THE EFFECT OF SELECTED PROPERTIES OF VISUAL PATTERNS ON OBSERVING BEHAVIOR IN THE SQUIRREL MONKEY

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CHAPTER I

INTRODUCTION AND REVIEW OF THE LITERATURE

Introduction

Numerous studies appearing in the recent literature in experimental psychology reflect the increasing emphasis placed on the study of the stimulus determinants of exploratory and observing behavior (e.g., Berlyne, 1960). The two stimulus variables receiving special attention have been Novelty and "Complexity," although some interest has been directed toward such stimulus properties as Color, Intensity, Three-Dimensionality, and Angular Variability. Novelty in particular has dominated experimental interest. "Complexity," which may be defined as "the amount of variety or diversity in a stimulus pattern" (Berlyne, 1960, p. 38), has received far less experimental concern, although its critical importance to exploratory and observing behavior has been suggested by the results of several studies. The experiments reported below were designed and performed with the purpose of further investigation of the relation between stimulus complexity and observing behavior.

Two variables directly associated with Complexity, Angular Variability, and Numerosity, and two variables more loosely related to Complexity, Size, and Three-Dimensionality were selected for study. In addition, Color was also employed as a stimulus variable.

Duration of response was used as a measure of observing behavior.

Review of the Literature

Orienting Behavior. The term, orienting behavior, has been used to refer to a complex of physiological and behavioral responses elicited reflexively by a change in the properties of the external environment. Berlyne (1958b, 1958c), using series of stimulus patterns representing different degrees of complexity, found that the most complex pattern in each of the series shown attracted visual fixations in infants significantly more often than the less complex stimuli. Fantz (1958a, 1958b) found a preference for looking at a pattern containing more contour than another with which it was paired in both an infant chimpanzee and a group of human infants. In a more recent experiment Fantz (1961) found that the most complex stimuli attracted more attention than less complex stimuli.

The influence of color on visual fixation in infants has been investigated by Valentine (1914) and by Staples (1932). Valentine presented two different colored strands of wool side by side and noted how long each was fixated. Staples used a similar procedure, except that colored paper discs were used as stimuli. Both investigators found that infants preferred to look at the warm hues in the long-wave portion of the spectrum. Brandt (1944), photographing eye movements, found that adults spend more time looking at red and white designs than at black and white designs and, also, that they observed a preferred member in each of a pair of hues significantly more often.

Inspective Locomotor Exploratory Behavior. Berlyne (1960) has referred to locomotive behavior directed at properties of external stimulation as _inspective_ _locomotor_ _exploratory_ _behavior_. The same author (Berlyne, 1955) allowed one group of rats to explore an empty alcove and another group to explore the same alcove containing a gray cube. The cube, which added to the complexity of the stimulus field, provoked a significantly larger number of approaches in the first minute. Using mazes shaped like the figure "8" Dember, Earl, and Paradise (1957) exposed rats to alternative situations involving differential stimulus complexity. In the first experiment the walls of one loop were lined with black and white stripes arranged vertically, while the walls of the other loop were lined with black and white stripes arranged horizontally. Since there were more stripes per unit area in the vertically-striped portion, it was considered more complex than the horizontal member. In the second experiment the horizontal stripes in one loop were matched for half the subjects against plain white inserts in the other loop and for half against plain black inserts. After an initial aversion presumably elicited by the novelty of the situation, rats in both experiments soon came to prefer the more complex circular path. Williams and Kuchta (1957) used a Y maze with one white arm containing various black objects and a second white arm containing black stripes equal in area to the black objects in the first arm. The three-dimensional objects were assumed to increase the complexity of the environment and it was found that the preference for this area increased from the first to the last day of testing.

Welker (1957) used a similar procedure in allowing rats to explore an enclosure whose walls bore five cubes and five irregularly shaped objects. The rats were observed to approach the irregular objects more frequently than the cubes.

Brown (1961), attempting to treat complexity more systematically, found locomotor exploratory behavior in rats to increase with (a) number of three-dimensional objects and (b) object numerosity.

Inquisitive Locomotor Exploratory Behavior. The term inquisitive locomotor exploratory behavior has been used by Berlyne (1960) to refer to locomotor exploratory behavior occurring prior to the presentation of a change in external stimulation. Since this behavior has been found to increase in probability with the number of trials presented, the change in stimulus conditions contingent on the behavior has been classified as a rewarding event.

Utilizing a Y maze Berlyne and Slater (1957) found rats tended to enter the arm that led to the opportunity to explore stimuli in preference to the arm which led to an empty goal box. In a similar experiment, Miles (1958) showed that kittens preferred the arm of a maze that led to manipulable objects (a rubber ball, a small box, crumpled paper, torn towelling), rather than the arm that led to an empty goal box. The kittens also learned to go to the arm leading to a door that allowed them to leave the maze and explore the room in preference to an arm leading to a goal box that contained a familiar, but empty, food dish.

