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The Effects of Two Color Conditions on Muscular Strength in Trained and Untrained College Males and Females

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THE EFFECTS OF TWO COLOR CONDITIONS ON MUSCULAR STRENGTH IN TRAINED AND UNTRAINED COLLEGE MALES AND FEMALES

An Abstract of a Thesis

Submitted

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

Mary Jane Asimus

University of Northern Iowa

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ABSTRACT

The purpose of this study was to determine the effects of three color conditions on handgrip strength and shoulder abduction strength in trained and untrained college males and females. It has been suggested that differences in electromagnetic properities under exposure to visual stimuli (color) may affect muscular strength throughout the body. Subjects consisted of forty male and forty female volunteers from the University of Northern Iowa. Six different treatments were administered to all subjects. Maximal strength exertion under all conditions (normal, blue and pink) was measured with a cable tensiometer. Statistical analysis revealed significant main effects on the SEX factor for both handgrip and shoulder abduction and on the COLOR variable for shoulder abduction. The SEX factor reflected the greater grip strength of the male subjects over all the color conditions combined. The COLOR variable reflected the higher shoulder strength scores in the normal and blue condition over male and female subjects combined. The main effect of training and the interaction for both strength measures was not significantly different at the .01 level.

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has been approved as meeting the thesis requirement for the Degree of Master of Arts

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Chapter 1

INTRODUCTION

Color is a collective name for the distinctive characteristic of light which enters the eyes from environmental objects. Differing colors evolve and are visualized when environmental objects are viewed in different kinds of light. Consequently, without light, nothing can be seen, and particularly, color cannot be seen apart from light (Birren, 1969; Committee on Colorimetry, 1970; Sheppard, 1968).

The psychological significance of color as it affects human responses is by no means a new area of interest. Research concerned with the intimate relationship between light and color can be found in the scientific literature of biology, medicine, physics, psychology and physiology (Birren, 1961, 1969, 1978; Evans, 1974; Kerenyi, 1977; Ott, 1974; Padgham & Saunders, 1975; Sharpe, 1974; Sheppard, 1978; Snipley, 1964; Thomsen, 1974; Valenzeno & Pooler, 1979; Wurtman, 1975). Recently, developments in photobiology have generated provocative findings. Such findings are especially notable through the research of photobiologist, Ott (1979). His research concerns primarily the role of the human visual system in regulating a variety of psychophysiological functions (Ott, 1979).

Ott's (1979) conclusions are based primarily on research which indicated that the complex biochemical mediating mechanisms in the sensory processing of light stimuli may cause significant collateral effects both neurologically and endocrinologically (Kerenyi, 1977; Pelligrini & Schauss, 1980; Shipley, 1964; Wurtman & Axelrod, 1967; Wurtman, 1975).

Ott (1979) suggested that differences in electromagnetic properties under exposure to visual stimuli may affect muscular strength throughout the body. Ott (1979) assumed that pink or orange colors cause the greatest loss of strength and blue the least loss. Specifically, the question of whether or not color has a significant effect on muscular strength has only been briefly studied. To date only one study has attempted to generate possible answers to this question. In this study, Pelligrini and Schauss (1980) tested the kinesoid hypothesis involving visual stimuli of differing colors and its effect on muscular strength. Thirty-six males and thirty-six females were measured using a hand dynamometer as the subjects stared at a blue or pink cardboard plate. In a previous study by Schauss (1979), the "kinesoid test" (an arm push-down test) had been used as a subjective measure of strength. This measure is based entirely upon the demonstrator's impressions or perceptions of the subjects' resistance to having his or her arm pushed down by the experimenter. Thus, Pelligrini and Schauss (1980) attempted to eliminate the subjectivity of the procedure by using a hand dynamometer as a more objective measure of strength. However, even though the hand dynamometer is a more objective measure, it does not resemble the kinesoid push-down test previously used. Conversely, the use of a cable tensiometer to measure both handgrip strength and shoulder abduction strength may be a more suitable measure which simulates more precisely the "kinesoid test" stated by Pelligrini and Schauss (1980) and Schauss (1979, 1980). In summary, the relationship between specific colors and muscular strength deserves further consideration and study.

Statement of the Problem

Data on the relationship between color and human physical response are virtually non-existent and this area has not been sufficiently explored. The purpose of this study was to determine the effects of three conditions (a) normal condition (no color), (b) blue condition and (c) pink condition on handgrip strength and shoulder abduction strength in trained and untrained college aged males and females. It was hypothesized that visually observing the color blue will elicit a stronger muscular response than observing the color pink. It was further hypothesized that all groups, males and females, trained and untrained will respond similarly to the effects of hue differences.

