Motivation and Emotion, Vol. 6, No. 3, 1982

Color Preference, Arousal, and the Theory of Psychological Reversals

Jean Walters
University of Wales Institute of Science and Technology
Michael J. Apter[1]
University College Cardiff
Sven Svebak
University of Bergen

The theory of psychological reversals asserts that there are two levels of preferred felt arousal, one high and one low. Only one of them is preferred at a given time, although discrete switches ("reversals") occur from time to time, so that each level is preferred at different times. In order to document such changes in preferred levels of arousal, 75 subjects were asked to make color preference choices at regular intervals during their working day, some for as many as 8 days. The assumption was that different colors are arousing or relaxing, and that color choice indicates arousal preference. The typical patterns of color choices that occurred clearly displayed the expected reversal effect over time and were considerably more consistent with reversal theory than with optimal arousal theory. In a second study, 41 new subjects were asked to respond to a simple mood adjective checklist each time they made their color preference choices. The results strongly supported the association between arousal preference and color preference and also supported the reversal theory thesis that low arousal preference is associated with seriousness and planning orientation (all these characterizing the "telic state"), and that high arousal preference is associated with playfulness and spontaneity (all these characterizing the

[1]Address all correspondence to Dr. M. J. Apter, Psychology Department, University College Cardiff, P.O. Box 78, Cardiff CF1 1XL, Wales, U.K.

0146-7239/82/0900-0193$03.00/0

"paratelic state"). Finally, both studies showed that there is a systematic tendency for long-wavelength colors to induce feelings of high arousal and for short-wavelength colors to induce feelings of low arousal.

The work to be reported here represents an attempt to test some key hypotheses derived from a new theory of motivation and personality known as "the theory of psychological reversals." However, since the approach adopted to test these hypotheses involved the recording of color preferences, the research could also be said to constitute a contribution to the study of the psychological significance of color.

Reversal theory was originally proposed by Smith and Apter in 1975. (A short account will be found in Apter, 1979, and an extended and detailed account in Apter, 1982.) It is a phenomenological theory in the sense that it is concerned centrally with experience, especially with various aspects of the experience of motivation. One of these aspects will concern us particularly here: the experience of arousal in relation to hedonic tone. In this respect, reversal theory differs markedly from optimal arousal theory. Although the latter (following Hebb & Thompson, 1954; Hebb, 1955) has taken many different forms, all optimal arousal theorists appear to assume that there is only one arousal system and that this system has a single optimal point on the arousal dimension, this point being optimal in terms of both performance and hedonic tone. A number of theorists (e.g., Fiske & Maddi, 1961) have elaborated this idea by suggesting that the optimal point may change, but such theories still assume homeostasis within a single system, and assume that the optimal point remains intermediate on the arousal dimension. Reversal theory, by contrast, argues that there are two systems, each with its own optimal point, and in place of the notion of homeostasis, therefore, it substitutes the notion of bistability (Apter, 1981). Furthermore, it argues that these two optimal points, or "preferred levels," are toward opposite ends of the arousal dimension. So instead of there being one level of preferred arousal to which there is a tendency to return, and which is felt as pleasant, reversal theory suggests that there are two such levels, only one of which is preferred at a given moment, this being the preferred level of the arousal system that is operative at that moment. Furthermore, switching from one system to the other, which involves switching from one preferred level to the other, can be induced by any one of a number of different factors specified in the theory; since the two alternative preferred levels are assumed to be toward opposite ends of the felt arousal dimension, such switches are referred to as *reversals*. (It should be noted that the optimal point for each system is defined by reversal theory in terms of hedonic tone rather than performance.)

This idea can be made clear by reference to Figure 1, in which there are *two* hypothetical curves relating arousal to hedonic tone instead of the single curve of optimal arousal theory. Each of these curves relates to a different system, one of which may be thought of as an "arousal-avoiding" system and the other as an "arousal-seeking" system. At any given level of arousal, it is possible, according to the theory, to switch from the curve representing one of these systems to the curve representing the other—that is, reversal can be induced. One of the results of such a reversal may be a sudden change of hedonic tone in relation to the level of arousal experienced at that moment.

This view of the relationship between felt arousal and hedonic tone presents a number of advantages over optimal arousal theory. These can be summarized as follows.

1. It accounts more easily than optimal arousal theory for the fact that on some occasions even very high arousal can be pleasant (e.g., during sexual behavior, or watching football) and on other occasions even very low

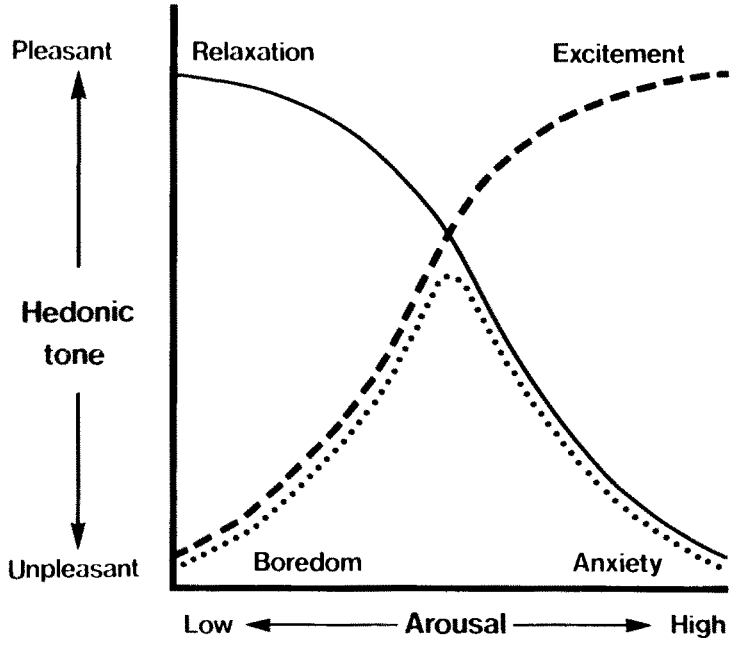

Fig. 1. The two hypothetical arousal curves suggested by reversal theory. One is represented by a continuous line and the other by a dashed line. The curve represented by a dotted line shows, for comparison, a form of curve suggested by optimal arousal theory.

arousal can be pleasant (e.g., relaxing after a hard day's work). If evidence for this were needed, it will be found in Apter (1976). It should be noticed that the optimal arousal curve is, in a sense, encompassed within Figure 1 since if the shape and position of the curves are as shown here, then intermediate levels of arousal will also tend to be reasonably pleasant.