Investigatory Behavior. The term investigatory behavior has been used by Berlyne (1960) to describe exploratory behavior in which the organism manipulates and, hence, alters some aspect of the external situation.

Welker (1956), for example, showed that chimpanzees preferred multicolored, mottled rectangular blocks to rectangular blocks of uniform color. Further, the highest rate of response was found when the blocks were heterogeneous in both color and shape.

Inquisitive Investigatory Behavior. Berlyne has employed the term <u>inquisitive investigatory behavior</u> to describe investigatory behavior occurring prior to the onset of the change in stimulation. As for inquisitive locomotor exploratory behavior, the change in stimulation has been found to possess rewarding properties, i.e., with repeated trials inquisitive investigatory responses increase in rate.

Barnes and Baron (1961), working with rats, used as sensory reinforcement luminous line drawings which appeared on a dark screen just above the lever in a Skinner box. The stimulus patterns consisted of a circle, a square, and a "X," assumed by the authors to be in order of increasing complexity. Their results showed that increases in complexity of visual patterns are associated with increases in the magnitude of the sensory reinforcement effect.

Butler (1953) has demonstrated that monkeys will learn to open a door for the opportunity to look out of a box in which they are confined and further, that they will form a discrimination between colors characterizing a door that can be opened and another door that will not yield to pressure. In an investigation designed to determine the strength of visual exploration in monkeys, Butler and Harlow (1954) used an apparatus similar to the above and found the behavior of their animals to be strikingly resistant to extinction of satiation. Three normal animals continuously responded for 9, 11, and 19 hours before satiating, while the exploratory behavior of monkeys with bilateral damage to the temporal lobes was relatively depressed. Using an improved apparatus designed to permit monkeys to control both frequency and duration of responses, Butler and Alexander (1955) found that animals will work to maintain relatively fixed amounts of daily visual experience. Six rhesus monkeys tested for ten hours on each of six consecutive days spent approximately 40% of the time looking out of their confinement box.

In a study of observing behavior in preschool children as a function of stimulus complexity, Cantor, Cantor, and Ditrichs (1963) presented 31 boys and 29 girls with six stimulus triads, each triad containing stimulus patterns considered to be low, medium, and high in complexity level. A 60-second viewing period was allowed for each triad, and the time spent viewing each of the patterns was recorded. The complexity level effect was significant, the Ss spending more time on the average observing the most complex pattern. The difference in viewing time between medium- and low-complexity stimuli was not significant, nor was there a significant effect associated with the stimulus triads or with the various spatial arrangements of the stimuli within triads.

Purpose of the Study

One of the major problems in studies investigating the effects of complexity as a stimulus variable has been the failure of researchers to isolate with any degree of precision the variables present in visual configurations. Brown (in press) has attempted to remedy this situation by compiling a relatively exhaustive list of properties by which complex visual patterns may be described.

In this study an attempt was made to investigate the effects of five stimulus properties (Color, Size, Angular Variability, Number of Components, and Three-Dimensionality) arbitrarily selected from Brown's list, on the inquisitive investigatory behavior of the squirrel monkey. The study was designed with two general purposes in mind: (a) to identify, using a more analytic approach than has customarily been employed, some specific properties of visual patterns which are important to observing or attentional behavior and (b) to measure the attentional effects of these stimulus properties using one species of subject and one standard procedure - a practice which has rarely been followed, but which precludes the necessity of comparing results stemming from studies employing differing procedures and groups.

The term <u>observing behavior</u> has been used throughout this paper to describe the kind of behavior under investigation, since the term inquisitive investigatory behavior is somewhat cumbersome. The two terms are regarded as synonymous. Duration of time spent in pressing a transparent window to illuminate a visual display was selected as a measure of observing behavior. A time measure, rather than a frequency measure, was selected since it has been shown that the former is somewhat more sensitive to differential responding in a sensory reinforcement situation (e.g., Berlyne, 1955; Montgomery, 1953).

Predictions were based on the findings of other workers, although in some cases these workers employed other animals and procedures. It was predicted: (a) that a hue from the long wavelength portion of the spectrum would elicit greater observing behavior than a hue from the middle portion of the spectrum (e.g., Valentine, 1914;

Staples, 1932); (b) that observing behavior would increase with an increasing number of components in the pattern, e.g. Brown (1961), Dember, Earl, and Paradise (1957); (c) that observing behavior would increase as the amount of Three-Dimensionality in the patterns increased (e.g., Brown, 1961; Williams and Kuchta, 1957); (d) that observing behavior would increase with increasing Angular Variability of the shapes; and (e) that shapes of larger sizes would evoke greater observing behavior than shapes of smaller size.

