EYE COLOR
AND ITS POSSIBLE RELATION TO BEHAVIOR

BY

Debra Lee Hollister
B.A., Florida Technological University, 1975

SPECIALTY PAPER

Submitted in partial fulfillment of the requirements
for the degree of Master of Science: Psychology
in the Graduate Studies Program of the College
of Social Sciences
of Florida Technological University

Orlando, Florida
1977

Abstract

A variable that is capable of indicating one's cognitive and motor capaciteis has been the dream of many researchers. Until recently however, no researcher has seriously considered an independent variable that is obvious among all people regardless of race or culture. This variable is eye color. This paper is a review of the experimental literature in this field and covers many areas including sociability, perception, learning, athletic abilities, and a few medical anomalies. Several alternative hypotheses are also offered as reasons for the obtained correlations. These ideas include culture, learning, and environment. Two other hypotheses are also presented to explain why eye color does play an important role in determining one's response to environmental stimuli. These ideas include a genetic and physiological basis. It is the hope of this author that this review may stimulate other researchers to perform more experiments in the area to help determine the amount of influence that the eye color has in individual responses to the environment.

Acknowledgment

I would like to thank the members of my committee for their help and advisement in the writing of this paper. Many thanks to J. Sutton and Larry for their continued support throughout the writing of "the paper."

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Introduction

Name, address, sex, race, and eye color. These questions appear on many applications that we fill out either for jobs or when we try to obtain credit at a local store. They are needed to help identify the applicant. However, recent research indicates that one question, eye color, may help identify the way a person relates to himself and to his environment.

Can differential eye color make a significant difference in one's reaction to the external environmental stimuli that are enountered in everyday activities is the question that this paper is addressing. Should this hypotheses be supported it would mean changes in both teaching and counseling techniques. It would also mean more individualized training in sport activities emphasizing one's particular athletic ability. We will begin by briefly reviewing the anatomical parts of the eye and their functions. A review of some selected research will follow attempting to connect differential eye color to differential responses to environmental stimuli.

Section I

The Activity of the Eye

Many people have compared the eye to a camera and the parts of the eye to the parts of a camera. Kagan

and Havemann (1972) have stated that the retina is like the film in the camera; the cornea and lens are like the lens; the eyelids could be compared to the shutter of the camera; the pupil would be the aperture; the iris or the colored part of the eye is like the diaphragm; and the melanin is like the black coating on the inside of the camera designed to keep out excess light.

The amount of light that enters the eye is controlled by the constriction or the dilation of the iris. The light first passes through the pupil and is focused on the retina by the lens. The pupil appears to be black because there is a layer of melanin behind the retina. The retina after receiving the input then has the job of processing and transmitting the stimuli to different parts of the optic system.

Melanin is just one of the pigments that is found in both animals and humans. It may differ slightly in color but is generally brown. A question that has often been asked is, if the melanin in the eye is brown how could the color in the iris appear to be anything but brown? However, there is not just one layer of the pigment in the eye but rather several layers, and the color of one's eyes is directly related to how much total pigment is present and how it is distributed. If the pigment is densely layered, that is, if there is a lot of

it throughout all the layers, it will appear to be black and serves as a very effective light shield. The closer to the surface of the iris you get and the less pigment that is contained, the lighter the iris appears to be. This is called the Tyndall Scattering Phenomenon.

Although there are no definite distinctions between eye colors, there are varying degrees of the same eye color. For this reason it is thought by some that eye color is the result of a polygenic trait (Moody, 1967). This means that there are many genes responsibile for the color of one's eyes.

The eye contains many different types of receptors and some of those receptors are more sensitive to light than others. For example, there are cells in the eye that are referred to as cones. These cells allow us to perceive the different colors in the visual spectrum. Other cells, the rods, enable us to see shades of black, gray, or white in very dim light such as is found in the evening (Kagan & Havemann, 1972). Pigmentation serves mainly as a light shield and helps to lessen the amount of light that is able to enter the eye through the pupil. If the iris color is very dark less light is allowed into the eye. Likewise if the iris color is very light then more light is permitted into the eye which facilitates better vision in the dark.