2. It accounts for *four* nouns that describe different pleasant and unpleasant states of arousal—namely, anxiety, relaxation, excitement, and boredom—and it brings out the structural relationship between them. These four types of arousal are shown in the appropriate positions on the graph. (In this respect the theory, of course, elaborates on Schachter's (1964) notion that a given level of arousal can be interpreted by the individual in more than one way.) By contrast, optimal arousal theory has difficulty in assimilating these four adjectives to its interpretation and has to do so by making such unwarranted assumptions as that excitement is always a lower form of arousal than anxiety (cf. Hebb, 1955). This particular assumption of optimal arousal theory also implies that as arousal increases, excitement will always be felt before anxiety, and that it will always be felt after anxiety as arousal decreases—an implication for which there is no evidence and which would appear to be totally inconsistent with everyday experience.

3. It allows for the possibility of certain rapid changes in the way in which arousal is felt. For example, it explains how anxiety can be converted almost instantaneously into excitement and vice versa. Like Zillmann's (1971) excitation-transfer theory, it helps to explain such psychological phenomena as the enjoyment of dangerous sport (in which residual arousal is enjoyed after threat is removed), or sexual dysfunction (in which arousal due to sexual stimulation may suddenly be converted into a form of anxiety, which then inhibits sexual behavior).

In general, then, the extra dimension that is introduced through a reversal theory notion of different arousal-regulation systems allows the theory to give new interpretations to a number of psychological phenomena, including humor (Apter & Smith, 1977; Apter, 1982; Apter, in press), religious behavior (Apter, 1982), sexual behavior (Apter & Smith, 1978, 1979a), and family interaction patterns (Apter & Smith, 1979b). It also has implications for counseling and therapy (Svebak & Stoyva, 1980; Murgatroyd, 1981; Apter, 1982).

The two different arousal-preference systems are, according to reversal theory, associated closely with (and may be regarded from some perspectives as subsystems of) a more all-embracing pair of systems, which have been labeled in the theory as "telic" and "paratelic." (The reason for this choice of words is explained in Apter, 1982, chap. 3.) These two systems are most conveniently characterized in terms of the phenomenological states with which they are associated. The telic state is defined as a state of mind in which one conceives oneself to be pursuing an

important goal, the behavior being chosen to achieve the goal. The paratelic state of mind is one in which the orientation is toward the behavior itself, together with its concomitant sensations, any goal being conceived essentially as an excuse for the behavior. In other words, there is a sense in which the goal is at the focus of the phenomenal field in the telic state and the ongoing activity is at the focus in the paratelic state. When a reversal does occur, this is somewhat analogous to a figure-ground perceptual reversal, with the figure being in one case a goal and in the other a form of activity.

In the telic state, which is the state associated with low arousal preference, the state of mind is a serious one, and the concern is more likely to be with the future than the present; in this state the individual tries to plan ahead wherever possible. In the paratelic state, which is the state associated with high arousal preference, the state of mind is a more lighthearted or playful one in which the orientation is toward the present moment and its enjoyment; it is also characterized by a preference for spontaneity rather than planning. Reversal theory, then, sees the telic and paratelic states as a bistable pair of opposite but complementary phenomenological states, each associated with its own underlying system, and with the continual possibility of reversal between these states/systems. Although these states are defined in terms of the primacy of goal or activity, it will now be appreciated that the states themselves, and their underlying systems, are complex and involve a number of related characteristics or components.

The research to be described here is based on the assumption, for which evidence is in fact provided in the course of the research, that color has an effect on felt arousal, some colors making a given individual feel more highly aroused, and some making him/her feel more relaxed. This being so, preference for one color or another may then be said to reflect a preference for one level of felt arousal rather than another, and color choice at a given moment would therefore act as an indicator of the preferred level of arousal at that moment. (It should be noted that *felt* arousal rather than physiological arousal is being referred to here. Although felt arousal may relate to a number of different physiological measures, such measures were not used in these experiments.)

The idea that color can have an effect on psychological processes dates back at least to the work of Goldstein (1939, 1942; Goldstein & Rosenthal, 1930). In particular, in the field of personality, use has been made of color in a number of personality tests, including notably the Rorschach and the Luscher Color Test (Luscher, 1965), the latter being based entirely on color preference responses.

Our concern here, however, is that of the effect of color specifically on arousal. The most widespread view of the relation of color to arousal seems

to be that the degree of arousal is related in general to the position of the color on the color spectrum, long-wavelength colors, like red, orange, and yellow, being arousing and short-wavelength colors at the other end of the spectrum, like blue, indigo, and violet, being relaxing. In these terms, colors in the area of green on the spectrum would be expected to be relatively neutral. Several studies have been carried out on the upper half of the spectrum by comparing the effects of red and green. Thus, Nakshian (1964) has provided results that give some mild support to the notion that red is more "exciting" than green. His subjects performed various tasks in a semi-enclosed structure that was painted either red or green, or was achromatic. Although most of these tasks showed no significant differences between conditions, he did find that subjects displayed a significantly greater hand tremor when they were in the red than in the green condition, and that their speed of movement in a motor inhibition task was significantly faster in the red than in the green condition. Wilson (1966) has obtained evidence that is more direct and more supportive of the idea that red is more arousing than green. He directly measured physiological arousal in terms of average skin conductance level and skin conductance response (SCR, i.e., maximum increase in conductance) in reaction to exposure to red and green slides. The scores for each measure were ranked for each subject and then the ranks averaged on each of five trials across subjects. The means of the "red" scores were consistently higher than those of the "green" scores for both measures, although differences were more clear-cut in the SCR data. Subjects also reported that the red felt more "stimulating," "exciting," etc., than the green. It is unfortunate that neither of these studies used colors from a short-wavelength end of the spectrum. Fortunately, a detailed study had earlier been carried out by Gerard (1957, 1958) using blue as well as red. Gerard made use of red, blue, and white lights transmitted on a diffusing screen. He also used a variety of physiological measures. Of the various measures used, only one (heart rate) showed no appreciable differences. For two measures (palmar conductance, cortical activation), activation was found in response to both blue and red, but with activation consistently greater for red than for blue. With the remaining measures (blood pressure, respiratory movements, frequency of eye blink), each variable concerned showed an increase under the influence of red light and a decrease under the influence of blue light. These results are generally most consistent with the idea that red is arousing and blue relaxing, and this is the way that the subjects themselves reported to Gerard that they experienced these two colors. Nourse and Welch (1971), using only one physiological measure (*GSR*), however, found that violet, at the extreme cool end of the spectrum, produced a significantly greater response than green, although only on the first trial. But unlike the green light, which was relatively