Significance of the Study

Different colors entering the eyes may be extremely important in affecting man's muscular strength (Ott, 1974, 1979; Pelligrini & Schauss, 1980; Schauss, 1978, 1979). Identifying the colors which would promote greater gains in strength or those that decrease strength could have relevant application to training techniques for competitive as well as recreational sports. The results could be utilized to determine the appropriateness and usefulness of color as an adjunct in enhancing strength. Schauss (1979) has utilized the color pink in correctional institution holding cells to reduce aggression and to cause muscular relaxation in inmates. In addition to this reduced aggression response and in addition to training and performance, color identification which would either decrease or increase strength might also be used to facilitate fitness, athletic rehabilitation and cardiac rehabilitation. For instance, Janiszewski (1979) examined the effect of certain protective colors on the degree of effort tolerance in myocardial infarction patients and he found significant differences in effort tolerances under different monochromatic colors. Specific color identification may help to maximize effort tolerances for individuals involved in fitness or rehabilitation programs.

Assumptions of the Study

The following assumptions of this study were noted:

1. All subjects were encouraged to perform to their maximal ability on all strength measures and it is recognized that some subjects probably were not able to do so on all tests. It is assummed that this effect would be randomly distributed across all trials.

2. It is assumed that cable tensiometry is a valid assessment of strength.

Limitations of the Study

The following limitations of this study were recognized:

1. Since this study utilized available volunteer groups of apparently healthy trained and untrained college aged males and females, the results may not be applicable to the general public.
2. Color responses may have been limited by the use of the colored cardboard squares whereas painting of the entire room pink and/or blue may have produced different responses.
3. It is possible that some subjects may consciously or unconsciously bias the results due to previous exposure to the topic of color and strength.
4. It is difficult to account for the influence of individual differences in response to color differences.

Delimitations of the Study

The following delimitations of the study were recognized:

1. The age of subjects was established and set at 18-30 years.
2. Only two colors of the color spectrum (pink and blue) were used to test the hypotheses of this study.

Definition of Terms

Kinesoid hypothesis - the hypothesis that visual stimuli of different hues may differentially affect muscular strength.

Kinesoid test - a deltoid strength demonstration used as a subjective measure during which the subject holds his arm out in front or to the side of him, parallel to the floor at a 90^{o} angle to his own body. The task is to resist as vigorously as possible the demonstrator's effort to push down toward the floor.

Muscular strength - the tension that muscles can exert in a single maximal contraction.

Shoulder abduction - range of arm movement (involving both shoulder joint and shoulder girdle): sideward-upward elevation of the arm away from the side of the body in the coronal plane, from 0 degrees to 180 degrees.

College aged	- a group of persons considered by law to be a unit. Most commonly, this unit ranges from 18-30 years.
Monochromatic Colors	- having or consisting of one hue or color and also consisting of radiation of a single wavelength or of a very small range of wavelengths.

Chapter 2

REVIEW OF RELATED LITERATURE

The full extent of electromagnetic energy, including visible light and color, is vast and existing literature reveals a repeated concern with the manifestations of light and color as they affect living things (Arehardt-Treichel, 1974; Birren, 1961, 1969, 1978; Evans, 1974; Kerenyi, 1977; Ott, 1974; Padgham & Saunders, 1975; Sheppard, 1978; Shipley, 1964; Thomsen, 1974; Valenzeno & Pooler, 1979; Wurtman, 1975). According to Wurtman, "It seems clear that light and color are the most important environmental input, after food, in controlling bodily function" (Birren, 1978, p. 13).

Krieg (1932) has shown that visible wavelengths of light reach the pineal gland and pituitary gland via neurochemical channels which are independent of the optic system. This research and more recent investigations support the premise that colors can have a direct effect on the endocrine system (Kerenyi, 1977; Ott, 1979; Pelligrini & Schauss, 1980; Schauss, 1979; Shipley, 1964; Wurtman & Axelrod, 1967; Wirtman, 1975; Valenzeno & Pooler, 1979). Ott (1979) confirmed the fact that in addition to the optic track and independently thereof, neurochemical channels connect with a photoreceptor mechanism in the retina. This connection in the retina is formed by both the pineal and pituitary glands and the hypothalmic mid-brain regions (Kerenyi, 1977; Shipley, 1974; Wurtman, 1975). The pineal and pituitary glands act as master glands in controlling the entire endocrine system and basic body chemistry. This seems to be a carry-over into animal life of the basic principles of photosynthesis in plants, sometimes described as a conversion of light energy to chemical energy, and this phenomenon has not been previously recognized (Ott, 1979).

Recent studies indicate that specific endocrine responses exist through the photoreceptor mechanisms in both the skin and the retina to narrow bands of wavelengths within the entire electromagnetic spectrum and not solely to differences between light and dark alone. If the specific wavelengths to which a photoreceptor mechanism responds are missing, this is considered the equivalent of darkness to the photoreceptor mechanism and there would be no response even though other wavelengths are present (Ott, 1974, 1979).

Ott's (1979) recent findings now indicate that the electromagnetic environment significantly affects the strength of all muscle, including the heart muscle. Ott further states that this phenomenon is very positive, yet how this effect is mediated in the muscular system is not clear.

The muscle-mechanism that opens and closes the iris is one obvious direct response of the eye to light. In comparison to other biological responses it appears to react to certain wavelengths and not just to light alone (Ott, 1974).