A person who is an albino lacks melanin. These individuals seem to be deficient in the enzyme tyrosinase which is needed by the body for the synthesis of melanin. Albinism may affect a person totally (make the hair, skin and eyes light) or cutaneous (which just affects the skin) or it may be restricted to the ocular system. If it affects the eyes then they appear to be pink because there is very little melanin in the iris or behind the retina and the closest pigment to the surface is that of red which is in the blood from capillaries close to the surface of the eye itself (Moody, 1967).

Section II

Eye Color and Athletic Ability

The topic of behavior and eye color has not generated any research journals and few major book publications. However, there have been a few researchers who have performed experiments in this area. Among the most highly noted researchers is Dr. Morgan Worthy of Georgia State University in Atlanta, Georgia. He has contributed extensively to the area because of the different abilities displayed by both black and white athletes. He later expanded his research efforts in order to find out if athletic difference existed between players of the same race but who had differing eye color. In 1971, Worthy

presented a paper to the Southeastern Psychological Association suggesting that there is:

> a genetic interpretation of the observed racial differences in the self-paced versus reactive performance since similar differences are also observed between light-eyed and dark-eyed whites such that the light-eyed perform better than the dark-eyed on self-paced tasks but not on the reactive tasks (pp. 2).

Four important terms used by Worthy need to be clarified. "Self-paced" tasks are those over which the individual has a certain amount of control, i.e., he can perform them when he feels like he can do his best. On the other hand, a "reactive task" requires someone who can respond quickly to the action of others in a split second. In these activities the individual has little control over when he responds, he just responds to changes in the stimulus situation when those changes occur (Worthy, 1974).

Light eye colors are those colors that are light brown, green, blue, or hazel while dark eye colors are either dark brown or black (Worthy, 1975).

Athletic behaviors may be easily classified into being either self-paced or reactive. Golf, bowling and pitching either a softball or baseball are all self-paced

tasks while boxing, batting either a softball or baseball, or playing the tackle position on a football team are all reactive. One may also find aspects of both behaviors in one sport such as in football while the tackle position is apparently reactive, the quarterback has a self-paced position because he is able to delay his response (throwing the football) until one of the runners is clear of interference (Worthy, 1975).

The first research that was done by Worthy involved an investigation of differences that he had observed between athletes in self-paced and reactive skills. Worthy and Markle (1970) obtained information on the baseball players in both the National and the American Leagues. They used only those athletes who were American born. Their sample consisted of 411 players who were listed on the playing roster at the beginning of the 1969 season. They had hypothesized that there would be proportionately fewer black pitchers than black non-pitchers. They found that while 24% of the non-pitchers were black only 7% of the pitchers were black (Worthy & Markle, 1970). This difference was significant ($\underline{x}^2 = 19.305$, $\underline{df} = 2$, $\underline{p} < .001$). In the same study they obtained the data from the 1967-1968 National Basketball Association. They determined the race of the players based on team pictures and only used those athletes who

had played at least 1000 minutes. It was hypothesized that the white players would have a significantly higher percentage of free throw attempts than the black players. There were 53 black players and 45 white players. The white players were found to have a higher free throw scores minus field goal scores than blacks. The means for the two groups were 30.884 and 26.377. This difference was significant (t = 2.544, df = 96, $p < .02$). The players were also matched on height in order to control for that dimension and in the matched t-test, 37 pairs of players were compared. The whites were also found to have higher difference scores than blacks (t = 2.994, df = 36, $p < .01$). Another study was attempted using college basketball players. The researchers hoped that they would be able to replicate previous findings and were also interested in trying to find out if the factors of father absence and socio-economic class had any effect on measured performance. Worthy and Markle (1970) sent out questionnaires to coaches who were members of the National Collegiate Athletic Association. They received 73 responses which resulted in a sample of 302 players. There were 229 white players and 73 black players. Players reporting father-absence did not perform as well as the father-present group in free throw performance, although this difference was not

statistically significant (60% versus 65%; z = 1.741, $p < .10$). The two groups did not differ on field goals percentages (45% versus 44%; $z < 1$). Social class was determined by the amount of education that the father had. There did not appear to be any significant differences as a function of social class, and there were no consistent trends in this study. The previous findings, in the earlier Worthy and Markle study, were substantiated in the free-throw performance but not on the field goals.