"pure," the violet light used consisted of a band of wavelengths covering the entire visible spectrum and peaking both at 455 nm (blue) and 677 nm (red), and this may have confused the issue.

A number of studies have also been carried out specifically on subjective ratings of colors, rather than on the behavioral or physiological response to color. Ratings have typically been carried out in terms of a number of types of affect or mood-state, but generally these have included excitement, calmness, and the like. Thus, Wexner (1954) found, among other things, that red was associated more than other colors with the adjectives *exciting, stimulating,* followed in frequency by yellow and orange, whereas blue was the color most frequently associated with *calm, peaceful, serene.* Schaie (1961a) found that the mood "exciting, stimulating" had its strongest association with yellow and orange, while "secure, comfortable" and "tender, soothing" had their strongest association with blue, which also, together with white and gray, was the color most strongly associated with "calm, peaceful, serene." In another study by Schaie (1961b), using the Q-sort, very similar results were obtained. And in both studies, green showed no strong association with any mood. Wright and Rainwater (1962) carried out a rather complex study using factor analysis and involving saturation and brightness as well as hue. They were able to discern, among other things, a relationship between degree of blueness and calmness and also between degree of redness and both greatest warmth and less calmness. Taken together, then, such studies also provided evidence that is generally consistent with the notion that position on the spectrum is correlated with arousal level, the long-wavelength end of the spectrum representing high arousal and the short-wavelength end low arousal.

As part of both studies reported below, subjects were asked to rate how arousing or relaxing each of the colors used in the study was. Although the primary aim of doing this was to allow each individual subject's sequence of color preference choices in the main part of the study to be interpreted in such a way as to disclose that subject's changing pattern of arousal preference, it also meant that it was possible to look at the data across subjects and see if there was a general pattern of association between wavelength and arousal value, especially of the kind indicated by the studies that have been surveyed here.

The main interest of this research, however, was in the individual *patterns* of arousal preference disclosed by color preference. The first study was designed to look, in a general way, at the frequency, extent, and pattern of changes in arousal preference as indicated in this way. Reversal theory would predict that change would be a more obvious feature of these data than stability, that it would tend to take the form of switching between opposite ends of the arousal-preference dimension (i.e., that "reversals" would be apparent), and that overall more time would be spent toward the

extreme of this dimension than in the more central positions, so that frequency distribution of choices by a given subject would be bimodal rather than normal.

The second study to be reported also looked at the pattern of changes in arousal preference as indicated by color preference, but a brief mood adjective checklist was also administered on each occasion that the subject was asked to make a color choice. The aim of this was to test the postulated relationship between arousal avoidance and other features of the telic system (seriousness and a preference for planning ahead) and between arousal seeking and other features of the paratelic system (playfulness and a preference for spontaneity). The checklist also contained arousal adjectives that allowed a further test to be made of the validity of using color-choice to represent arousal preference.

STUDY ONE

METHOD

Subjects

The 75 subjects were all office workers in offices in the Cardiff area. The sample encompassed a wide range of ability and seniority, from office junior to manager, and an age range from 17 to 65. The organizations involved included a technical college, a department store, and several firms of solicitors. Since different types of research permission were granted by these different organizations, the subjects can be divided into four groups, which were tested with different frequencies and duration (see below). Group I consisted of 10 males and 12 females, Group II of 5 males and 12 females, Group III of 7 males and 7 females, and Group IV of 13 males and 9 females.

Apparatus

The apparatus consisted of a large gray display card, measuring 60 × 30 cm, into which was cut a row of seven rectangular windows each measuring 6 × 24 cm. Seven different color cards could be inserted in any order into these windows. Each of these cards was of a different hue taken from the Munsell color collection, the hues being chosen at roughly equal intervals from across the color spectrum. The hues chosen were as follows

(the Munsell description being given in brackets after each): Red (7.5R), Orange (2.5YR), Yellow (5Y), Green (7.5GY), Blue (7.5B), Indigo (2.5P), and Violet (5RP). Because the color space, according to Munsell, is not symmetrical (see Munsell color solid, Munsell, 1966), it is not possible to match exactly for brightness and saturation across the whole range of hues within the Munsell color system (except for very low values of brightness and saturation, in which case the colors are considerably less distinctive). What we did, therefore, was to match by choosing the strongest Munsell saturation for each hue, and then taking the most neutral Munsell brightness value available for this combination of saturation and hue.

Procedure

Subjects were asked at regular intervals to choose the color they liked the best at that particular moment from the standard set of seven colors used throughout the experiment. They were all tested at their place of work during their normal working day. Since a pilot study had indicated that an individual's choice of color and time of switching could be influenced by the responses of other subjects, only one subject was tested in any one office, i.e., one subject from the costing department, one from the invoicing department, one from the typing pool, etc. Subjects were also asked not to discuss the experiment with anyone until all the data had been collected.

Subjects fell into four groups (see above) in terms of frequency and duration of testing.

Group I. Subjects were tested every ¼ hour, for a period of 5 hours. Testing took place between 10:00 a.m. and 1:00 p.m., and between 2:00 p.m. and 4:00 p.m., on a single day.

