Experimental

PHOTOSENSITIVE ASSESSMENT: A STUDY OF COLOR PREFERENCE, DEPRESSION AND TEMPERAMENT

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ABSTRACT

This was an exploratory study (with an extensive literature review) using the Photosensitive Assessment (PA) method designed for Brief Strobic Photostimulation. Colored strobic light was used to conduct PA of 15 extroverted/ depressed (ED), 15 introverted/depressed (ID), 15 extroverted/non-depressed (EN), and 15 introverted/non-depressed (IN) individuals. These groups were compared on the basis of their preferences for 11 colors. Significant results were found for colors ruby, yellow, yellow/green, green, red/orange, and blue. Depressed participants tended to avoid the color ruby more than the non-depressed participants. Extroverts preferred the colors yellow, yellow/green, and green more than did introverts. Red/orange was preferred more by the EN subgroup than by the ED subgroup. Blue was preferred more by the EN subgroup than the IN subgroup, and by the ID subgroup than the IN subgroup.

KEYWORDS: Light therapy, brief strobic photostimulation, photosensitive assessment, color and depression, color and temperament.

INTRODUCTION

Recent studies have shown evidence that colors, lights, and wavelength patterns affect such things as fatigue,[1] anxiety[2] and mood states.[3-6] Many scientists have studied the effects of color and light on levels of biogenic amines such as norepinephrine, serotonin, and dopamine,[6,7] the adrenocorticotropic hormone (ACTH), and melatonin.[8,9]

Light therapy has been shown to be effective in the treatment of Seasonal Affective Disorder (SAD) and to significantly relieve the symptoms of depression. However, relapse usually occurs within a relatively short time.[10-12] A wide range of scientific research[7,12-15] has sought to understand and clarify the factors involved in the process and outcome of light therapy. Many researchers have investigated the use of colored lights with differing wavelengths.[11,13,14,16] Some have sought to find a link between color preference and innate temperament.[17]

Color and light studies are fraught with complexities. Various factors such as culture, social preferences, and individual experiences have influenced perceptions of color. Other complications have arisen because of the difficulty in using consistent hues and densities. In addition, researchers have made little effort to standardize colors.[1] More questions than answers have arisen from each study, and there have been very few definitive answers. The present study is an attempt to integrate the previous knowledge on color and light and examine the relationship of color preference to depression and temperament.

In 1979, Hollwich,[18] an ophthalmology professor from West Germany, established that significant physiological and emotional disturbances are created when patients have been denied light through the eyes. Hollwich also conducted studies comparing the effects of artificial cool-white lighting and full-spectrum lighting that simulated sunlight. His studies indicated that subjects under artificial lighting showed significantly higher levels of adrenocorticotropic hormone (ACTH) and cortisol (stress hormones) than subjects under sunlight-simulating light.

Ott[19] studied the effects of full-spectrum lighting on plants and animals. His findings suggested that all living organisms need the full-spectrum lighting

provided by sunlight to enjoy optimum health and growth. In his research report, Ott reproduced a 1975 publication released by the County Office of Education of Santa Cruz, California. This release stated that Mrs. Burhnis Lyons, who taught a class of nine autistic and emotionally disturbed children, conducted an experiment designed to measure the incidence of hyperkinetic activity in her classroom. She evaluated the differences in hyperkinetic activity in her classroom when using bright white fluorescent lights as compared to incandescent lamps with the same candlepower and illumination. The following week, they repeated the observation procedures. At the end of the three-week period, results showed that hyperkinetic incidences decreased from 297 the first week to 201 the third week—a drop of 32.3 percent under incandescent lamp.

Wohlfarth conducted three studies on the effect of color of environment on absences due to illness,[20] disciplinary incidents,[21] and I.Q. scores[22] of elementary students. All three of these studies were carried out at four homogeneous elementary schools in Wetaskiwin, Alberta, Canada during the 1982-1983 academic school year. A significant trend in reduction of the average reported incidence of destructive behavior, aggressiveness and habitual disruptiveness in the psychodynamically colored classrooms was indicated. The colors used were a warm light yellow and a warm light blue. The two experimental schools with psychodynamic color and psychodynamic color plus full-spectrum lighting reported significantly lower absences due to illness than did the control school, with no psychodynamic color or full-spectrum lighting, or the school with only full-spectrum lighting. Also, significant reductions in illness related absences were reported in classrooms where additional mid- and long-range ultraviolet lights had been installed. These studies support the study conducted by Ott,[19] which indicated the importance of mid-range ultraviolet lighting on optimum growth of plants and animals.