Worthy next reported findings that indicated that the observed differences between blacks and whites in athletic abilities could also be found in dark- and light-eyed whites. This difference he felt could be contributed to genetic factors. To test for this difference Worthy (1971) studied four professional sport activities: football, baseball, basketball, and bowling. He procured an independent rater to determine the eye color of those individuals whose records of performance could be obtained. This rater had no knowledge of the experiment that was to be executed. Only black and white pictures were used to judge either the lightness or darkness of the eyes and then at a later date another rater was obtained to determine interjudge reliability. Those coefficients obtained were as follows:

football, +.75; baseball, +.86; basketball, +.88; and, bowling, +.91 (Worthy, 1971).

The hypothesis for the sport of football was that "the average eye darkness by position would increase as a function of the relative reactiveness of the position played" (Worthy, 1971). The only restriction placed on the participating sample was that the players had to have played a minimum of five years. This resulted in a sample consisting of 105 black players and 190 white players. The correlation was based on observation on whether the average eye darkness of the white athletes in a particular position was postively related to the number of blacks that also played the same position. The results were rank ordered and the correlation coefficient obtained was +.96 ($p < .01$). This correlation suggests that dark eye color for white athletes in this study was postively related to the probability of that individual playing a similar position as a black athlete, and that this position would have been classified as a "reactive" one.

Eye color was then related to the performance measures in the other three sports. In baseball, the won-lost percentages was one of the variables that was measured. Here it was found that the light-eyed pitchers had better performance records than the

dark-eyed pitchers (t = 2.68, df = 52, $p<.01$). In basketball it was found that although there were no differences in shooting field goals, there was a significant difference in shooting free throws, thus, the light-eyed players clearly performed better than the dark-eyed players (t = 2.83, df = 51, $p<.01$). In this study only those players that had at least 50 free throw attempts were included, and the player's height was controlled through covariation procedure. In the sport of bowling, the amount of money that had been made in one season was considered to be the performance measure, and only those bowlers who had been professional bowlers for at least five years were evaluated. It was found that light-eyed bowlers had won more money than dark-eyed bowlers (t = 2.29, df = 53, $p<.05$).

The results of the above study demonstrated that the light-eyed athletes had done significantly better on the self-paced activities than on the reactive ones. In the baseball study eye color predicted the success that a pitcher would have but it did not correlate with the batting success. Basketball results closely replicated those found earlier in that the light-eyed players performed better when shooting free throws than the dark-eyed players but no differences were found in shooting field goals. Of the athletes who had chosen

bowling as their profession, those having lighter eye colors had won more money during the bowling season.

In a paper presentation at the Midwestern Psychological Association Convention in 1974, Morgan Worthy presented his findings in the field of major league baseball and eye color. His hypothesis for this study was that dark-eyed players would perform better as hitters, and that light-eyed players would perform better as pitchers. Eye color information for all the players on 13 of the 24 major league baseball teams was obtained and classified as either dark or light. The performance records for the 1973 season were obtained from Sporting News and those players who had played enough to be considered by Sporting News for league honors were included in the study. To be considered for league honors the pitchers must have pitched at least 162 innings, non-pitchers had to bat at least 450 times. This resulted in a sample of 65 major league hitters and 48 major league pitchers. The non-pitchers were rated on their batting averages while the pitchers were rated on their won-lost records.

The findings were broken down in two different ways. First the overall results of the pitchers including black, white, and foreign born showed that the light-eyed pitchers had a higher won-lost percentage (56.9%)

than the average won-lost record for dark-eyed pitchers (48.1%). This was statistically significant (F = 16.578, df = 1,109, $p < .001$). The sample was then broken down to include only American born whites. The results were the same: light-eyed pitchers had a won-lost percentage of 57% while the dark-eyed pitchers had 47.8% for their average (F = 10.501, df = 1,109, $p < .01$).

The dark-eyed hitters had higher batting averages than those hitters with light eyes (F = 5.515, df = 1,109, $p < .05$). The mean batting average for dark-eyed players was .280 while the light-eyed players had an average of .262. In the American born white sample dark-eyed hitters still had higher batting averages than the light-eyed hitters but the difference did not prove to be significantly different (F = 2.456, df = 1,60, $p < .10$). The batting averages were .278 for the dark-eyed hitters and .262 for the light-eyed hitters. These findings lend strong support to the original hypothesis that more dark-eyed players perform better as hitters and light-eyed players perform better as pitchers.