In addition to the effect of light on eye muscle action, recent studies have demonstrated that light entering the eye has an immediate effect on the muscle strength of other muscle groups in the human body (Ott, 1979; Pelligrini & Schauss, 1980). Ott (1979) contends that gross loss of strength in the deltoid muscle due to a distorted light spectrum entering the eye can readily be demonstrated. This phenomenon can be demonstrated in the following manner. In outdoor natural daylight, or under the new type radiation shielded full spectrum fluorescent fixtures, and without wearing any eyeglasses or contact lenses, hold one arm straight forward at a right angle to the body. Resist hard while a second person applies downard pressure on the top of the wrist to establish normal deltoid muscle strength. This procedure is then repeated wearing different eyeglasses or contact lenses.

Ott (1979) through use of the kinesoid test demonstration concluded that clear glass or ultraviolet absorbing plastic will noticeably weaken muscular strength. Ultraviolet absorbing plastic causes weakness more so than clear glass since the ultraviolet inhibitor stops all the ultraviolet light more efficiently. Sunglasses which are designed to block both the ultraviolet and infrared, plus distorting the natural balance of visible wavelengths, cause the greatest loss of muscular strength. Lenses which darken outdoors or those that eliminate glare and reflection also cause gross loss of muscular strength. However, these statements are based on subjective kinesoid testing with no specific data or statistical analysis reported.

Generally speaking, Ott (1979) subjectively considered the average loss of muscle strength to be approximately plus or minus fifty percent using his kinesoid test. With regard to color, Ott (1979) claimed that pink or orange cause greater loss of strength and blue the least. He also stated that instruments to accurately measure muscle strength loss are available, but that the results are usually so apparent and obvious that such instrumentation is not necessary for overall observation.

Similarly, Diamond (1979) in his book of Behavioral Kinesiology, has stated a fifty percent reduction in muscle strength when a weakening stimulus is introduced. This statement is based on his testing of the quadriceps muscles when measured on the Cybex Dynamometer. Again, there is no data or statistical analysis reported to support his statement.

During Ott's (1979) kinesoid test, if the eyes are closed while testing various types of sunglass lenses, the muscle strength will return in a second or two. This indicates that distorted wavelength spectrum and not less intensity causes muscle strength loss. After numerous kinesoid tests with various types of lenses, the experiment may be repeated again under natural or shielded full spectrum light using no lenses and the muscle will regain full strength. This suggests that the weakened condition was not caused by fatigue. However, these findings rest solely upon outcomes utilizing kinesoid tests which are totally dependent upon the judgement of the examiner as he estimates the ability of the deltoid muscle to overcome gravity and outside forces (Diamond, 1979; Ott, 1979; Pelligrini & Schauss, 1980).

When considering how the electromagnetic environment affects the heart muscle, Ott (1979) revealed that preliminary tests using the new type blood pressure dynamometer also demonstrate a loss of strength in the heart muscle. Janiszewski's (1979) study found differing degrees of effort tolerance under the influence of various colors of light. Thirty-six post myocardial infarction patients were examined. An ergometric test was done in the same lighting conditions but with varying colors of light and significant differences were found in effort tolerances for the different monochromatic colors.

Schauss (1979) and Pelligrini and Schauss (1980) paid considerable attention to the endocrinological and neurological importance of light and color affecting muscular strength throughout the body after exposure to visual stimuli differing in electromagnetic properties. Using Ott's (1979) assumptions, Schauss (1979) has utilized the color pink in correctional institution holding cells to reduce aggression and to cause muscular relaxation in inmates. In 1978, Schauss (1978) demonstrated the kinesoid test, involving the color pink to a series of classes on innovative treatment methods in correctional institutions. As a result of this kinesoid demonstration Schauss (1978) suggested that a pink holding cell might be used as a "time-out" room for aggressive confinees. The U.S. Naval Correctional Center in Seattle decided to try the pink holding cell early in 1979. After 223 days of continuous use as a temporary holding cell for new confinees, there had been no reported incidents of erratic or hostile behavior for the initial phase of confinement. A maximum of 15 minutes exposure was used to ensure that the potential for violent or aggressive behavior had been reduced. The effect continued for thirty minutes after release from the cell. Similar results have been reported by the San Bernardino County Probation Department and the Santa Clara County Jail in San Jose, California (Schauss, 1979). It seems that this phenomenon affects the endocrine system and causes a relaxing, quiescent effect on the muscular system (Ott, 1979; Schauss, 1979). According to Schauss (1979) this factor of noncontrol has been proven through experiments with accomplished athletes in the martial arts and yoga and it produces similar effects with the color-blind. Repeated experiments with adults and adolescents show the tranquilizing effect to occur on the average of 2.7 seconds after exposure. Use of the color pink in any situation involving sudden or uncontrollable aggression is highly suggested by Schauss (1979).