According to Liberman,[23] color therapists have combined the colors red and blue-violet to stabilize emotions. Rosenstein,[5] in a study of the effect of color on performance, found significant effects on mood. Fabrics in four colors, medium blue, bright red, bright yellow, and neutral (burlap), were used to line the rooms in which subjects took the Scholastic Aptitude Test (SAT). Four groups of subjects were assessed: women who scored high on the SAT (WH),

women who scored low on the SAT (WL), men who scored high on the SAT (MH) and men who scored low on the SAT (ML). All of the groups but one, WL, reported themselves to be calm and in good moods while in the blue room. While in the red room, all of the groups but one, WH, reported themselves to be in better moods than when in the yellow and neutral rooms. Only one group, MH, reported themselves to be in good moods while in the yellow room.

Several studies have been conducted on the effects of environmental color on productivity and mood in the workplace. Kwallek and Lewis[4] investigated the effects of bright red, bright green, and white painted walls in otherwise identical offices on production and mood of workers. Subjects in the white office made more errors on a clerical test than subjects in the red office. Kwallek and Lewis also found that the subjects working in the bright red office had significantly lower confusion-bewilderment post-test scores when compared with those working in the bright green office.

Greene et al.[3] conducted a study on boredom and color. Subjects completed Mehrabian and Russell's Emotional Response Scale (ERS) that assesses subjective pleasure, arousal, and dominance. Subjects also completed Griffitt's Personal Feelings Scale (PFS), which assesses comfort levels. Subjects were then placed in carrels with two sides painted one of the following colors: light blue, blue, pink, red, orange, white, brown, green, yellow, or gray. Once again, subjects were asked to complete the ERS and the PFS and to also complete Russell and Pratt's Affective Quality of Place Scale (AQPS). Subjects were then asked to complete a task designed to produce boredom. After completion of the task, subjects were asked to complete the ERS, PFS and AQPS again. After exposure to colored carrels, significant differences were found for the AQPS pleasant-unpleasant and arousal-sleepy dimensions. Significant ratings were found for yellow as more pleasant than white, brown or gray, and for orange and yellow colors as more arousing than brown or gray. The exciting-gloomy dimension showed yellow to be significantly more exciting than the brown, gray or white hues.

In the initial study designed to investigate the effects of a particular shade of pink (now called Baker-Miller pink) on aggressive behavior, Schauss[24] asked two military officers at a correctional facility to provide sites for an experiment.

Commander Miller and CWO Gene Baker (without notifying Schauss) painted all but the cell floor of an admissions cell with the pink hue requested. Although they did not approach this research scientifically, their report stated that 15 minutes of exposure ensured reduced aggressive behavior and that the effects of this color exposure lingered for 30 minutes after prisoners left the cell. Another study of Baker-Miller Pink, Profusek and Rainey,[2] upheld these findings.

Hamid and Newport[25] examined a warm color (pink) and a cool color (blue) to evaluate their effects on physical strength and mood in children. Scores of handgrip strengths were significantly greater in the pink room than in the blue room, with grey in between. The mood of children was also significantly more positive in the pink room.

To find evidence of change in emotional states due to color, Jacobs and Blandino[1] asked 110 men and 121 women undergraduates to evaluate their moods by completing the Profile of Mood States. The same test was given to all subjects, however, subjects were told that different tests were on different colored paper; blue, green, canary, and red, and that the study was designed to assess the consistency of forms used in psychological testing. Control forms were printed on white paper. Forms were randomly distributed to students. The results showed that the red and green colors significantly affected fatigue states, with green resulting in highest fatigue scores and red resulting in lowest fatigue scores.