Summary and Conclusion

To recapitulate the findings in this section, it appears that there is a difference in the athletic abilities between blacks and whites which are systematically related to darkness or lightness of eye color

(Worthy & Markle, 1969). Furthermore these different abilities may also be found between light- and dark-eyed whites alone (Worthy, 1971). Although the color of eyes that one may have is obviously not a perfect predictor of the position one may play in professional sports activities, it has been shown to be a significant contributor to the variance involved in the type of position played, and in the quality of performance at a given position (Worthy, 1974).

The results cited above cannot be interpreted to suggest that eye color is causative of one's athletic performance. There is a need for more research to be done in this area, both to replicate the findings of these experimenters and to rule out any confounding variables such as many of these experiments possess. One of the main problems of all of these studies is that they are correlational in design. Although correlational studies are designed to determine the degree of relationship between two variables they do not allow for a control group and therefore possess little power in identifying causal relationships among the variables studied.

While genetic factors, including eye color <u>may</u> be responsible for some of the variance in athletic performance, other factors including learning opportunities,

role expectations, and racial discrimination may account for the findings noted above (especially the preponderance of whites who play the more "prestigious" positions of pitcher and quarterback). However, these factors do not easily account for the consistent significant relationships noted, within the all white samples, between eye color and position played or performance at a given position.

Section III

Medical Research Involved with Eye Color

Dr. Gary while serving as a consulting psychologist for the Southeastern Tennessee Educational Cooperative was attempting to help identify children with special learning needs. The 14 school systems involved in the Cooperative were complying with the state legislation mandating that children of all abilities were to be instructed within the school complex. Of the approximately 43,000 students that were tested from grades kindergarten through eight, 11,281 of those students were identified as "suspected of needing special help" (Gary & Glover, 1975, pp. 116). One of the variables studied in this research was in the area of physical disabilities, including those students who were exceptionally thin, obese, short, tall, or premature. Medical conditions that were examined included cardio-

vascular disease, endocrine disorders, or simple nervous system disorders. It was found that the light-eyed individuals appeared more susceptible to these medical and physical conditions than the dark-eyed individuals at a ratio of 30:1. The Southeastern Tennessee Educational Cooperative included both rural and urban, black and white families in a wide socio-economic range.

Some medical researchers have been attempting to link eye color to the incidence of autism. The etiological basis for autism is unknown and it is a very rare syndrome. Rimland (1964) has reported that he has seen children from all over the world and less than 1% of them could be classified as truly autistic. Autism may be defined as "a distorted self-centered form of thinking that may be controlled by the thinker's needs or desires and bears little relation to external reality. It is the type of thinking that takes place in dreams and in fantasies" (Rimland, 1964). Happy and Collins (1972), after becoming interested in the etiology of autism made several assumptions before undertaking their research. First, they speculated that the autistic child was at the extremely introverted end of the behavioral continum. Secondly, they hypothesized that introversion is linked to the physiology of the Ascending Reticular Activating System (ARAS). The ARAS is responsible

for relaying sensory impulses to the cerebral cortex and is part of the system responsible for maintaining wakefulness and the ability to concentrate on one activity (Morgan, 1965; Thomas, 1973). Using correlational studies they found a statistically significant over-representation of hypo-pigmented children (those with little melanin) and an under-representation of hyper-pigmented children (those with more melanin) in autistic children ($p < .05$). These researchers now feel that there is an existing link between melanin and a postulated defect in the noradrenergic pathways in the ARAS. The ARAS uses the noradrenaline as a transmitter substance and tyrosine is a precursor of both the noradrenaline and melanin (Thomas, 1973). The conclusion drawn from this study by Happy and Collins was that some "lightly pigmented individuals seem to have an inherited tendency to autism and general predisposition to introversion".