Research by Pelligrini and Schauss (1980) has disclosed strength potentials under the influence of the colors pink and blue. Most of the evidence as to the effects of color on muscular strength have been derived from the results of demonstrations utilizing the "kinesoid test". This test is similar to Ott's (1979) kinesoid test previously mentioned. The subject holds his arm straight out in front, parallel to the floor at a 90^{0} angle to his/her body. Again, the test basically observes muscular resistance. The subject is required to resist as "vigorously" as possible the efforts of the demonstrator (comparable in strength to the subject) to push the arm downward to the floor. This procedure establishes a "baseline" level of strength. Immediately following this procedure, a significant loss of strength has been observed while the test is conducted with a piece of pink construction paper held 15 inches in front of the subject's eyes. An apparent return in the subject's resistance strength is similarly noticed when a piece of blue construction paper is placed 15 inches in front of the eyes (Pelligrini & Schauss, 1980).

In view of methodological confounds in test procedure, Pelligrini and Schauss (1980) designed a systematically controlled experimental test of the kinesoid hypothesis under laboratory conditions. The maximum squeeze strength of 72 right handed subjects (36 females, 36 males) was measured with a hand dynamometer while subjects closely viewed two different cardboard plates--one pink and one blue. The results of the 2 (SEX) x 2 (PLATE COLOR) mixed design factorial ANOVA indicated significantly higher squeeze strength: a) for males over females and b) in response to the color blue as compared to the color pink. The results indicated only partial support of the kinesoid hypothesis in view of the limited magnitude in plate color effect which accounted for only about five percent of the variance on the dependent measure. The results also suggest that judgement of the strength-color hypothesis be suspended until clearer empirical bases for inference is established (Pelligrini & Schauss, 1980).

In summary, the statistically significant color effect in the Pelligrini and Schauss study (1980) cannot be ignored. Nor can the color difference obtained be totally disregarded. Overall, the line of reasoning proposed in this review on color and strength is intuitively appealing, however, more thorough exploration and clarification of these factors is needed.

Chapter 3

METHODS

The purpose of this study was to determine the effects of three color conditions on handgrip strength and shoulder abduction strength in trained and untrained college aged males and females.

Subjects

Subjects consisted of eighty University of Northern Iowa students. Forty male and forty female volunteers were recruited from various 1981 Summer Session classes. Twenty-three of the males were considered to be trained while seventeen were untrained. Females were seventeen trained and twenty-three untrained. Trained subjects were classified according to the following criteria: a trained subject is one who participated in regular physical exercise of aerobic nature for six weeks or longer, three or more times per week, for a period of 30 minutes or longer during the exercise bout. All subjects who did not meet this standard were classified as untrained. Information concerning the subjects' level of condition was derived from the subjects' Exercise Information form (see Appendix A) which subjects completed prior to testing.

Research Instruments

Two Pacific Scientific Company 75 Cable Tensiometers were used. Model T5-6007-114-00, #1, diameter 1/16 was used to measure shoulder abduction strength, Model T5-6007-114-63, #1 diameter 1/16, was used to measure handgrip strength. A wooden plywood platform (4' x 4' x 4 1/2") was constructed and used to secure the shoulder abduction apparatus by means of an eye-bolt on the right and left side. Two 18 inch by 24 inch carboard plates, one piece of pink and one piece of blue construction paper (see Appendix B) were secured to the cardboard. A Sport Craft Digital Stopwatch, model 12846 was used for timing. For skinfold measurement, a Lange Skinfold Caliper (Cambridge Scientific Industries, Cambridge, Maryland) was used. A Detecto scale was used to obtain height and weight.

Experimental Procedures

In order to closely simulate the laboratory setting used by Pelligrini and Schauss (1980), a quiet room, softly lighted by a 150 watt incandescent bulb was used. A total of six different treatments were administered to all subjects: (1) handgrip strength under normal color conditions (off-white walls) (2) shoulder abduction strength under normal color conditions (3) handgrip strength under pink color conditions (4) shoulder abduction strength under pink color conditions (5) handgrip strength under blue color conditions and (6) shoulder abduction strength under blue color conditions. Maximal strength exertion under all conditions was measured by a cable tensiometer. In order to control for order effects, the subjects received the six treatments according to randomized order. All subjects were given three warm-up trials on both the handgrip cable tensiometer and the shoulder abduction strength tensiometer. These trials were administered at submaximal effort in order to produce sufficient warm-up and in order to maximize voluntary strength. Fatigue from repeated maximal exertions was reduced by a two minute rest interval in between treatments.

Upon entering the room the subject read and signed the informed consent form (see Appendix C), filled out the exercise information form and general descriptive information of sex, age, height, weight, and skinfolds were obtained. The skinfold sites used in this study were the triceps, iliac crest, subscapular, and abdominal with the measurements recorded in millimeters. Skinfold sites were utilized to further designate trained from untrained groups. After descriptive information was obtained, treatments were assigned by random selection. The subject was then instructed to stand in a designated spot approximately 10 to 16 inches from the wall marked by a piece of red tape on the wooden platform. Nails were spaced and mounted on the wall so that the experimenter could easily place either of the cardboard plates directly in front of the subject's field of vision, approximately 10 to 16 inches from his/her eyes. The handgrip cable tensiometer was placed on the subject's preferred side within the subject's field of vision resting on a desk top. Hand size adjustments on the handle were made prior to testing. The shoulder abduction cable tensiometer was secured to the platform and the subject was situated so that it was on his/her preferred side at a distance of full arm extension and at a height horizontal with the shoulder. The looped handle for this strength measure was not in the subject's plain sight but was placed on the subject's wrist by the experimenter at the appropriate time. Except for the normal color condition treatments, the cardboard plates were always in the subject's direct field of vision whether the subject used the right or left shoulder abduction cable tensiometer.