Attneave (1957) has found Angular Variability to be an important determinant in judgments of complexity; and since complexity has been found to increase observing behavior, e.g., Welker (1956a), it was predicted that increasing Angular Variability would be associated with increasing observing behavior. The prediction regarding the effects of Size was made on the basis of an extension of the experimentally established importance of numerosity to observing behavior, i.e., both properties involve variation in amount of pattern contour.

CHAPTER II

METHOD

Subjects

Ten adult squirrel monkeys, seven males and three females, served as subjects. The monkeys were from the colony maintained for the Department of Psychology by the Research Foundation of Oklahoma State University.

Apparatus

The apparatus consisted of a cylindrical metal chamber 24 in. in diameter and 20 in. high, with a $\frac{1}{4}$ in. plywood top (see Figure 1). Three vertically sliding doors, 7 in. high by 6 in. wide, were centered 120 degrees apart. Three 10 in. high by 10 in. wide by $7\frac{1}{2}$ in. deep stimulus boxes, mounted on the exterior of the chamber approximately 7 in. from the floor and 120 degrees apart, contained the stimulus plaques. The stimulus plaques could be changed easily by means of doors hinged to the top of each box. Subject could view the plaques through three $3\frac{1}{2}$ in. high by $3\frac{1}{2}$ in. wide by 1/8 in. thick lucite windows which separated the stimulus boxes from the interior of the main chamber.

A slight depression of the window (approximately 1/8 in.): (a) illuminated a 7 w. lamp mounted on the box lid above the response window actuated a timer by means of copper contacts. The lamp and timer operated only as long as the window was depressed. The only source of light in the chamber was supplied by a 2.5 w. lamp which was mounted in the center of the ceiling of the apparatus and provided continuous illumination. Power was supplied from a 110 v. AC source, reduced to 10 v. at the windows by means of a remote transformer-relay system. The interior of the chamber was painted flat gray and the stimulus boxes were painted flat white.

Fifty nine-sided shapes were randomly plotted according to Method One of Attneave and Arnoult (1956). Briefly, this method consists of randomly plotting points within a matrix and connecting these points according to a standard set of operations. The angular variability (Attneave, 1957) of each of the fifty shapes was then determined. This variable describes the degree to which adjacent angles on the contour of the shape vary in size. One shape with moderate angular variability (Basic Shape) was selected for use on all but two of the stimulus plaques.

Treatment of each of the five variables investigated is briefly described below; Table I summarizes and Figure 2 illustrates the three values employed for these variables. Each of the shapes was centered 7 in. from the bottom of a masonite plaque (10 in. wide by 10 in. high) painted matt-white. The area of each shape was 1284.37 mm^2, except, of course, for the size variable.

Color (C). The Basic Shape was painted in three colors selected from the Color Harmony Manual (Jacobson, 1958): gray (e-matt of the gray series), green (23pa-matt), and orange (6ia-matt). The three colors were chosen so as to be equal in reflectance, and the orange and green were selected to be equal in purity. The paints were prepared according to special formulae developed by the Martin-Senour Paint Company. The wavelengths of the orange and green were selected on the basis of data obtained on the squirrel monkey (Miles, 1958; Jacobs, 1963) showing that both are discriminable from the gray and from each other.

Size (S). The Basic Shape was painted in three different sizes so that the average of the three sizes equaled 1284.37 mm^2. These sizes are shown in Table I. The shapes were placed on the stimulus plaques in the same manner as the colored shapes.

Number of Components (N). Using the smallest shape constructed for treatment of Size, one plaque was assigned one component shape, the second plaque, three components, and the third plaque, nine components. It will be noted that, again, the average area of the three patterns was equal to 1284.37 mm^2. The shape of the one-component pattern was placed as for Size and Color, while the components of the remaining two patterns were placed randomly with the restriction that the average distance between the components be the same for the three- and the nine-component patterns.

Angular Variability (A). From the collection of the fifty shapes described above, two additional shapes were selected, one for low angular variability (40.33) and one for high angular variability (138.33). These two shapes, along with the Basic Shape, were painted with an area of 1284.37 mm^2 in the same location as for Color and Size.

Three-Dimensionality (D). For treatment of Three-Dimensionality, the Basic Shape, with an area of 1284.37 mm^2 was again used and