Group II. Subjects were tested every ¼ hour, over a period of 40 hours. Testing took place between 10:00 a.m. and 1:00 p.m., and between 2:00 p.m. and 4:00 p.m., over a period of 8 days.

Group III. Subjects were tested every ½ hour, over a period of 40 hours. Testing took place between 10:00 a.m. and 1:00 p.m., and between 2:00 p.m. and 4:00 p.m., over a period of 8 days.

Group IV. Subjects were tested every ¼ hour, over a period of 6 hours. Testing took place between 10:00 a.m. and 1:00 p.m., and between 2:00 p.m. and 5:00 p.m., on a single day.

The position of the seven colors on the display card was determined for each trial by means of a table of random numbers, but was the same for all subjects in a given group on a given trial.

When testing was completed for each subject, the subject was asked to rank the seven colors used in the study in terms of their arousal value, along

a scale from the most arousing, through a neutral point, to the most relaxing. Subjects were given the opportunity to have ties in their rankings, but none of them took advantage of this. They appeared to have no difficulty in ranking the colors in accordance with the requirements of the scale, which implies that subjects did feel that different colors have different effects in terms of felt arousal, and also that some colors were arousing and some relaxing (rather than all being arousing to different degrees).

Results

In order to look at the pattern of color preference (and hence arousal preference) choices over time, these choices were mapped for each individual into a graph in which one axis represented time and the other the colors arranged in the order of felt arousal *as rated by that individual subject.* Each color choice, therefore, can be taken as indicating arousal preference at that time, since if the subject wants a high level of arousal he will be expected to choose a highly arousing color, and similarly for other levels of arousal.

Two typical patterns are shown in Figure 2, both subjects being from Group II. It will be apparent from these samples that subjects responded in the way expected by reversal theory: fluctuations in choices were more obvious than stability, and choices tended to be toward one end or the other of the color/arousal dimension, with the neutral arousal position (usually green) rarely or never being chosen. The changes of choice therefore tended to be of two kinds: shifting of choice between neighboring colors on one side or the other of the neutral point, and clear-cut switches, or reversals, from one side of the color/arousal dimension to the other. The two examples shown in Figure 2 are similar in this respect, although the frequency of reversal is different in the two cases. (The reader is reminded again that the arousal dimension in this figure is an arousal *preference* dimension; arousal preference may or may not be the same as actual arousal level at each choice-point.)

The frequency distributions of color choices for each subject, therefore, were generally bimodal, as predicted by reversal theory, although there were occasional instances of unimodality and trimodality. Adding together bimodal distributions, of course, does not necessarily produce bimodal distributions, but in this case combining individual distributions into group distributions for each of the four groups did produce bimodal distributions in each group. These distributions are shown in Figure 3, which summarizes the data as a whole in this way. This figure shows particularly clearly the tendency for color choices to be polarized along the arousal dimension; in fact, on only four occasions was the neutral point chosen throughout the whole period of testing on all four groups (all such neutral choices occurring in Group III).

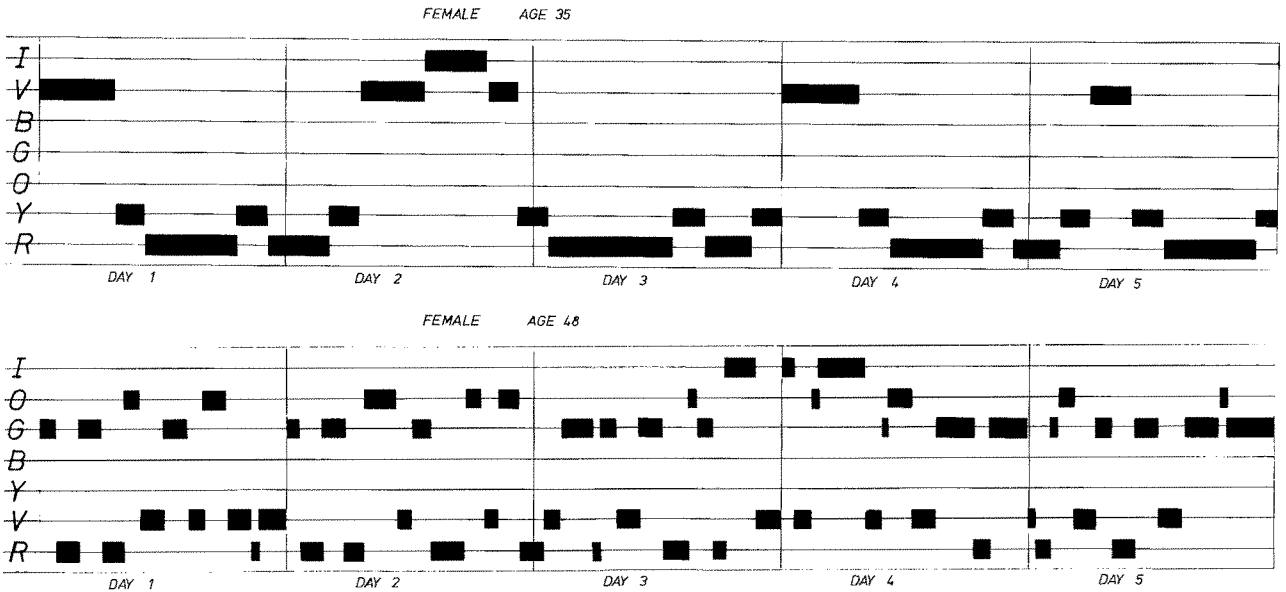

Fig. 2. The color preference (and by implication arousal preference) choices of two different subjects over 5 days of testing. The position of each of the colors on the vertical dimension is determined by each subject's rating of each color in terms of its arousal value, the highest value being at the lower and the lowest value at the higher end of the dimension in each case.