After the subject was positioned for either the handgrip strength or the shoulder abduction measure, the experimenter hung either the pink cardboard plate, blue cardboard plate, or no plate at the subject's eye level as described above. The subject was instructed to stare at a spot in the center of the plate until told to stop. The plates were concealed until presented in the above manner. When the subject had stared for exactly 60 seconds (stop-watch timed), the experimenter instructed the subject to either grasp the handgrip cable tensiometer handle or to be ready for the experimenter to hand him/her the shoulder abduction handle. Both instruments were positioned such that the subject could grasp either one easily without interrupting the staring procedure. The subject then was instructed in the handgrip strength measure as follows: "Keep staring at the card. As you continue to stare reach for the handle, get a good grip and squeeze as hard as you can." The instruction for the shoulder abduction measure was as follows: "Keep staring at the card. As you continue to stare at the card hold your arm out to the side and I will place the looped handle on your wrist. Continue to stare at the card and pull up as hard as you can while maintaining your arm in a horizontal position."

As the subject completed the maximal contraction the experimenter took the cable tensiometer instrument from the subject, removed the colored plate, and instructed the subject to stand in the same position but to relax for two minutes. This time interval allowed the experimenter to record the maximum tension and to reposition the instruments for the next treatment. All treatments were administered in this manner except for the tests under normal color conditions which did not utilize the color plates. The tests under normal color conditions were an attempt to establish a strength baseline in a relatively normal environment.

Each testing session took approximately thirty minutes. Subjects were encouraged to refrain from talking about the experiment in order to avoid possible biasing of subjects who had not yet been tested.

<u>Data Description</u>

The subject's age, sex, height, weight, and skinfolds were recorded. The dial readings (an arbitrary scale) on the cable tensiometers for maximum tension were recorded as they appear on the cable tensiometer dial face.

Data Analysis

Two strength measures in cable tensiometer arbitrary units for maximal tension were collected for each subject. It was not essential to convert the arbitrary units to units of tension pounds in order to confirm differences in the color conditions. Therefore, for ease in handling and calculating the data, arbitrary units for maximal tension were used.

The mean strength measures were calculated for both handgrip and shoulder abduction for all eighty subjects under each experimental color.

A Two Factor Design (AxBxS) was used for specifying the sources of variance for strength between sex (A), and for strength between trained and untrained (B). A Repeated Factor (A/s x S) was used for specifying the sources of variance for strength between plate color. A BMDP2V Program (Dixon, 1979) was used to determine if differences existed among variables. Scheffe's method of multiple comparisons was used to determine the difference among the main effects (Ferguson, 1976). The data was analyzed to determine if the handgrip and shoulder abduction strength differed under the normal color condition. The .01 level of significance was set to test the hypothesis that all groups visually observing the color blue would elicit a stronger muscular response than observing the color pink. This level of significance was choosen due to the nature of the data and in order to assure conservative analysis of the data.

Chapter 4

RESULTS

The purpose of this study was to determine the effects of three color conditions (a) normal (no color), (b) blue and (c) pink on handgrip strength and shoulder abduction strength in trained and untrained college aged males and females. Eighty subjects, 23 trained males, 17 untrained males, 17 trained females, and 23 untrained females performed the two different strength measures under the three color conditions mentioned above. The two strength measures (1) handgrip strength and (2) shoulder abduction strength were measured according to the arbitrary scale of maximal tension on two cable tensiometers. It was hypothesized that visually observing the color blue would elicit a stronger muscular response than visually observing the color pink. Furthermore, it was hypothesized that all groups, males and females, trained and untrained would respond similarly to the effects of the hue differences.

Data Description

The data resulting from this experiment consisted of: (a) basic demographic and descriptive information; (b) an analysis of variance for repeated measures for both handgrip and shoulder abduction strength and (c) where needed, Scheffe's test of multiple comparisons.

Descriptive Information of Experimental Subjects

Four college aged groups were represented in the experiment: 23 trained males, 17 untrained males, 17 trained females and 23 untrained females. The descriptive information pertaining to the total 80 subjects is listed in Table 1. The means and standard deviations for age, height, weight and sum of skinfolds are relatively equal for all groups with the exception of the sum of skinfolds where an expected difference is noted between males and females overall and between trained and untrained groups for both sexes. The trained males mean sum of skinfolds was 51.760 and the untrained males mean sum was 55.882. The trained females mean sum of skinfolds was 72.882 and the untrained female mean sum was 78.391. The mean sums of skinfolds designated trained from untrained groups with the trained groups having less body fat than the untrained groups. Generally, males carry less fat than females and this is also indicated by the above mean sums of skinfolds. Overall, untrained males were a little older than the other groups with a mean age of 23.647. The means for height and weight were similar for all groups.