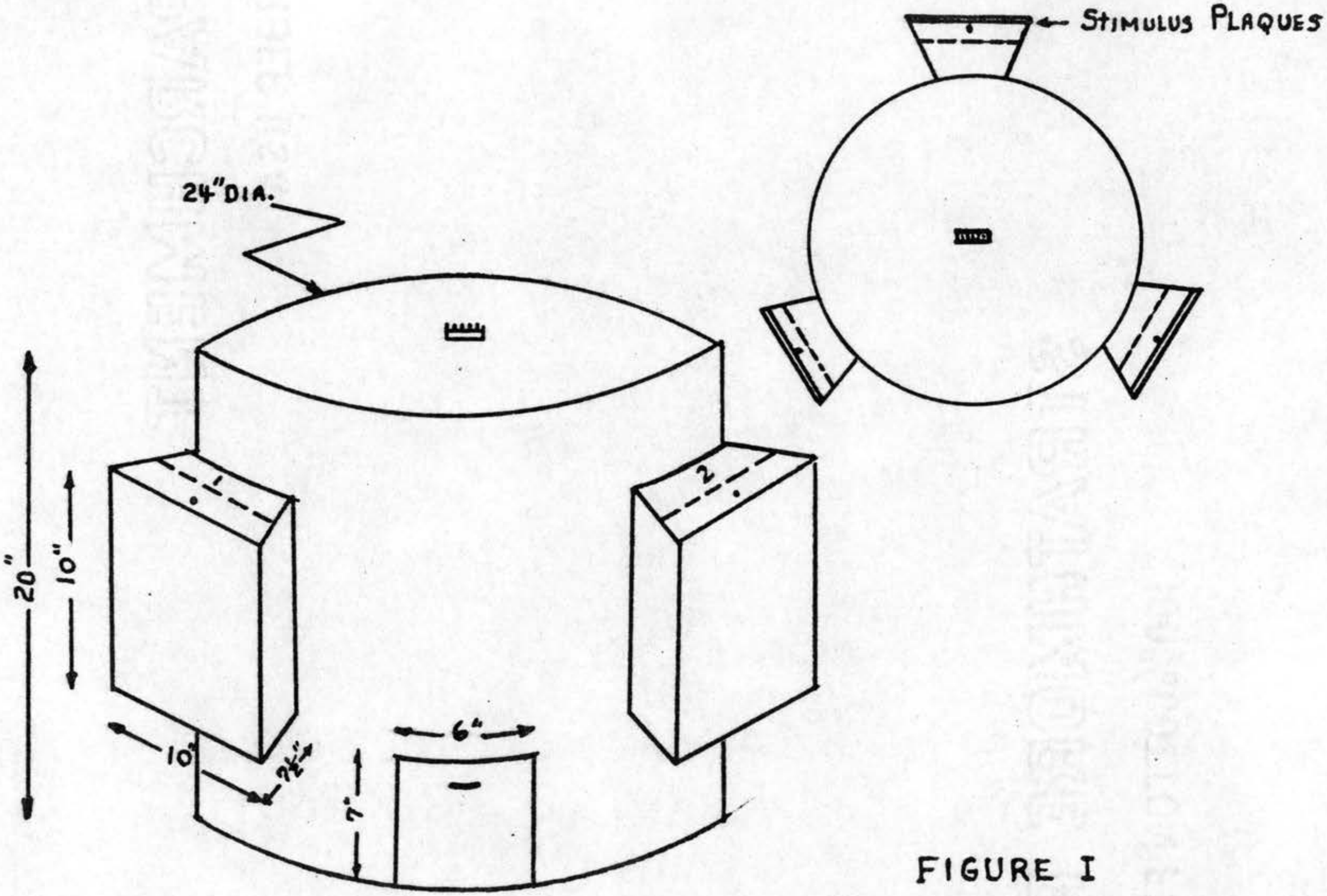


FIGURE I

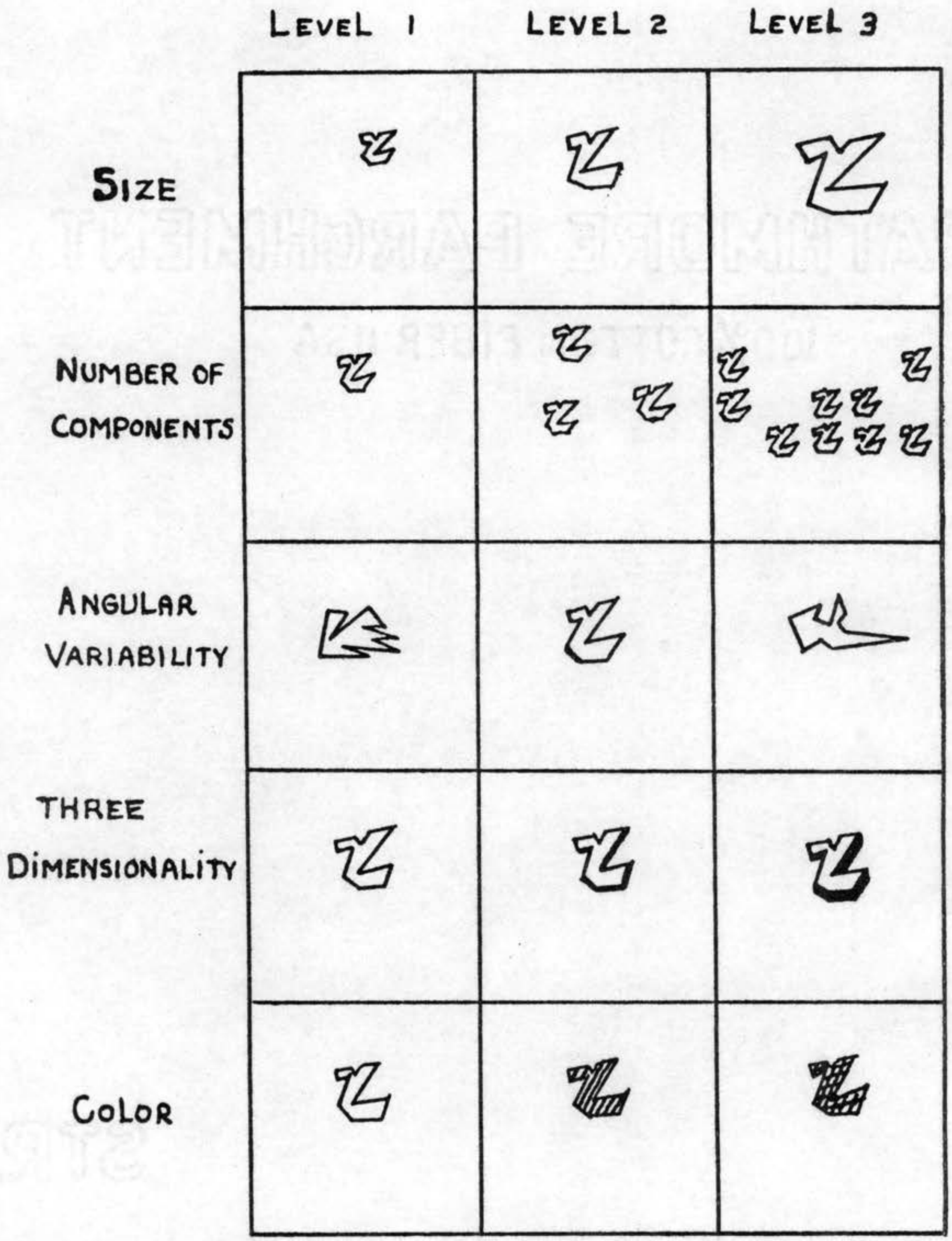
Diagram of Apparatus

TABLE I

VARIABLES AND DIMENSIONS USED IN THE FIVE STIMULUS TRIADS

Variable	Level I	Level II	Level III
Color (C)	Gray	Green (553.4 mu)	Orange (600.5 mu)
Size (S)	296.5 mm^2	889.25 mm^2	2668.5 mm^2
No. of Comp. (N)	1	3	9
A. V. (A)	40.33	84.5	138.33
3-D (D)	0 cm.	$1\frac{1}{2}$ cm.	$4\frac{1}{2}$ cm.

FIGURE 2


LEVEL 1
LEVEL 2
LEVEL 3
SIZE
NUMBER OF COMPONENTS
ANGULAR VARIABILITY
THREE DIMENSIONALITY
COLOR

placed as described for Color above. The shape was painted directly on the first plaque; for the second and third patterns it was constructed from balsa wood and attached to the plaque. The thickness for the second pattern was $1\frac{1}{2}$ cm, and the thickness for the third pattern was $4\frac{1}{2}$ cm.

Procedure

In a series of preliminary sessions each of the twenty-three subjects was placed in the chamber and allowed to adapt to the experimental situation. Various pictures taken from magazines, etc., were inserted in the choice boxes during these sessions. The sessions were continued until the subjects responded to one or more windows within a thirty-minute period. In this manner the ten subjects used in the experiment were selected. These adaptation sessions were presented for two reasons: (a) to adapt animals to the experimental situation and (b) to reduce the reinforcing effects of novelty or stimulus change (e.g., Berlyne, 1960, p. 43). A single pretest trial using stimulus patterns similar to the ones employed during the experiment was given one day prior to the beginning of the test sessions. During this trial, each of the ten subjects was allowed thirty minutes in which to respond and, following the first response, was given fifteen minutes additional time in the apparatus. All ten subjects responded within the thirty-minute period.

During the experimental trials, the same limits as those used for the pretest trials were utilized. Each subject received one triad each day so that all five triads were presented within a five-day period. During the second five-day period the triads were presented for a second time. Within each five-day period, the order of presentation of the triads was randomly determined for each subject with the restriction that each triad appear twice, i.e., for two subjects, on each of the five days. The spatial position of the triads was systematically varied so that each level of each variable appeared an equal number of times in each stimulus box. The daily experimental sessions, lasting approximately four hours, were begun at the same time each day. The order in which each animal was placed in the apparatus was randomly determined for each daily session.

During the criterion trial and throughout the experimental sessions the apparatus was placed in a soundproof and light-proof room. The subjects were transported in carrying cages to the experimental room, one at a time, and returned to the colony immediately after each trial. Response times were recorded after each trial; the three timers were located in a room immediately adjacent to the experimental room.