Research involving the study of color and projected light has been done fairly recently. Most of these studies have focused on the treatment of seasonal affective disorder (SAD). In 1990, Brainard et al.[13] investigated the therapeutic value of white, red, and blue light sources in the treatment of SAD. Lighting conditions were standardized and wavelengths were measured with special equipment. A balanced incomplete block crossover design was used. Subjects were randomly assigned to two of the three treatment conditions. Light treatments were one week in duration with at least one week of washout before the second treatment was administered. Treatments consisted of two hours each morning and two hours each evening. Results of this investigation indicated that the blue and red lights did not ameliorate the depressive state of subjects any more than a placebo effect.

White light therapy was shown to have a greater therapeutic result than either blue or red lights. Preliminary indications were that the white light therapy could not be improved upon; however, Brainard et al.[13] suggested further studies using the color green.

In 1991, Oren et al.[14] investigated the effectiveness of green and red light in the treatment of SAD. They chose green because retinal photoreceptors are most sensitive to the green wavelength. They chose red because it has been used in other studies as a possible placebo. A significantly superior antidepressant result was seen treating individuals with green light versus red light. They also found the treatment effects similar to that of previous white light studies.

Lam et al.[10] investigated the efficacy of bright white and dim red light in the treatment of bulimia nervosa. The first two weeks of this study established a baseline. Patients initiated regular sleep hours and kept sleep/mood logs and daily diaries of binge-eating and purging incidents. Patients were then randomly selected to enter the dim red or the bright white light treatment. The light boxes used were identical. Patients sat under the light boxes for 30 minutes each day for two weeks. After two weeks of one light treatment, a crossover was immediately implemented, with patients switching to the other light treatment for two weeks. This study suggested that white light therapy was significantly more effective than dim red light in the treatment of bulimia nervosa.

Parry et al.[26] studied the effects of red evening light, bright white evening light and bright white morning light on late luteal phase dysphoric disorder. They found that all three light treatments were effective. They concluded that a placebo effect could not be ruled out. They also noted that mania ratings of normal subjects were significantly reduced with the dim red evening light as compared to the bright white evening light and the baseline figures.

In 1994, Levitt et al.[11] investigated dim versus bright red light in the treatment of 43 SAD patients. They used head-mounted units (HMUs) that placed the light source at approximately 8 cm from the cornea. Subjects were randomly selected for the two different light treatments. Treatments lasted two weeks, with subjects wearing their HMUs for 30 minutes each day. Subjects were

administered a pre-treatment Structured Interview Guide for the Hamilton Depression Rating Scale—SAD (SIGH-SAD), which was repeated after one week and two weeks of treatment and again after one week of withdrawal. At the end of the 2-week treatment, subjects completed a Clinical Global Impression of Improvement scale. Results of this investigation indicated no significant difference in results of the bright versus the dim red light treatment. Both treatments were effective. Levitt et al.[11] had hypothesized that the dim red light was a placebo. Results of their investigation suggested that either both dim and bright red lights had a placebo effect, or both lights were effective and a more appropriate placebo should be used in future studies.

Vazquez[27] used Brief Strobic Phototherapy (BSP) to elicit significant affect and mood changes. He found that a variety of symptoms and mental disorders disappeared or were alleviated after BSP. In BSP, colored lights and differing flicker rates are used. Vazquez uses a Lumatron to project colored lights into his patients' eyes. Based on his clinical practice outcome, Vazquez[28] hypothesized that reactions to the colored light can have different inherent meanings for different individuals, which may result in mixed findings when attempting to generalize the meanings of color to individuals. For example, the color green appears to inherently stimulate issues of affection, which would range on a continuum from unresolved issues such as abandonment, to issues of separation, and finally to the potential experience of union with others. Therefore, Vazquez prefers to individualize phototherapy treatment plans, assessing each client's color preferences and self-disclosed distortions of colored light.

Almost all color assessments have used reflected light, instead of projected light, *i.e.,* light generated into the eyes. Before the optic nerve receives impulses from the eye, those impulses pass through other pathways in our nervous system. We process impulses about the color before it actually reaches our optic nerve.[29] According to Vazquez,[27] when a colored light is projected into someone's eyes, their perception of the color does not remain consistent. Vazquez found that individuals see a color with many distortions, much like a "moving Rorschach." When an individual experiences true catharsis, distortions begin to clear, and he/she tends to perceive the color in a truer form. Clinically, stronger emotional reactions are associated with projected-light colors, making the use of projected colors more effective in the study of color.