The post experiment questionnaire is found in Appendix D. With regard to the first question, the majority of the subjects expressed that the experiment was interesting and easy. The next two questions dealt with previous exposure to the topic of strength and color. The results revealed that 31% of the subjects had been previously

TABLE 1

Descriptive Information of the Subject Groups

		TRAINED		UNTRAINED	
		Males	Females	Males	Females
AGE	$\overline{X}$	21.957	20.294	23.647	21.609
(years)	S	2.421	1.404	3.334	2.350
HEIGHT	$\overline{X}$	179.677	167.043	180.787	165.651
(cm)	S	8.113	7.269	5.405	5.248
WEIGHT	$\overline{X}$	78.576	61.732	77.231	62.802
(kg)	S	14.860	8.804	9.266	7.750
SUM OF SKINFOLDS	$\overline{X}$	51.760	72.882	55.882	78.391
(mm)	S	19.169	22.895	29.698	23.854

exposed to the topic by means of television and in psychology classes. The last question involved color preference with the results indicating that 52 subjects preferred blue, 10 preferred pink and 18 had no particular preference.

Effect of Color on Strength Performances

Table 2 presents the data for both strength measures for all groups with mean performance scores and associated standard deviations under each color condition. The mean scores for handgrip and shoulder abduction performance are significantly higher for males in both the trained and untrained groups under all color conditions. The mean scores for handgrip performance for the trained males and females for all three conditions are presented as follows: (male scores are reported first and female scores second) normal-no color (45.969, 28.174), pink (46.000, 26.147) and blue (47.239, 27.265). The mean scores for handgrip performance for untrained males and females is presented in the same manner: normal (46.676, 27.196), pink (45.794, 26.370) and blue (46.412, 26.174)/

The same pattern follows for shoulder abduction mean performance scores for trained males and females: normal (19.913, 12.529), pink (17.978, 10.853) and blue (19.652, 12.324). Likewise, the shoulder abduction mean performance scores for untrained males and females are: normal (19.706, 9.630), pink (18.676, 8.345) and blue (20.353, 10.022).

TABLE 2

Means and Standard Deviations for Strength Measures

A. HANDGRIP PERFORMANCE SCORES

		TRAINED		UNTRAINED	
		Males	Females	Males	Females
NORMAL HANDGRIP	$\overline{X}$	45.969	28.147	46.676	27.196
	S	11.190	5.782	5.815	5.698
PINK HANDGRIP	$\overline{X}$	46.000	26.147	45.794	26.370
	S	10.688	4.602	4.880	5.476
BLUE HANDGRIP	$\overline{X}$	47.239	27.265	46.412	26.174
	S	10.334	4.963	4.751	6.253

B. SHOULDER ABDUCTION PERFORMANCE SCORES

		TRAINED		UNTRAINED	
		Males	Females	Males	Females
NORMAL SHOULDER ABDUCTION	$\overline{X}$	19.913	12.529	19.706	9.630
	S	5.950	3.328	3.207	2.634
PINK SHOULDER ABDUCTION	$\overline{X}$	17.978	10.853	18.676	8.348
	S	5.540	3.014	3.259	2.534
BLUE SHOULDER ABDUCTION	$\overline{X}$	19.652	12.324	20.353	10.022
	S	5.260	3.167	3.191	4.152

The higher mean performance scores for males over females under all conditions for both strength measures was an expected sex difference. It is well established that males possess greater absolute strength than females and that strength differences between the sexes vary among different muscle groups (Fox & Mathews, 1981).

It should be noted that in almost every condition for all groups for both strength measures the normal and blue mean performance scores are absolutely greater than the pink scores but not significantly different. For example, trained female handgrip mean performance scores were as follows: normal (28.147), blue (27.265) and pink (26.147).

There is an expected and significant difference between sex for handgrip strength with $F = 144.44$, $\underline{p} \leq .01$. This is presented in Table 3 which contains analysis of variance pooled subject data on sex and training for handgrip strength.

Table 4 presents analysis of variance data on color for handgrip strength. A three way repeated measures ANOVA revealed no main effect or interaction for handgrip strength.

Table 5, which contains analysis of variance pooled subject data on sex and training for shoulder abduction strength, shows a significant difference between sex. This was also an expected sex difference with $F = 102.05$, $\underline{p} \leq .01$.

Analysis of variance data on color for shoulder abduction (Table 6) shows no interaction but there is a significant difference on the main effect of color with $F = 26.48$, $\underline{p} \leq .01$.

