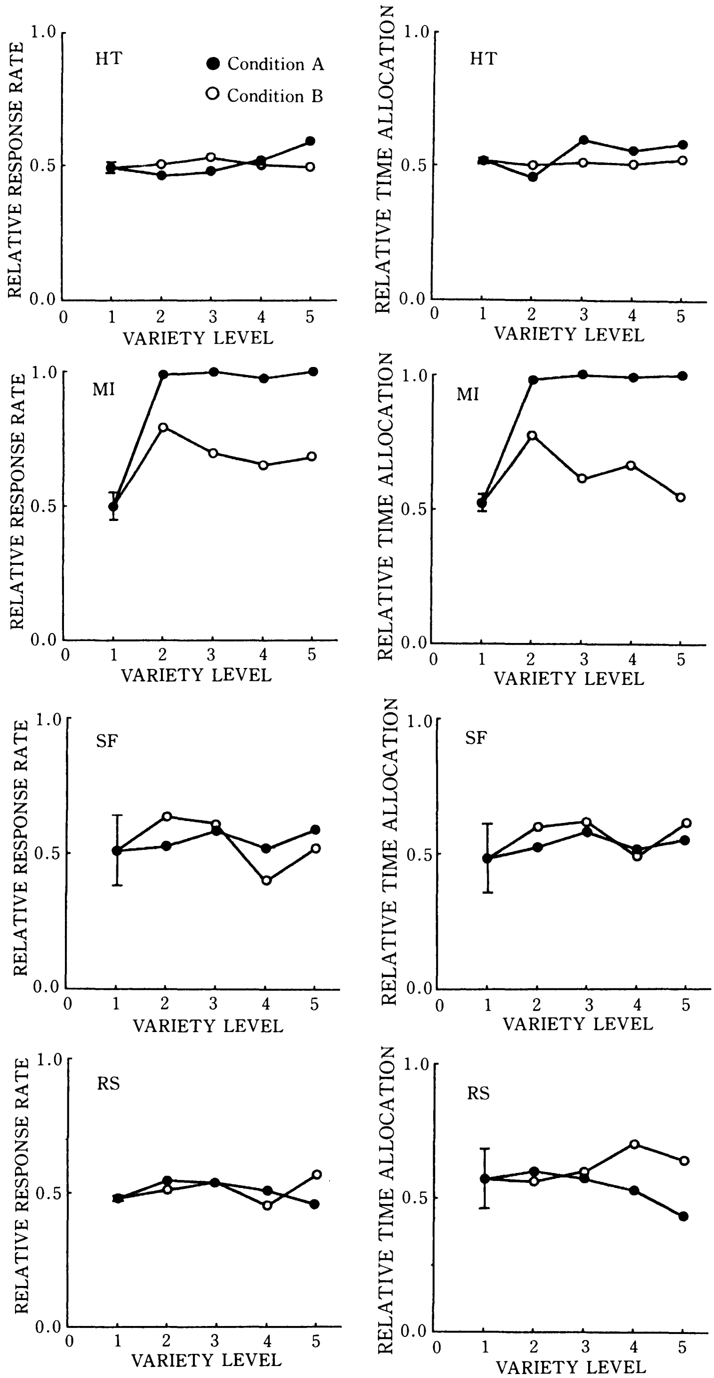

Fig. 1. The individual subject relative response rate and relative time allocation for component schedule with the varied stimulus as a function of variety level of that stimulus. The data at Level 1 are averaged between two conditions and vertical bars indicate the range of there two data.

were tested first under Condition A and then under Condeition B. Subject SF and Subject SR were tested under the two conditions in the reverse order.

Results

The choice proportions measured in terms of rate of responses and time spent for each subject are presented in Fig. 1. The graphs on the left in Fig. 1 show functions relating the proportions of number of responses on the right button to the level of stimulus variety. The graphs on the right in Fig. 1 show functions relating the proportions of time spent responding on the right button to the level of stimulus variety. Filled circles represent the data obtained under Condition A. Open circles represent the data obtained under Condition B. The data were obtained during the last three sessions at each variety level. However, since visual sequence produced by pressing the right button at Level 1 was identical (blue) under both conditions, the data at Level 1 were averaged between two conditions. Vertical bars in Fig. 1 indicate the range of these data.

For Subject HT, there was no apparent systematic trend. The function of response data and the function of time data under Condition A were dissimilar, and both data under Condition B were stable. Subject MI showed strong preferences for more various stimuli. Under Condition A, both measures showed that preference for more various stimuli increased from Level 1 to Level 2 and then appeared to reach a ceiling. Under Condition B, preference appeared to rise to Level 2 and then to drop slightly with inconsistent fluctuations. For Subject SF, every function was a N-shaped curve. However, these data were somewhat unreliable because the range at Level 1 was quite wide in both measures. Subject RS showed a inverse-U relation between variety and preference in both measures under Condition A, although these measures were inconsistent each other under Condition B.