CHAPTER III

RESULTS

The time spent by each S viewing each of the three patterns of each of the five triads is presented in Appendix A for the first five-day period and in Appendix B for the second five-day period.

The time data, arranged in a Levels X Blocks factorial design with repeated measures on both factors, were analyzed by means of analysis of variance for each of the five variables.

Number of Components. The analysis of variance, summarized in Table II, revealed no significant differences across either Levels of complexity or Blocks. The mean response times, in seconds, by Levels were 33.6, 26.7, and 43.1, suggesting that the single shape may actually have evoked slightly more observing behavior than the three-shape pattern.

Size. The analysis of variance for the Size data is summarized in Table III. No significant effects due to Size for Blocks were revealed. The mean response times in seconds were 32.6, 36.5, and 50.8 indicating a possible tendency for the largest shape to evoke greater observing behavior.

Color. Table IV shows that the analysis of variance failed to reveal a significant effect associated with either Color or Blocks. The mean response times in seconds for gray was 37.6; for green, 46.3; and for orange, 55.4. It should be noted that green and/or orange were preferred over gray on eighteen of the twenty total presentation (10 subjects by 2 blocks).

Three-Dimensionality. The analysis of variance for time scores obtained during the presentation of patterns varying in three-dimension is summarized in Table V. Again, no significant effects were observed. The mean response times, 35.6 sec., 42.5 sec., and 64.5 sec., suggested a tendency for observing behavior to increase with increasing Three-Dimensionality.

Angular Variability. Table VI summarizes the analysis of variance performed on the Angular Variability data. Once again, no significant effects due to either the pattern or Blocks variables were revealed. The mean response times for the shape of moderate Angular Variability was greater (68.5) than the mean response time for the shapes with low or high Angular Variability (42.4 and 46.6, respectively).

CHAPTER IV

DISCUSSION AND SUGGESTIONS FOR FURTHER RESEARCH

Although the hypothesis that the simultaneous presentation of stimulus patterns varying in several selected properties would elicit significantly disparate amounts of responding were not confirmed, support for these and similar hypothesis has been obtained many times in the past (e.g., Berlyne, 1955; Welker, 1953; and Barnes and Baron, 1961).

There are several factors which may have contributed to the lack of significant results. First, the animals may not have been sufficiently adapted to the experimental situation to control for the effects of the novelty of the response situation, effects which may have tended to wash out effects due to stimulus complexity. In other words, the proprioceptive and visual feedback from pressing the windows may have provided important incentives in their own right, with the specific properties of the visual patterns playing a minor role. Second, the time allotted for responding to each triad may have been too short. Dember, Earl, and Paradise (1957) found an initial aversion to complex patterns by rats which disappeared as the subjects became increasingly accustomed to the novel stimuli. Third, the physical differences among the levels of the patterns may have been too narrow to elicit highly preferential or discriminable responding in the squirrel monkey.

Many suggestions for further research were generated by this study. By increasing the number of replications, for example, the reliability should be increased allowing a more stable evaluation of the observing behavior of the subjects. Increasing the response times for each subject might attenuate the effects associated with stimulus change, thus accounting for any initial aversion toward complex patterns that may occur (c.f., Dember, Earl, and Paradise, 1957). The use of subjects higher on the phylogenetic scale (e.g., rhesus or chimpanzee), or, alternatively, the presentation of stimulus variables with greater inter-pattern differences should serve to lessen the danger of confusion in the subjects preferences.

A final point involves a modification of the apparatus used in the experiment. By placing the stimulus boxes closer together, the observing time of each subject might be increased due to the minimal time required for the subject to move from window to window.

CHAPTER V

SUMMARY

Recent experimental interest in the psychology of motivation and attention has centered on the motivating properties of external stimulation, especially with respect to various types of exploratory, observing, and attentional behavior. Unfortunately, however, few attempts have been made to specify with any degree of precision those particular properties of visual patterns which play a major role in these behaviors. The present study was designed to explore, at a relatively analytic level, the differential effects of a number of arbitrarily selected stimulus properties on the observing behavior of the squirrel monkey. A simultaneous-presentation approach was employed. The variables chosen for study (Color, Size, Three-Dimensionality, Number of Components, and Angular Variability) were drawn from a list of stimulus properties compiled by L. T. Brown (in press). Three patterns were prepared and painted on masonite plaques for each of the five variables. The three patterns represented widely disparate levels of the appropriate stimulus properties. The plaques for each variable were placed in a predetermined manner in three stimulus boxes mounted at equal intervals around a cylindrical chamber. A slight depression of a transparent window separating the interior of the chamber from the stimulus boxes illuminated the interior of the corresponding box, and, at the same time, activated

a timer associated with that box. Both the timer and lamp operated only as long as the window was depressed.