The complexities of variables involved in the study of color have created a difficult arena for research. However, the trends seen in previous research and an increasing amount of current interest in BSP for treatment of medical and psychological problems stimulated our interest in the current study. Since no empirical study was found using BSP methods, we designed this exploratory study to assess the relationship among color preference, depression, and temperament. Depressive disorders, as defined by the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-VI)[30] present symptoms of tearfulness, irritability, brooding, obsessive rumination, anxiety, phobias, and excessive worry and complaints regarding health, inability to think or concentrate and decreased energy, tiredness and fatigue. Historically, temperament, as it relates to extroversion and introversion has been described in Jungian terms.[31,32] They are characterized as people who work best interacting with the outside world. Extroverts prefer open communication and interaction with others. In contrast, introverts prefer solitude and working in their inner world of concepts and ideas. Introverts desire privacy and peace and it is not likely that they will reveal to others the thoughts and desires that really matter to them.

The present study focused on color preference in relation to depression and temperament. Also of interest was the interaction between depression and temperament with regard to color preference. The first independent variable, depression, was varied as depressed (D) and non-depressed (N), and the second independent variable, temperament (T), was varied as extroverted (E) and introverted (I). Depression was measured by the Beck Depression Inventory (BDI), and temperament was measured by the Keirsey Temperament Sorter (KTS). Dependent variables were color preferences for 11 colors measured by the Photosensitive Assessment (PA).

METHOD

SUBJECTS

Sixty unpaid volunteers who met the criteria for the current study were invited from the community and mental health clinics in Dallas/Fort Worth, Texas area in United States of America. These English speaking participants were 25 males

and 35 females, with mean age of 44.5 (SD = 2.93). The sample consisted of 92% Caucasians, 5% Hispanics, and 2% African Americans from the middle socioeconomic class. They were divided into four subgroups of 15 extroverted/depressed (ED), 15 introverted/depressed (ID), 15 extroverted/non-depressed (EN), and 15 introverted/non-depressed (IN). Of the 30 depressed participants, 14 were taking anti-depressants and did not report any previous mental illness. None of the 30 non-depressed participants reported having any mental illness at the time of assessment.

Materials

Materials included Informed Consent Form, Demographic Questionnaire, Beck Depression Inventory, Keirsey Temperament Scale, Photosensitive Assessment, and Lumatron Light Stimulator.

The Beck Depression Scale (BDI), which requires from 10 to 15 minutes to complete, is a 21-item self-report test designed for ages 13 and older. Each question has four possible answers, ranging from no complaint to severe distress. The BDI was originally developed by Beck in 1961, and was revised in 1971.[33] Test-retest reliability for diagnostic groups has been reported to be between .48 and .86. Reliability for non-psychiatric populations is between .60 and .90. Internal consistency is reported as .86 with psychiatric inpatients, and .81 with a non-psychiatric individuals.[34,35]

The BDI was not designed to diagnose depression, but to indicate the level of depression experienced by an individual at the time of testing.[33] The depression on BDI is rated as minimal (scores 0-9), mild (scores 10-16), moderate (scores 17-29), and severe (scores 30-63). For purposes of the current study, individuals who scored 10 and above on the BDI or individuals who were diagnosed with a depressive disorder, regardless of their BDI score, were considered depressed. Those scoring below 10 were considered non-depressed.

The Keirsey Temperament Sorter (KTS) is a self-report test used to assess four bipolar dimensions or attitude polarities: extroversion-introversion, sensing-intuition, thinking-feeling, and judgment-perception.[36,37] Only the E and I scores were used in this study. There are 10 points available for the E and I

scale. Individuals scoring 5 points on both the E and I scales express equal tendencies toward extroversion and introversion and they were excluded from this study. The KTS is based on the Myers-Briggs Type Indicator (MBTI). Both the KTS and the MBTI reflect Jung's theory of psychological types. According to Berens[38] the KTS' reliability and validity correlated with the MBTI at acceptable levels. Berens stated that correlations of two administrations of test-retest for reliability of the MBTI exceeded + or - .70. Berens also stated that correlations for validity of the MBTI were from + or - .60 to .80. Coan[39] and Sharf[37] report that a substantial amount of empirical data supports the construct validity of the MBTI. Sharf also relates that internal consistency and test-retest measures were used to verify reliability.