TABLE 3

Analysis of Variance for Handgrip Strength by Sex and Training

SOURCE	SS	DF	MS	F
Main Effect				
SEX	22118.739	1	22118.739	144.44**
TRAINING	5.709	1	5.709	0.04
Interaction				
Sex x Training	5.088	1	5.088	0.03
Error	11638.597	76	153.139	

**$p \leq .01$

TABLE 4

Analysis of Variance for Handgrip Strength on Color

SOURCE	SS	DF	MS	F
Main Effect				
COLOR	32.095	2	16.047	3.19
Interactions				
Color x SEX	26.161	2	13.080	2.60
Color x Training	12.278	2	6.139	1.22
Color x Sex x Training	14.395	2	7.197	1.43
Error	763.930	152	5.025	

TABLE 5

Analysis of Variance for Shoulder Abduction by Sex and Training

SOURCE	SS	DF	MS	F
Main Effect				
Sex	4502.868	1	4502.868	102.05**
Training	69.130	1	69.130	1.57
Interaction				
Sex x Training	128.979	1	128.979	2.92
Error	3353.514	76	44.125	

$^{**}p \leq .01$

TABLE 6

Analysis of Variance for Shoulder Abduction on Color

SOURCE	SS	DF	MS	F
Main Effect				
Color	126.415	2	63.207	26.48**
Interactions				
Color x Sex	0.134	2	0.067	0.03
Color x Training	6.509	2	3.254	1.36
Color x Sex x Training	0.649	2	0.324	0.14
Error	362.803	152	2.386	

**$p \leq .01$

Scheffe's test for multiple comparisons was performed and revealed a significant difference among the simple main effects. A significant difference exists between the normal color condition and the pink color condition with F = 9.42, $p \leq .01$. A significant difference also exists between the blue color condition and the pink color condition with F = 11.16, $p \leq .01$. The mean shoulder abduction means under the conditions were: blue (15.475), normal (15.343) and pink (13.843).

Chapter 5

DISCUSSION AND CONCLUSIONS

The purpose of this study was to determine the effects of three conditions (a) normal condition (no color), (b) blue condition and (c) pink condition on handgrip strength and shoulder abduction strength in trained and untrained college aged males and females. Maximal strength exertion for handgrip and shoulder abduction strength under all conditions was measured by a cable tensiometer. It was hypothesized that visually observing the color blue would elicit a stronger muscular response than observing the color pink. It was further hypothesized that all groups, males and females, trained and untrained would respond similarly to the effects of hue differences.

Findings

The results of this study revealed statistically significant main effects on the SEX factor for both strength measures and on the COLOR variable for shoulder abduction. The SEX factor reflected the greater grip and shoulder strength of the male subjects over all the color conditions combined (Tables 3 and 5). The COLOR variable reflected the higher shoulder strength scores in the normal and blue condition over male and female subjects combined (Table 6). The main effect of training and the interaction was not significant for either strength measure.

Discussion

Pelligrini and Schauss (1980) studied 36 males and 36 females to test the kinesoid hypothesis that visual stimuli of different hues may differentially affect muscle strength. An ANOVA of maximal squeeze strength scores using a hand dynamometer indicated significantly higher squeeze strength scores for males versus females and for blue as compared with the pink color response. In comparison to the present study, there were significantly higher handgrip and shoulder abduction strength scores for males over females. The higher strength scores of males over females is not surprising since it is well established that strength differences exist between the sexes with males possessing greater absolute strength. General muscular strength in the female is approximately two-thirds that of the male. Also, strength differences between the sexes vary among different muscle groups. In comparison with males, females are weaker in the chest, arms and shoulders and less weak in the legs (Fox & Mathews, 1981).

In the present study, handgrip scores were not significantly different in response to any color condition but shoulder abduction strength scores were significantly different. Scheffe's test revealed a significant difference between no color and pink and also between blue and pink. It is possible that handgrip differed from shoulder abduction in response to color due to the nature of the movement involved. Handgrip is a more common movement whereas shoulder abduction is a more novel and complex movement. Also, it should be mentioned that the magnitude of the plate color effect was limited in the Pelligrini and Schauss (1980) study and this was stated as providing only partial support for the kinesoid hypothesis. That is, even though a greater strength response was found in response to the blue color which constituted a statistically significant difference, the absolute behavioral magnitude value of this color effect was reported as "quite small" (Pelligrini & Schauss, 1980).

In opposition to the present study and to the Pelligrini and Schauss (1980) study, Schauss (1979) mentions two similar experiments. One subjective kinesoid method experiment utilizing 153 subjects demonstrated a loss of 0.01% strength to the pink color with only two subjects failing to demonstrate a loss of strength. Another experiment with 38 subjects used an adjustable dynamometer where all 38 subjects exhibited strength losses (ranging from 6 to 23%) when exposed to the color pink. Because these experiments are vague and lack statistical support they compound the confusion surrounding the effect of color on strength.

The present study poses two puzzling questions:

1. Why were the results significantly different on the color variable for shoulder abduction but not for handgrip?
2. Why is the apparent color effect referred to by Schauss (1979) and Ott (1979) more evident and

dramatic in the "push-down" test used in kinesoid demonstrations?

Concerning the first question and as previously mentioned, it is possible that the nature of the movement for the two strength tasks could produce different responses.