Ten squirrel monkeys served as subjects. Each subject was given each stimulus triad twice over a period of two weeks, making a total of one hundred trials (ten subjects by five stimulus triads by two presentations).

Using total response time in seconds as the measure, the time that each subject spent viewing each stimulus triad was recorded. A separate analysis of variance, with the data arranged in a Levels X Blocks factorial design, was performed for each of the five variables. The results of the analyses failed to reveal a significant effect associated with either the Levels or Blocks, although trends in the predicted direction were observed. Discussion centered around the importance of controlling for such factors as novelty and extent of diversity in the selection of stimulus values.

TABLE II

ANALYSIS OF VARIANCE OF TIME SCORES FOR PATTERNS VARYING IN COLOR (N=10)

Source	df	MS	f	p
A	2	391.68	1.10	ns
AS	18	357.059		
B	1	763.268	1.00	ns
AB	2	837.028	1.92	ns
BS	9	1,128.053		
ABS	18	436.650		
S	9	4,799.363		
Total	59			

TABLE III

ANALYSIS OF VARIANCE OF TIME SCORES FOR PATTERNS VARYING IN SIZE (N=10)

Source	df	MS	f	p
A	2	460.962	1.60	ns
AS	18	287.212		
B	1	8.067	1.0	ns
AB	2	171.654	1.29	ns
BS	9	172.918		
ABS	18	132.617		
S	9	4,933.444		
Total	59			

TABLE IV

ANALYSIS OF VARIANCE OF TIME SCORES FOR PATTERNS VARYING IN NUMBER OF COMPONENTS (N=10)

Source	df	MS	f	p
A	2	338.6	1.68	ns
AS	18	200.975		
B	1	156.817	1.49	ns
AB	2	13.616	1.0	ns
BS	9	105.270		
ABS	18	42.918		
S	9	38.820		
Total	59			

TABLE V

ANALYSIS OF VARIANCE OF TIME SCORES FOR PATTERNS VARYING IN THREE-DIMENSIONALITY (N=10)

Source	df	MS	f	p
A	2	1,603.179	1.96	ns
AS	18	818.656		
B	1	473.204	1.0	ns
AB	2	23.005	1.0	ns
BS	9	663.574		
ABS	18	214.472		
S	9	7,663.222		
Total	59			

TABLE VI

ANALYSIS OF VARIANCE OF TIME SCORES FOR PATTERNS VARYING IN ANGULAR VARIABILITY (N=10)

Source	df	MS	f	p
A	2	983.113	1.43	ns
AS	18	685.332		ns
B	1	1,837.066	1.0	ns
AB	2	1,153.080	1.30	ns
BS	9	2,297.363		ns
ABS	18	885.702		ns
S	9	9,541.324		ns
Total	59			

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APPENDIX A

RESPONSE TIMES IN SECONDS FOR EACH SUBJECT
DURING FIRST BLOCK OF TRIALS (DAYS 1-5)

S	Variable	Level I	Level II	Level III	Total
S_1	C	1.5	2.0	4.0	7.5
	D	13.0	2.0	5.0	20.0
	A	4.0	6.0	12.0	22.0
	S	1.0	2.0	2.0	5.0
	N	1.0	1.0	6.0	8.0
	Total	20.5	13.0	29.0	62.5
S_2	C	12.0	23.0	34.0	69.0
	D	20.0	69.0	68.0	157.0
	A	7.0	8.5	40.0	55.5
	S	7.0	17.0	4.0	28.0
	N	7.5	5.0	14.0	26.5
	Total	53.5	122.5	160.0	336.0
S_3	C	30.0	18.5	31.0	79.5
	D	17.0	--	3.0	20.0
	A	6.0	9.0	7.0	22.0
	S	26.0	9.0	53.0	88.0
	N	--	--	1.	1.
	Total	79.0	36.5	95.0	210.5
S_4	C	15.0	124.0	37.0	176.0
	D	75.0	128.5	235.0	438.5
	A	76.0	80.0	76.5	232.5
	S	77.0	77.0	123.0	277.0
	N	88.0	65.0	114.0	267.0
	Total	331.0	474.5	585.5	1391.0
S_5	C	1.0	--	1.5	2.5
	D	2.0	.5	3.0	5.5
	A	3.0	4.5	--	7.5
	S	2.0	7.0	1.0	10.0
	N	6.0	1.0	4.0	11.0
	Total	14.0	13.0	9.5	36.5