Vazquez[27] has prepared the self-report Photosensitive Assessment (PA) for use with the Lumatron™ Light Stimulator, which was developed by John Downing, O.D., Ph.D. The Lumatron™ is the primary device used in Brief Strobic Phototherapy (BSP). BSP is used in conjunction with psychotherapy in treating depression, chemical addictions, dream work, anxiety disorders, eating disorders, brain injury, and some life threatening illnesses such as AIDS, multiple sclerosis, and breast cancer. A portable unit called the Photron® Light Stimulator is also used in BSP. The Lumatron™ and Photron® have a white light source of xenon gas, which provides a stable full spectrum light source. Color purity is supplied by 11 color filters of optical quality glass. The therapist controls the flicker rate of the light and the color projected into the subject's eyes. The flicker rate adjusts from one to 60 cycles per second. The brightness of the light is low, and it is measured in lux. One lux is equal to the light of one candle. The full spectrum lighting used to treat SAD is usually over 2,500 lux. The light projected by the Lumatron™ and Photron® is from approximately .151 lux to 31.101 lux. Filters used in the Lumatron™ and Photron® are calibrated to include the entire spectrum of visible light, except ultraviolet. The following colors are included: ruby, red, red/orange, orange, yellow, yellow/green, green, blue/green, blue, indigo, and violet.

Of the five questions in the PA interview schedule, question number 5, "What is your preference for looking at this color?" is the only one utilized in this study. Other questions allowed participants time to adjust to each color. Color preference was measured on a scale from 1 to 10. There were no right or wrong answers to this type of assessment; therefore, the participants were not to feel

pressured to answer in a particular way. When a viewer scored a preference below 3 on a color, this indicated that the viewer found the color unpleasant. A score of 8 or above indicated that the viewer had a high preference for that color.

PROCEDURE

All participants signed the Informed Consent Form after the nature and possible consequences of the current study had been explained to their complete satisfaction. To be assured of consistent mood states, the participants were asked to complete all tests within the same day. Individual testing required 1 to 1 1/2 hours per participant. The participants were asked to fill out the Demographic Questionnaire, BDI and KTS before taking the Lumatron™ assessment and PA.

A darkened room was used for the Lumatron™ assessment. Each participant was asked to keep his or her responses brief during the PA. A small book light was used to supply light to facilitate coding of the participants' answers. White (with no filter) was the first light exposed to the participants; however, responses to the white light were not used in the current study. Exposure to each color was limited to two minutes. Before the first exposure to the flickering white light and between each subsequent colored light, participants were asked to close their eyes, take a deep breath and let it out slowly. Recorded responses regarding the color preference were reviewed with the participants after the assessment. Participants were allowed to reassess their color preferences after reviewing the entire spectrum of colors.

RESULTS

Data obtained in the current study were analyzed using a two-way analysis of variance (ANOVA) with the alpha level set at .05. Post hoc pairwise comparisons between subgroups (EN, IN, ED, and ID) were conducted using Tukey's *t*. Data analyses were performed on a microcomputer using GB-STAT by the Dynamic Microsystems, Inc. The mean PA scores for 11 colors by temperament and depression are presented in Table I and mean PA scores for 11 colors by four subgroups are presented in Table II. Table III contains the ANOVA results. Data analysis yielded significant results for colors ruby, yellow, yellow/green, green, red/orange, and blue.

Table I
Mean Scores and Standard Deviations for Color Preferences by Depression and Temperament

Color	Depression				Temperament			
	N		D		E		I	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Ruby	6.60	1.75	5.37	2.58	5.93	2.21	6.03	6.73
Red	4.53	1.76	4.20	2.34	4.67	2.06	4.07	2.08
Red/Orange	4.77	1.87	4.23	2.34	4.33	2.12	4.67	2.16
Orange	4.93	2.05	4.70	2.44	4.93	2.27	4.70	2.23
Yellow	4.77	2.89	4.97	2.46	5.87	2.61	3.87	2.21
Yellow/Green	6.70	1.77	5.87	2.66	6.93	2.18	5.63	2.22
Green	5.47	2.23	5.87	2.15	6.27	2.02	5.07	2.10
Blue/Green	7.30	2.50	7.07	2.46	7.53	2.35	6.83	2.32
Blue	5.30	2.12	5.70	2.35	6.07	2.12	4.93	2.92
Indigo	6.00	2.33	6.00	2.18	6.43	2.15	5.57	2.28
Violet	7.33	2.51	7.43	2.70	7.60	2.50	7.17	2.32