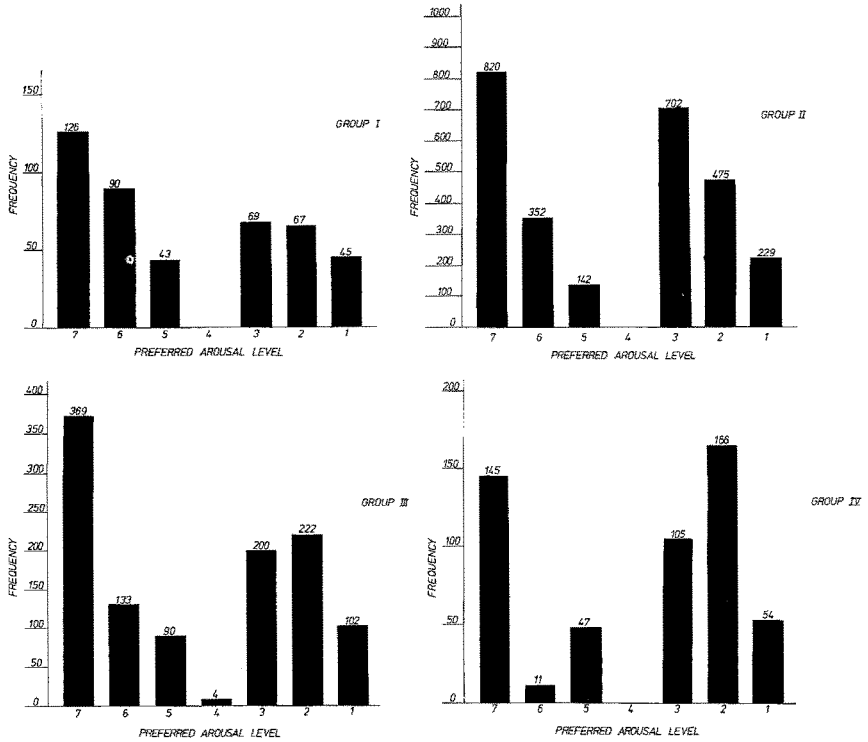

Fig. 3. Each graph depicts the total number of times that each color was chosen in the group concerned over the period of testing.

Another way of summarizing these results is in terms of the frequency with which subjects reversed—i.e., switched from the choice of an arousing to a relaxing color—from one choice to the next, and hence from a high to a low arousal preference (or vice versa). Most subjects reversed in this sense fairly regularly, although some did so more frequently than others, while a few did not reverse at all. If these figures are broken down in terms of age, as they are in Table I, then it becomes apparent that there is, in fact, a strong age effect. This table gives the mean number of reversals in unit time for each age level, across the three groups (I, II, and IV) that were tested every ¼ hour and for which it is therefore meaningful to combine results. The unit time chosen is 5 hours, the period of time in the group tested for the shortest period, meaning that the number of trials was 20. (Subjects may of course have switched to and fro *between* the moments at which they were tested, and it is not possible to tell from these data how frequently this occurred. But since the time sampling was the same for everyone in these three groups, it is possible to make comparisons with reasonable assurance.) The table also shows the mean number of different colors that ¼-hour-

Table I. Mean Number of Reversals Recorded and Colors Chosen for Different Age Groups in ¼-Hour-Tested Subjects over 5 Hours (i.e., 20 Trials)

		Reversals (*N*)		Colors (*N*)	
Age	Subjects (*N*)	Mean	*SD*	Mean	*SD*
17-19	22	1.18	2.40	1.72	.82
20-29	16	2.13	1.48	2.88	.77
30-39	4	2.50	.80	3.50	.57
40-49	12	4.08	2.70	3.58	.88
50-59	5	1.80	.45	3.20	.44
60-65	2	0	0	1.00	0

tested subjects chose in unit time. This is broken down in terms of the same age categories. The pattern for this variable over the different ages is similar to that for the mean number of reversals, in both cases the pattern being unimodal with the peak in the age range 40 to 49.

Arousal-value means and standard deviations across all 75 subjects for all seven colors were also estimated. These are shown in Figure 4 in, for this sample, the graph on the left. This graph shows that there was in fact a high interpersonal agreement on the arousal value of each of the colors (with the exception of violet) and that, as expected, there was a fairly close association between position on the spectrum and estimated felt arousal. There was, however, not a perfect negative association between arousal value and wavelength, since yellow was rated higher than orange and violet higher than indigo. Nevertheless, within-subject analysis of variance showed that there was a highly significant effect of wavelength upon arousal-value (see Table II).

Tukey's multiple-comparison test of honestly significant difference in pairwise comparison among means was also applied to the data (cf. Kirk, 1968, pp. 88-90). As can be seen from Table III, this revealed significant differences (at or beyond the 1% level) for all pairs of means except for the difference between the blue and violet mean arousal scores. There was thus a general trend for all colors to obtain arousal values different from all other colors.

Further discussion of the results from this first study will be deferred until Study Two is reported.

STUDY TWO

The first study was based on the assumption that the rated arousal value of each of the colors used remains reasonably constant for each

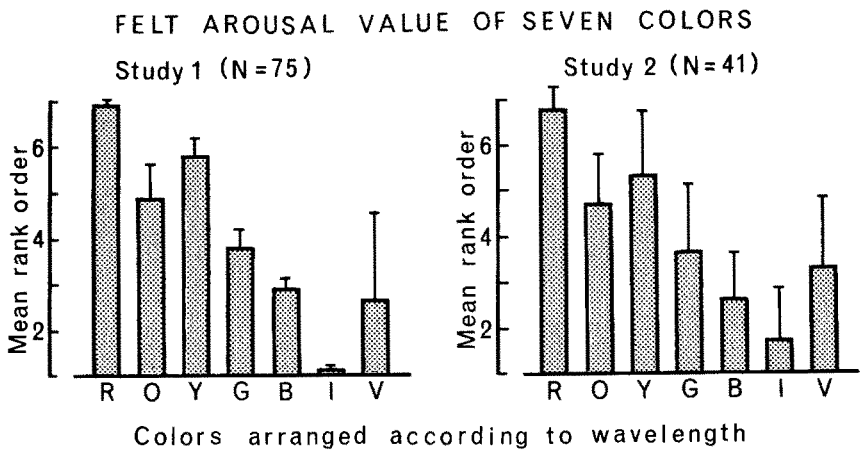

Fig. 4. The mean rank order of colors in relation to felt arousal value, shown separately for each of the two studies. Standard deviations are also shown.