However, with regard to both of these questions, an explanation proposed by Ott (1979) deserves consideration. That is, that exposure to stimuli differing in their electromagnetic properties has differential effects on different muscle groups and organ systems in the body. According to Ott (1979) recent findings indicate that the electromagnetic environment significantly affects the strength of all muscles, including the heart. Physiologically, it is not yet clear how this effect is mediated to the muscle system. Likewise, Janiszewski (1979) has found significant differences in effort tolerances under different monochromatic colors in myocardial infarction patients. Also, the matter of individual differences is currently under investigation (Pelligrini & Schauss, 1980). Due to the sparse amount of strength/color research, failure to find dramatic supportive evidence for the hypotheses could easily be due to procedural and methodological confounds.

Recommendations

The following recommendations are made for those who might conduct further research on the issue of color and strength.

1. More statistical support should be made available by other color/light researchers.
2. The primary color researchers mentioned in this study (Ott, Pelligrini & Schauss) state that the results of their color testing are generally so apparent that instrumentation to accurately measure the exact amount of muscular strength (gain or loss) is not necessary. A study which would test all subjects both subjectively (as in the kinesoid test) and objectively may provide further insight.
3. It is suggested that a retest between specific color presentations be made to assure that the subject has returned to baseline strength.
4. Instead of utilizing a confined field of vision with color plates, results may be more dramatic by painting the entire room where the strength task is to be performed.
5. Investigate and report responses to other colors in the color spectrum other than just blue and pink.
6. Report specific information concerning hues, shades, brightness, and saturation, etc.
7. Investigate and report responses to more muscles or muscle groups other than handgrip and shoulder girdle strength.

Hopefully, further research will not only determine which colors will enhance muscular strength but also provide insight concerning the mechanisms that elicit such effects.

Conclusion

Although the possibilities presented in this chapter cannot account for the total lack of significant results, they do offer logical reasoning for the results of this experiment. As in the Pelligrini and Schauss (1980) study, the statistically significant color effect of shoulder abduction cannot be totally ignored with the implications that light and color hold in affecting man's environment and in an attempt to further resolve and clarify the issue of color and strength more research should be conducted in consideration of the recommendations previously mentioned.

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Appendix A

EXERCISE INFORMATION

Name: ______________________________

Age: ______________________________

Sex: ______________________________

EXERCISE PRESENTLY ENGAGED IN	DAYS PER WEEK	APPROXIMATE TIME/ACTIVITY

IF YOU WERE A PARTICIPANT OF A UNI ATHLETIC PROGRAM THIS YEAR, PLEASE LIST THE SPORT(S) AND THE SEMESTER(S) PLAYED.

______________________________ ______________________________

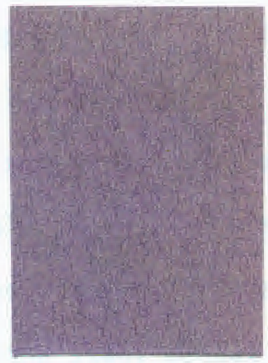
______________________________ ______________________________

______________________________ ______________________________

Appendix B

PLATE COLOR SAMPLES

PINK



BLUE

Appendix C

INFORMED CONSENT

I, the undersigned, agree to voluntarily participate in a strength study which will require approximately thirty minutes of my time. I understand that I will be required to perform six different tasks which will require six maximal exertions of strength; three using a handgrip cable tensiometer and three using a shoulder abduction cable tensiometer. I also understand that a more detailed description of the study cannot be disclosed at this time in order to avoid possible biasing of the treatment effects. I realize that I must refrain from talking about the experiment after I have completed it in order to possibly avoid biasing those subjects who have not yet participated. A more complete explanation of this study will be available to me when the data is compiled.

The information obtained will be treated as confidential and will not be released or revealed to any person without my expressed written consent. The information obtained, however, may be used for statistical or scientific purpose with my right of privacy retained.

Signature of Subject ______________________ Date ____________

Signature of Witness ______________________ Date ____________

THANK YOU FOR YOUR HELP WITH THIS STUDY!!!!

Appendix D

POST EXPERIMENT QUESTIONNAIRE

1. What did you think of this experiment? (check one or more if appropriate)

   interesting _______ easy _______

   boring _______ hard _______

2. Have you had any previous exposure to the topic of strength and color?

   YES _______ NO _______

3. If YES, by what medium were you exposed to the topic?

   TV _______

   Radio _______

   Newspaper _______

   Magazine _______

   Other _______ Explain ______________________________

4. What was your color preference?

   Blue _______ Pink _______ No Preference _______

<u>THANK</u> <u>YOU</u> for your willingness to participate in this study!!!!!!

Appendix E

STRENGTH & COLOR EXPERIMENT

SUBJECT DATA SHEET

NAME: ______________________________

SEX: _________ HEIGHT: ____________

AGE: _________ WEIGHT: ____________

SKINFOLDS: Triceps ____________

Iliac crest ____________

Subscapular ____________

Abdominal ____________

		Dial Readings
Handgrip Strength	- N	________
Shoulder Abd. Strength	- N	________
Handgrip Strength	- P	________
Shoulder Abd. Strength	- P	________
Handgrip Strength	- B	________
Shoulder Abd. Strength	- B	________