KEY: N = Non-depressed; D = Depressed;
E = Extraverted; and I = Introverted

Table II
Mean Scores and Standard Deviations for Color Preferences by Four Subgroups

Color	EN		IN		ED		ID	
	M	SD	M	SD	M	SD	M	SD
Ruby	6.47	1.51	6.73	2.02	5.40	2.69	5.33	2.55
Red	4.93	1.67	4.13	1.81	4.40	2.41	4.00	2.39
Red/Orange	5.13	1.77	4.40	1.96	3.53	2.20	4.93	2.37
Orange	5.47	1.60	4.40	2.35	4.40	2.75	5.00	2.14
Yellow	5.73	2.71	3.80	2.57	6.00	2.59	3.93	1.87
Yellow/Green	7.40	1.50	6.00	1.77	6.47	2.67	5.27	2.60
Green	6.47	2.10	4.47	1.68	6.07	1.98	5.67	2.35
Blue/Green	7.80	2.04	6.80	2.40	7.27	2.66	6.87	2.33
Blue	6.60	1.99	4.00	2.70	5.53	2.17	5.87	2.92
Indigo	6.87	1.96	5.13	2.42	6.00	2.30	6.00	2.14
Violet	7.33	2.29	7.33	1.99	7.87	2.75	7.00	2.67

KEY: EN = Extraverted Non-depressed; IN = Introverted Non-depressed;
ED = Extraverted Depressed; and ID = Introverted Depressed

Table III
Analysis of Variance Results for the Colors Ruby, Yellow, Yellow/Green, Green, Red/Orange, and Blue

Variable	*F*	*p*
Ruby		
Depression (A)	4.54	.04*
Temperament (B)	.03	.86
A x B	.08	.77
Yellow		
Depression (A)	.10	.75
Temperament (B)	9.93	.003*
A x B	.01	.91
Yellow/Green		
Depression (A)	2.16	.14
Temperament (B)	5.25	.02*
A x B	.03	.86
Green		
Depression (A)	.58	.54
Temperament (B)	5.17	.03*
A x B	2.30	.13
Red/Orange		
Depression (A)	.98	.67
Temperament (B)	.38	.55
A x B	3.92	.049*
Blue		
Depression (A)	.39	.54
Temperament (B)	3.15	.08
A x B	5.27	.02*

*Significant results

The ANOVA results for the color ruby indicated that the N participants' mean PA score was significantly higher than the D participants' mean PA score, F (1, 56) = 4.54, p = .04 (see Tables I and III).

The E participants' mean PA scores were significantly higher than the I participants' mean PA scores for the colors yellow, yellow/green and green (see Tables

I and III). The ANOVA results are as follows: yellow, F (1, 56) = 9.93, p =.003); yellow/green, F (1, 56) = 5.25, p = .02); and green, F (1, 56) = 5.17, p = .03.

The ANOVA results for the colors red/orange, F (1,56) = 3.92, p = .05, and blue, F (1, 56) = 5.27, p = .02, indicated significant interactions between temperament and depression with regard to the participants' PA scores (see Table III). Post hoc pairwise comparisons were conducted for the color red/orange with the help of Tukey's t. Only one comparison showed significant results. The EN subgroup (M = 5.13) preferred red/orange significantly more than the ED subgroup (M = 3.53), t = 2.1, p < .05. Tukey's t results of the post hoc pairwise comparisons for the color blue showed a significant difference between subgroups EN (M = 6.60) and IN (M = 4), t = 2.88, p < .01. Also subgroups IN (M = 4) and ID (M = 5.87) differed significantly, t = 2.07, p <.05.

DISCUSSION

This is the first empirical study using Photosensitive Assessment method designed by Vazquez.[28] In this exploratory investigation we found that ruby was the only color that differentiated between depressed and non-depressed individuals on the basis of their PA scores. The D group showed significantly greater preference for ruby than the N group. This lends support to Vazquez's[27] clinical observation that patients with depressive disorder respond favorably to the therapeutic use of the color ruby. Thus, ruby appears to be a useful color for the treatment of depression.