subject, at least for the relatively short period of the study, and that color choice therefore consistently relates to arousal preference throughout—so that color choice acts as a reliable indicator of whether the arousal-seeking or arousal-avoiding state is operative for each subject at each choice-point. The second study tested this directly by asking subjects at the time of each color-preference choice to indicate which adjective from the list "bored, excited, anxious, relaxed" best described the way they felt at that moment. These four adjectives of course describe not only degree of felt arousal (high in the case of excited and anxious, low in the case of bored and relaxed) but also arousal preference (high in the case of bored and excited, low in the case of anxious and relaxed). In other words, the words *anxious* and *relaxed* imply the arousal-avoiding state, and the words *excited* and *bored* the

Table II. One-Way Analysis of Variance of the Effect of Wavelength on Attribution of Arousal Value to Seven Colors

Source	*SS*	*df*	*MS*	*F* ratio	*p* value
Study 1 (N = 75)					
Total	2,100.0	524	4.01	–	–
Wavelength	1,817.7	6	302.94	476.39	.0001
Error	282.3	444	.64	–	–
Study 2 (N = 41)					
Total	1,148.0	286	4.07	–	–
Wavelength	749.8	6	124.97	75.32	.0001
Error	398.2	240	1.66	–	–

Table III. Differences Among Mean Scores on Arousal Value Given to Each of Seven Colors Tested by Tukey's Test of Honestly Significant Differences[b]

	$\bar{X}_Y$	$\bar{X}_O$	$\bar{X}_G$	$\bar{X}_B$	$\bar{X}_V$	$\bar{X}_I$
Study 1 ($N = 75$)						
$\bar{X}_R$	1.18[a]	2.11[a]	3.16[a]	3.99[a]	4.30[a]	5.91[a]
$\bar{X}_Y$		.93[a]	1.98[a]	2.81[a]	3.12[a]	4.73[a]
$\bar{X}_O$			1.05[a]	1.88[a]	2.19[a]	3.80[a]
$\bar{X}_G$				.83[a]	1.14[a]	2.75[a]
$\bar{X}_B$					.31	1.92[a]
$\bar{X}_V$						1.61[a]
	$\bar{X}_Y$	$\bar{X}_O$	$\bar{X}_G$	$\bar{X}_V$	$\bar{X}_B$	$\bar{X}_I$
Study 2 ($N = 41$)						
$\bar{X}_R$	1.47[a]	2.15[a]	3.10[a]	3.57[a]	4.20[a]	5.18[a]
$\bar{X}_Y$		.68[a]	1.64[a]	2.10[a]	2.73[a]	3.71[a]
$\bar{X}_O$			.95[a]	1.42[a]	2.05[a]	3.03[a]
$\bar{X}_G$				.47	1.10[a]	2.08[a]
$\bar{X}_V$					.63[a]	1.61[a]
$\bar{X}_B$						.98[a]

[a] $p < .01$.

[b] In Study 1, the honestly significant difference, i.e., HSD, between any pair of means must be greater than .36 for $p < .01$. The corresponding critical HSD value for Study 2 was calculated to be .53.

arousal-seeking state; if the subject chooses the negatively valued words *anxious* or *bored*, this implies that he is *not* experiencing a preferred arousal level for the state in question, and if he chooses the positively valued words *relaxed* or *excited* it implies that he is.

Since the arousal-avoidance and arousal-seeking states are seen as closely related to, or components of, the telic and paratelic states, then if color preference is related to arousal preference it should also be related to the other two dimensions of the telic and paratelic states—these being what one might term seriousmindedness (which, it will be recalled, was the defining feature of the two states) and "planning orientation." In the telic state one would expect the subject to feel serious rather than playful, and vice versa in the paratelic state. In the telic state one would also expect the subject generally to feel that he or she was attempting to plan ahead rather than behave spontaneously, and vice versa in the paratelic state. This was tested in the second study by asking subjects at the time of each color preference choice to indicate which adjective from the pair *serious* and *playful* best described the way they felt at that moment, and similarly with the pair *spontaneous* and *planning ahead*. In the second study, therefore, each subject was asked at regular intervals not only to make a color preference choice but also to make three simple choices of adjective, one relating to arousal preference, one to seriousmindedness, and one to planning orientation. Ideally, of course, a more detailed questionnaire

would have been administered at each choice-point, but it was felt that this would have disrupted the ongoing behavior too much and interfered unduly with the process being studied.

Method

Subjects

Forty-one subjects took part in the second study. Of these, 39 were females between the ages of 19 and 52; the remaining 2 males were aged 25 and 35, respectively. All subjects were either members of the secretarial staff or members of the library staff of University College Cardiff.

Apparatus

The color display apparatus was the same as that used in the first study. This was supplemented in the present study by copies of an adjective checklist, this list consisting of three sets of adjectives: (1) playful/serious, (2) spontaneous/planning ahead, (3) bored/excited/anxious/relaxed.

Procedure

The method was essentially the same as that used in the first study, except that subjects were asked not only to make a color preference choice on each trial but also to choose one adjective from each of the three sets, marking on the checklist the adjective in each set which most closely corresponded to the way they felt at that moment. Each subject was tested in this way every ¼ hour over a period of 4 hours, making a total of 16 sets of responses per subject. Testing for all subjects took place at their place of work between 10:00 a.m. and 12:00 p.m. and between 2:00 p.m. and 4:00 p.m. Whether the subject was asked to make a color-preference choice first or to mark the adjective checklist first was determined randomly for each of the 16 test periods, but the order was the same for all subjects.

As in the first study, at the completion of the main part of the study, subjects were asked to rate the seven colors in terms of their arousal-value.

Results

As far as color-preference over time was concerned, the same typical kind of pattern of switching and bimodality was found as occurred in the first study, thus providing further supportive evidence for reversal theory.