S	Variable	Level I	Level II	Level III	Total
S_6	C	25.5	31.0	8.0	64.5
	D	20.5	8.0	14.0	42.5
	A	17.0	16.0	27.0	60.0
	S	10.6	1.0	5.0	16.6
	N	6.5	14.0	12.0	32.5
	Total	80.1	70.0	66.0	216.1
S_7	C	9.0	25.0	24.0	58.0
	D	9.0	6.0	14.5	29.5
	A	14.0	18.0	13.0	45.0
	S	10.0	6.0	22.0	38.0
	N	10.0	5.0	5.5	20.5
	Total	52.0	60.0	79.0	191.0
S_8	C	23.0	16.0	30.0	69.0
	D	39.0	20.0	18.5	67.5
	A	12.0	29.0	38.5	79.5
	S	12.0	21.0	14.0	47.0
	N	30.0	11.0	22.0	63.0
	Total	116.0	97.0	123.0	336.0
S_9	C	5.0	22.0	10.0	37.0
	D	2.0	13.0	5.5	20.5
	A	19.0	18.5	18.0	55.5
	S	21.0	12.0	23.5	56.5
	N	2.5	9.0	5.0	16.5
	Total	49.5	74.5	62.0	186.0
S_{10}	C	13.0	6.0	7.5	26.5
	D	.5	6.0	5.0	11.5
	A	9.0	17.0	16.0	42.0
	S	8.0	2.0	35.0	45.0
	N	9.0	6.5	7.5	23.0
	Total	39.5	37.5	71.0	148.0
ALL Ss	C	589.5			
	D	822.5			
	A	621.5			
	S	611.0			
	N	469.0			
Grand Total		3113.5			

APPENDIX B

RESPONSE TIMES IN SECONDS FOR EACH SUBJECT DURING THE SECOND BLOCK OF TRIALS (DAYS 6-10)

S	Variable	Level I	Level II	Level III	Total
S_1	C	9.0	6.0	12.0	27.0
	D	8.0	10.0	64.0	82.0
	A	14.0	16.0	1.0	31.0
	S	7.0	10.0	3.0	20.0
	N	5.5	5.0	2.0	12.5
	Total	43.5	47.0	82.0	172.5
S_2	C	31.5	17.0	65.0	113.5
	D	12.0	23.5	19.0	54.5
	A	39.0	65.5	10.0	114.5
	S	47.0	10.0	1.0	58.0
	N	36.0	13.0	21.5	70.5
	Total	165.5	129.0	116.5	411.0
S_3	C	42.5	9.0	23.0	74.5
	D	--	8.0	7.0	15.0
	A	5.0	2.0	4.5	11.5
	S	3.0	12.0	10.5	25.5
	N	9.0	7.0	6.0	22.0
	Total	59.5	38.0	51.0	148.5
S_4	C	101.0	112.0	208.5	421.5
	D	72.0	73.5	151.0	296.5
	A	132.0	336.5	123.0	591.5
	S	61.0	117.0	147.0	325.0
	N	65.0	64.0	131.5	260.5
	Total	431.0	703.0	761.0	1895.0
S_5	C	--	1.5	--	1.5
	D	1.0	5.5	4.0	10.5
	A	8.0	3.0	1.0	12.0
	S	.5	1.0	1.5	3.0
	N	--	5.0	3.0	8.0
	Total	9.5	16.0	9.5	35.0

S	Variable	Level I	Level II	Level III	Total
S_6	C	15.0	6.0	3.0	24.0
	D	8.0	8.0	8.0	24.0
	A	4.0	5.0	6.0	25.0
	S	6.0	8.0	22.0	36.0
	N	8.0	7.0	24.0	39.0
	Total	41.0	34.0	73.0	148.0
S_7	C	11.0	5.5	11.0	27.5
	D	10.0	6.5	9.5	26.0
	A	8.0	14.0	8.0	30.0
	S	14.0	11.5	13.0	38.5
	N	8.5	10.5	12.0	31.0
	Total	51.5	48.0	53.5	153.0
S_8	C	13.0	23.0	18.0	54.0
	D	15.0	17.0	22.0	54.0
	A	18.0	25.0	31.0	74.0
	S	9.0	17.0	10.0	36.0
	N	14.0	8.5	19.0	41.5
	Total	69.0	90.5	100.0	259.5
S_9	C	13.0	4.0	14.0	31.0
	D	29.0	19.0	29.0	77.0
	A	28.0	6.5	19.5	54.0
	S	4.0	14.0	14.0	32.0
	N	27.0	27.0	20.0	74.0
	Total	101.0	70.5	96.5	268.0
S_{10}	C	5.5	11.5	12.0	29.0
	D	3.0	1.5	10.0	14.5
	A	.5	5.0	4.5	10.0
	S	--	11.0	4.0	15.0
	N	3.5	2.5	1.0	7.0
	Total	12.5	31.5	31.5	75.5
ALL Ss	C	803.5			
	D	654.0			
	A	953.5			
	S	589.0			
	N	566.0			
Grand Total		3566.0			

VITA

Paul T. Kemmerling

Candidate for the Degree of

Master of Science

Thesis: THE EFFECT OF SELECTED PROPERTIES OF COMPLEX VISUAL PATTERNS ON OBSERVING BEHAVIOR IN THE SQUIRREL MONKEY

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