No previous studies focused on the color ruby (a combination of red and violet);[40] however, several different hues and brightnesses of red have been studied.[11,14,18,26] The results of these studies indicated that individuals exposed to various hues and brightnesses of the color red experience improved emotional states, enhanced clarity and perception, reduced fatigue, and relief from depression. Liberman[23] reported that color therapists have combined the colors red and blue-violet to stabilize emotions.

Three colors (yellow, yellow/green and green) significantly differentiated between I and E individuals on the basis of PA scores in the current study.

Introverts tended to dislike the color yellow. Other research studies have shown that yellow produced statistically significant biological responses and higher anxiety-state scores,[1] and was reported to be more exciting than some other colors studied.[3,41] Vazquez[27] has found that yellow, when projected into his patient's eyes, elicits associations with issues of power, control, and letting go. Introverts seek to use minimal energy in dealing with the outer world. Sharing thoughts and feelings can be awkward for introverts, because of the flexibility and control required in interactions with others. Yellow may elicit a drawing out of thoughts and feelings, causing introverts to struggle with their natural tendency to hold those thoughts and feelings back. Dealing with these issues may cost the introverts privacy and peace, and it could require more energy than they can comfortably handle.

Introverts also appear to avoid the colors yellow/green and green. Vazquez[27] reported the issues most commonly elicited by his patients viewing the color yellow/green concerned peace versus conflict and acceptance versus rejection. Extroverts may find these issues easier to deal with than introverts do, because these issues lie at the core of an introvert's daily challenge with the outer world. Introverts do not wish to discuss their true feelings with others. Unless something they value most highly becomes threatened, introverts will avoid conflict by outwardly adapting to another's viewpoint.[32] Introverts may also feel less acceptance from others, as they are sometimes viewed as aloof and impersonal.

Vazquez[27] patients' responses to green light were associated with issues of affection, such as loneliness, grief and loss. This might explain why introverts prefer the color green less than extroverts. Introverts may have more difficulty dealing with these issues because of their tendency to keep their strong private feelings to themselves. Exposure to the color green may bring those private and emotional issues to the surface, making it difficult for them if they felt expected to share their thoughts.

Significant interaction was found between depression and temperament with regard to the participants' mean PA scores for two colors, red/orange and blue. The EN subgroup preferred red/orange significantly more than the ED subgroup. No significant results from other studies using the color red/orange were found. Red/orange, according to Vazquez,[27] has elicited issues associated with conscience, spontaneity, creativity and interpersonal boundaries. It is

possible that extroverts find it more difficult to handle the state of depression because it inhibits their ability to enjoy the outer world. The EN may find it more pleasant to view red/orange because of their natural tendency to be outgoing. They may also have better interpersonal boundaries because they tend to enjoy experiences of interacting with others in the normal course of their lives.

The interaction effect was significant for two pairwise comparisons for the color blue. The EN individuals tended to prefer blue significantly more than the IN individuals. Previous studies have indicated that blue helps people improve their mood[5] and creates an atmosphere that lessons aggressive behavior.[23] These studies did not help explain why EN individuals would prefer blue more than IN individuals. An explanation for these results may be based on Vazquez'[27] observations of his patients. He reported that blue elicited associations with issues of joy, expression, communication and independence. The EN individuals' higher preference for the color blue may be explained by their natural tendency to be expressive and communicating, whereas the IN individuals tend to find communication and interaction with others less desirable.

Also the results showed that the ID participants showed greater preference for the blue color than the IN participants. One explanation for this finding might be that though the IN individuals' natural tendency is to avoid interaction, there is a possibility that the ID individuals would be more strongly motivated to communicate and express their deeper feelings than the IN individuals. The desire for relief of depressive symptoms might become so important that introverts would find relief when allowing others into their inner world.

POST-RESEARCH COMMENTS

Some of the depressed participants might not have been depressed at the time of this study, because they were taking prescribed antidepressants which alleviate depressive symptoms. If these volunteers had not been taking antidepressants, their scores on the (PA) might have shown significant results for some colors. For example, one participant in the ED group scored zero on the BDI, while another scored a three. These participants were included in the D group

because of their clinical diagnoses; however, based on their scores on the BDI, they were not projecting symptoms of depression when they took the PA.