The relationship of the color choices to mood adjectives is represented in Figure 5. In this figure the bars in the histograms show the average number of choices per subject of telic or paratelic adjectives in relation to choice of color categorized as arousing or de-arousing (this categorization being made separately for each subject in terms of that subject's own arousal rating of the colors). Thus, in the first histogram, reading from left to right, the average number of choices of the paratelic adjective (*playful*) combined with the choice of a low arousal (i.e., de-arousing) color was 1.05 (*SD* 1.76), while the average choice of this same adjective in combination with a high arousal color was 5.10 (*SD* 2.38). The average number of choices combining a low arousal (i.e., de-arousing) color with the telic adjective (*serious*) was 8.68 (*SD* 2.90), and the average number of choices of this same adjective combined with a high arousal color was 1.17 (*SD* 1.30).

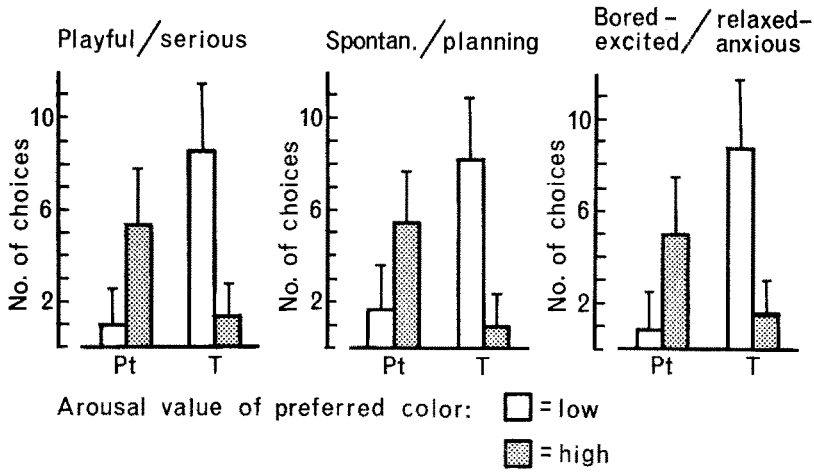

Fig. 5. The mean number of choices per subject of each adjective, when combined with choice of a low arousal or a high arousal color. In each histogram the paratelic adjective means (and standard deviations) in relation to both types of color choice are shown on the left and the telic on the right.

Table IV. Analysis of Variance

Source	*SS*	*df*	*MS*	*F*	*P*
A. Playful or serious versus arousal preference indicated by color choice					
Within subjects	2,388.0	123	–	–	–
Arousal	123.0	1	122.95	21.57	.0001
State	140.9	1	140.88	19.90	.0001
A × S	1,370.0	1	1,369.98	225.49	.0001
$Error_A$	228.0	40	5.70	–	–
$Error_S$	283.1	40	7.08	–	–
$Error_{A \times S}$	243.0	40	6.08	–	–
B. Spontaneous or planning versus arousal preference indicated by color choice					
Within subjects	2,180.0	123	–	–	–
Arousal	123.0	1	122.95	21.57	.0001
State	43.0	1	43.02	5.43	.03
A × S	1,191.2	1	1,191.24	171.56	.0001
$Error_A$	228.0	40	5.70	–	–
$Error_S$	317.0	40	7.92	–	–
$Error_{A \times S}$	227.8	40	6.94	–	–
C. Bored/excited or anxious/relaxed versus arousal preference indicated by color choice					
Within subjects	2,518.0	123	–	–	–
Arousal	133.6	1	133.56	23.59	.0001
State	197.6	1	197.56	24.36	.0001
A × S	1,404.9	1	1,404.88	243.14	.0001
$Error_A$	226.4	40	5.66	–	–
$Error_S$	324.4	40	8.11	–	–
$Error_{A \times S}$	231.1	40	5.78	–	–

As can be seen by visual inspection of all three histograms, de-arousing colors tended to be combined with telic adjectives and arousing colors with paratelic adjectives. This is exactly in conformity with the expectations of reversal theory.

A within-subject analysis of variance with two factors was applied to these data in relation to each of the three sets of adjectives. The results are shown in Table IV. This shows that, in all three cases, there is a significant preference during the period studied for colors associated with low arousal over colors associated with high arousal. In all three cases, too, adjectives were chosen in such a way as to imply that subjects spent significantly more time, during the period they were studied, in the telic rather than the

paratelic state. Both indicators (color preference and mood adjective) therefore agree that there was a preponderance of the telic state in the subjects studied during the period of data collection (although the level of significance was weaker on the spontaneous planning item); this outcome is not surprising since subjects were tested at their place of work.

The main interest of this study, of course, was in the relationship between color choice, representing a preference for low or high arousal, and adjective choice, representing various aspects of the telic or paratelic states. As can be seen from Table IV, this interaction effect turned out to be highly significant in all three analyses. Low arousal (i.e., de-arousing) colors were preferred when adjective choice indicated the telic state, and high arousal colors were preferred when adjective choice indicated the paratelic state. The F scores for these interactions revealed that this was in all cases the most significant effect. The result is therefore highly satisfactory from the point of view of reversal theory, being exactly in accordance with what was predicted. This result also validates the use of color preference to indicate arousal preference.

The way in which colors were rated in the sample as a whole in relation to felt arousal is shown in Figure 4 in, for this sample, the right-hand graph. The overall trend is much the same as for the first study. As before, the two colors that deviated from this trend were yellow, which was rated higher in arousal value than orange, and violet, which in this sample was rated higher than blue as well as being rated higher than indigo. Once again, within-subject analysis of variance showed a highly significant effect of wavelength on felt arousal (see Table II).

Tukey's multiple-comparison test, as can be seen from Table III, again revealed significant differences (at or beyond the 1% level) for nearly all pairs of means. In this case, the exception was the difference between the green and violet mean arousal scores. In both studies, then, except in relation to violet, all colors had arousal values that were significantly different from those of all other colors (at the 1% level of significance).