Discussion

The hypothesis that humans have a preferred or optimal amount of stimulus variety in terms of reinforcement was not confirmed. The preference curves of individual subjects were irregular, and two procedures for varying stimulus variety produced somehow different effects. In addition to this, the preference functions were inconsistent across subjects. Some of the variability in the functions may be due to the use of only one stimulus at each level of variety. Even if so, these results lead to the conclusion that the effect of stimulus variety per se, if any, is too weak to control choice behavior of adult humans.

Berlyne (1972) showed that more complex visual patterns had greater reinforcement value for humans than less complex patterns. However, Catania (1975) suggested that preference for stimulus variety or complexity was often confounded with preference for the availability of alternatives or prefernce for informative stimuli, and demonstrated that preference in pigeons for stimulus variety was small when the availability of altenatives and the informativeness of stimuli were separated. With respect to informativeness, Case, Ploog and Fantino (1990) showed that informative stimuli could maintain human observing behavior only when the stimuli were correlated with positive reinforcement. Viewed in this light, sensory stimuli may function as conditioned reinforcers as well as unconditioned reinforcers. Choice behavior may depend on the summation of these functions, and it is probable that the function as conditioned reinforcers is stronger and more important than the function as "intrinsic" (unconditioned) reinforcers for adult humans.

References

Alberti, E.T., & Witryol, S.L. **1990** Children's preference of complexity as a function of perceived units in collative motivation. *Journal of Genetic Psychology*, **151**, 91-101.

Berlyne, D.E. **1972** Reinforcement values of visual patterns compared through concurrent performances. *Journal of the Experimental Analysis of Behavior*, **18**, 281-285.

Berlyne, D.E. **1973** The vicissitudes of aplopathematic and thelematoscopic pneumatorogy (or the hydrography of hedonism). In D.E. Berlyne & K.B. Madsen (eds.), *Pleasure, reward, preference*. New York: Academic Press, 1-33.

Berlyne, D.E. **1974** The new experimental aesthetics. In D.E. Berlyne (ed.), *Studies in the new experimental aesthetics*. New York, Wiley, 1-25.

Bragg, B.W.E., & Crozier, J.B. **1974** The development with age of verbal and exploratory responses to sound sequences varying in uncertainty level. In D.E. Berlyne (ed.), *Studies in the new experimental aesthetics*. New York, Wiley, 91-108.

Case, D.E., Ploog, B.O., & Fantino, E. **1990** Observing behavior in a computer game. *Journal of the Experimental Analysis of Behavior*, **54**, 185-199.

Catania, A.C. **1975** Freedom and knowledge: An experimental analysis of preference in pegeons. *Journal of the Experimental Analysis of Behavior*, **24**, 89-106.

Crozier, J.B. **1974** Verbal and exploratory responses to sound sequences varying in uncertainty level. In D.E. Berlyne (ed.), *Studies in the new experimental aesthetics*. New York, Wiley, 27-90.

Dember, W.N., & Earl, R.W. **1957** Analysis of exploratory, manipulatory, and curiosity behaviors. *Psychological Review*, **64**, 91-96.

Fiske, D.W., & Maddi, S.R. **1961** A conceptual framework. In D.W. Fiske & S.R. Maddi (eds.), *Functions of varied experience*. Homewood, Illinois: Dorsey Press, 11-56.

Fleshler, M., & Hoffman, H.S. **1962** A progression for generating variable-interval schedules. *Journal of the Experimental Analysis of Behavior*, **5**, 529-530.

Hare, F.G. **1974a** Artistic training and responses to visual and auditory patterns varying in uncertainty. In D.E. Berlyne (ed.), *Studies in the new experimental aesthetics*. New York, Wiley, 159-168.

Hare, F.G. **1974b** Verbal responses to visual patterns varying in distributional redundancy and in variety. In D.E. Berlyne (ed.), *Studies in the new experimental aesthetics*. New York, Wiley, 169-173.

Kreitler, S., Zigler, E., & Kreitler, H. **1974** The complexity of complexity. *Human Development*, **17**, 54-73.

Normore, L.F. **1974** Verbal responses to visual sequences varying in uncertainty level. In D.E. Berlyne (ed.), *Studies in the new experimental aesthetics*. New York, Wiley, 109-119.

Vitz, P.C. **1966** Affect as a function of stimulus variation. *Journal of Experimental Psychology*, **71**, 74-79.

Walker, E.L. **1981** The quest for the inverted U. In H.I. Day (ed.), *Advances in intrinsic motivation and aesthetics*. New York : Plenum Press, 39-70.

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