The complexity of the physiology of the individual produces unique responses to color exposure. Wide variations in color sensitivity and in ocular and neurological responses to light therapy have been reported in many studies.[9,12,27,42,43] According to the Encarta encyclopedia,[44] the hormone melatonin was isolated in 1958. Research has since discovered some of the role of the pineal body in regulating endocrine organs and levels of melatonin. Though the pineal body is not light sensitive, there is a photoreceptive structure linking it and the eyes.[45] We are only beginning to understand the possibilities of how light can alter sleep and mood disorders.

During the administration of the PA, a variety of perceptual distortions of our projections onto a color were noted in association with the scoring of a less preferred color (including seeing other colors or a completely different color, a pattern within the lens, the color coming toward them or going away from them, etc.). Also, some individuals reported a high preference for a certain color while reporting distortions of the color. Participants reported physical and emotional reactions that indicated a definite state of stress. Obviously, measurement that only includes the preference score of the individual is insufficient.

Color preferences may have been affected by the intensity of photon brightness rather than by the actual colors. All respondents reported at least one color to be uncomfortable to look at because of the brightness. Reactions to colors were quite varied, but patterns of certain responses occurred frequently.

The scope and difficulty of obtaining participants for current study did not allow for a matched groups design or for a comprehensive demographic sample. Other variables that should have been controlled in this study were time of day, gender, age of subjects, and ethnicity.

Not only was this study conducted with projected light, but also, it was the only empirical study conducted at the time with the light projected directly into the eyes of the participants. Caution should be taken when comparisons are made between other research and this study. However, it should also be

noted that, even with the variability of methods, data in color research continue to indicate certain trends which cannot be ignored.

SUGGESTIONS FOR FUTURE RESEARCH

Questions not previously considered in light therapy research are (a) will colored lights projected directly into the eyes provide greater therapeutic results and (b) should light therapy be individualized?

Vazquez[27] appears to have established the most comprehensive psychotherapy treatment plans available for use with the Lumatron. Vazquez' patients' responses suggest that the most displeasing colors may hold the potential for greater therapeutic gains. The clinical process suggests that using the disliked color usually brings unconscious material to the surface and promotes the relief of symptoms. The positive clinical outcomes noted in the clinical use of phototherapy, along with a growing body of information regarding alternative methods of treatment, continues to encourage and challenge the mental health professional to investigate the possibilities of phototherapy. Therapeutic clinical research utilizing the Photosensitive Assessment and equipment that emits colored light, such as the Lumatron™ and Photron,® seems highly desirable. If possible, these studies should include the full array of colors.

Scientific research is only beginning to discover the varied uses of light in both the physiological and psychological realms.[45] Recent discoveries regarding the effects of light on the pineal body and the resulting reduction of melatonin have accentuated the need for research in this area. A study of the relationship between the pineal body and the effect of each of the 11 colors projected into the eyes might help to find the optimum wavelength for the treatment of SAD and other affective disorders.

Ruby appears to be a therapeutic color for depressive disorders, while red appears to have possibilities for improving individual factors such as anxiety or confusion. Future phototherapy studies using an experimental design with ruby and red might help to clarify the role of these colors in alleviating the symptoms of affective disorders.

The color yellow appears to relate to locus of control issues. Future studies of yellow as it relates to extroversion and introversion and locus of control might lead to the practical therapeutic and diagnostic use of yellow.

In the course of this study it was more difficult to find extroverted depressed individuals than to find introverted depressed individuals . Since the population as a whole has a 3:1 ratio of extroverts,[32] it would be possible to infer that people who are depressed become more introverted or that introverted people are more likely to become depressed. The criteria for depressive disorders[30] indicate that depressed individuals become less interested in activities that were once pleasurable. They also experience impairment in social, occupational or other important areas of functioning. More research with introverted depressed individuals seems highly desirable, as no information was found in the literature giving the ratio of extroverts and introverts in the depressed population.

The complexities of variables involved in the study of color have created a difficult arena for research. However, the trends seen in previous research and an increasing amount of current interest in this non-invasive treatment for SAD and other affective disorders establish that there are many possibilities for using this technology in diagnosis and treatment of many mental and physical disorders.

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