DISCUSSION

The results from both these studies taken together would seem to provide strong supporting evidence for reversal theory. In the first study, reversals were clearly discernible in terms of color preference and therefore also, by implication, of arousal preference. Indeed, such reversals constituted the most obvious feature of the data for most of the subjects (reversals occurring to a lesser extent in the youngest and oldest subjects). In other words, subjects appeared to be looking for high arousal (excitement) or

for low arousal (relaxation) rather than for intermediate levels of arousal, and most subjects seemed to switch from one arousal preference to the other on a number of occasions during the period of time they were being studied.

The same general reversal pattern also emerged clearly from the second study. The additional feature of the second study was that subjects assigned adjectives to themselves of a paratelic type when they were choosing high arousal-value colors and of a telic type when they were choosing low arousal-value colors. That is, when color preference indicated that they preferred high arousal colors, they also tended to indicate that they were in a playful state, spontaneous, and either excited (i.e., actually achieving a high level of arousal) or bored (i.e., wanting a high level of arousal but not achieving it). When color preference indicated a preference for a low arousal color, subjects tended to indicate that they were in a serious mood, were planning-oriented, and experiencing either relaxation (i.e., actually achieving a low level of arousal) or anxiety (i.e., wanting a low level of arousal but not achieving it). What the results show, then, is that certain characteristics that are postulated by reversal theory to go together in the telic and paratelic states do indeed seem to go together.

Furthermore, the results validated in some measure the assumption on which the first study was based—namely, that for a given subject his color preference will, at a given time, systematically indicate his arousal preference at that time—since adjectives implying that high arousal is pleasant and low arousal unpleasant were consistently associated by subjects with the choice of a color that they individually rated as arousing, while adjectives implying that high arousal is unpleasant and low arousal pleasant were consistently associated by subjects with the choice of a color that they individually rated as lowering arousal. In other words, what the adjectives chosen implied that subjects wanted, in terms of arousal level, was generally associated with a choice of color that also implied this arousal level when colors were rated for arousal level.

It might be argued that the data in relation to arousal could also be made to fit optimal arousal theory, since in optimal arousal theory the individual sometimes needs to increase his level of arousal and sometimes to decrease it in order to arrive at the optimum intermediate level. It could then be argued by optimal arousal theorists that subjects would choose long-wavelength colors in the former case and short-wavelength colors in the latter, and that as movement occurred away from the optimal level of arousal in one direction or the other, there would be switch from one to the other type of color choice to counteract it. In terms of this interpretation, the color choice would represent a need to increase or decrease arousal rather than a choice of an absolute preferred level of arousal. Unfortunately for the optimal arousal interpretation, one would also expect the neutral color

to be chosen a substantial number of times since there would be likely to be periods when the individual was in the optimal arousal state and did not need to become more aroused or more relaxed. In fact, one of the most astonishing features of the data presented in the present paper is that of how rarely the neutral color (whatever it happened to be for each subject) was chosen. Furthermore, in terms of optimal arousal theory, one would presumably expect the color choices to be normally distributed around the neutral point, since one would expect small deviations from the optimal position to be more frequent than large deviations; however, as we have seen, distributions were typically bimodal. The unavoidable inference therefore seems to be that subject are relating colors not to arousal *change* in relation to some chosen level of arousal but rather directly to absolute levels of arousal. This being the case, then, two levels on opposite sides of the arousal continuum are typically chosen rather than one at some relatively intermediate level on the continuum.

One implication of this research is that color preference may provide a simple form of telic/paratelic state indicator. Although some other forms of "telic state measure" have been developed (e.g., see Svebak & Stoyva, 1980; Svebak, 1982), the use of color preference may be particularly convenient where it is desired to obtain some indications of subjects' states during ongoing activities, without disrupting those activities more than can be helped. It should be noted that such state measures are different from, and complementary to, the "trait" measure that has already been developed in the form of the Telic Dominance Scale (Murgatroyd, Rushton, Apter, & Ray, 1978). The latter scale measures the bias that an individual subject may have toward being in one state rather than the other. Such a bias, or tendency, while not constituting a trait in the classical sense (since even a subject strongly biased to the telic state will nevertheless still be expected to be in the opposite paratelic state from time to time, and vice versa), could nevertheless be said to be a personality characteristic. (Incidentally, the state characteristics of seriousness, planning preference, and high arousal preference that were shown to go together in the second study reported here were also found by Murgatroyd et al. to go together at the dominance level in the Telic Dominance Scale, as were the characteristics of playfulness, spontaneity preference, and high arousal preference. Fontana, 1981, provides further corroborative evidence for this in relation to the Telic Dominance Scale.)

In order to see whether there might be a systematic relationship between color and arousal value *across subjects,* all subjects in these two studies were asked to rank colors in terms of arousal value. In general, the data from both studies show that felt arousal is largely a function of wavelength. The ratings of orange and violet, however, were anomalous in both studies. In particular, the rating of violet raises the question of

whether the data might not be more consistent with the idea that wavelengths toward the end of the visible spectrum, both long and short, are arousing, as suggested by Wilson (1966). Certainly, on the face of it, the latter hypothesis fits better with the data from the study by Nourse and Welch (1971) in which they also found a greater response to violet than to green. It should be emphasized, however, that none of this affects the inferences made here in relation to reversal theory, since the analysis of the results did not assume any kind of consistent relationship between color and arousal *across* subjects, but was based on each individual subject's ratings. However, there was probably enough interjudge consistency for five of the seven colors to be used with reasonable safety as arousal-preference state indicators in future research, without having to take the intermediate step of requiring subjects individually to rate the colors for arousal value.

Finally, as far as the psychology of color preference is concerned, the data presented in this paper suggest that color preference data from subjects who are each tested on only one occasion may be misleading since subjects' preferences tend to change dramatically over even short periods of time. This has implications especially for the use of color in personality testing (e.g., the Color Pyramid Test, Schaie & Heiss, 1964; the Luscher Color Test, Luscher, 1965), since a given color choice, or set of choices at a given moment, may represent a temporary state rather than an enduring personality characteristic. The results of these two studies also have obvious implications for the use of color in therapy, for the psychology of aesthetics, and for environmental psychology.

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