Cancer is rated second only to heart disease in the number of lives it takes every year. Two researchers have tabulated some interesting statistics relating to eye color and basal cell carcinomas and malignant melanomas. Using correlational studies, Bart and Schnall (1973) tried to determine if there was a difference in the eye color of people who were more prone to basal cell carcinomas or malignant melanomas. The study took place

at the New York University Medical Center. They found that the people who have a light iris pigmentation seldom have solidly pigmented black or dark brown basal cell carcinomas. However they were unable to find such a distinction with malignant melanomas. From this study, they concluded that a solidly pigmented black or dark brown malignant lesion in a patient that has blue, gray, or green eyes is more likely to be a melanoma. They acknowledge that this information may be important to the surgeon or dermatologist because the treatment for the two diseases are completely different, one demands radical surgery while the other one can be stopped with spot surgery.

Berg and Stern (cited by Worthy, 1975) found that individuals who have phenylketonuria (PKU) also had lighter eye color, as a group, than that of a control group or unaffected siblings. PKU is a disease that can cause brain damage as a result of the body's incapability to transform an amino acid into tyrosine. PKU is due to a recessive hereditary trait (Moody, 1967; Thomas, 1973).

The visual sense is considered to be one of our most important senses. Through our vision we are able to react to our environment on the basis of what we perceive. Blurred vision may force one to make inaccurate

perceptions and therefore, inaccurate responses to the environment. Karpinas (1960) was interested in the dimension of visual acuity and designed an experiment to find out if there were racial differences in acuity. He gathered the results of eye tests of over a quarter of a million American soldiers, both black and white. They were all considered to have normal vision (20/20). Of this number he found that while 82% of the black soldiers had good uncorrected distant vision only 69% of the white soldiers did. This led him to believe that black individuals (those with dark eyes) had better visual acuity on the average than white individuals (those with light eyes).

"Color blindness is a trait that is recessively inherited" (Moody, 1967, pp. 206). Because it is a recessive trait, more men than women are color blind. Employing samples from several different cultures, it was found that 8% of the Northern Europeans and American whites were color blind, 5% of the Chinese/Japanese were color blind, and less than 5% of the American Blacks, Mexicans, and American Indians were color blind (Spector, 1956). Generally, the Northern Europeans and American Whites are light-eyed while American Blacks, Mexicans, and American Indians have darker eye colors.

Research has also been conducted on the relationship

between eye color and diabetes. There appears to be a relationship between eye color and diabetes within a family. That is, if one parent is a diabetic and has a diabetic offspring, chances are that if the offspring has any siblings that have the same eye color he/she will be diabetic also. The eye color that is linked to diabetes within families is not always the same which gives impetus to the thought that although diabetes may be inherited, there may be different genetic linkages (Gates, 1946; Thomas, 1973). This also implies that genes for eye color may somehow be linked with genes that are involved with diabetes (Gates, 1946).

Children are born with very little eye pigmentation but by the time the child reaches an average of six months of age the eye color has obtained its maximum darkness. However, at middle age this change in eye color again occurs, this time the eyes appear to lighten. The change in coloring seems to be influenced by changes in the level of the sex hormones (Snell, 1967).

Summary and Conclusions

In this section studies dealing with the concept of eye color and medical and physical disabilities have been cited. It was found that children who lacked pigmentation were more prone to be diagnosed as autistic than those children who were more pigmented (Happy &

Collins, 1972). It must be stated here that the children that Happy and Collins observed had already been diagnosed as being autistic. According to Rimland (1964) this is a very rare syndrome and it cannot be ascertained that the children were diagnosed correctly.

Bart and Schnall (1973) found that there is a difference in the types of cancer that one may have. There does not appear to be a prevalent eye color in those individuals with a malignant melanoma. However, individuals with lighter eye colors seem to be less prone to have a solidly pigmented black or dark brown basal cell carcinoma. The researchers realized that this distinction would be important because the treatment for the two cancers is entirely different. This was a correlation study in which no control group was used.

Two medical problems, that of PKU and diabetes, have also been linked with eye color. PKU is not only recessively inherited but it has been found that individuals with this disease are generally light-eyed (Worthy, 1975). Diabetes, on the other hand, may also be inherited but one eye color is not consistently associated with the disease except in individual families (Gates, 1946).

Vision, one of our most important senses, is also connected with many anomalies. The absence of good

visual acuity prevents one from distinguishing small details in the environment. Acuity plays an important part in how one responds to different stimuli. It was indicated that dark-eyed individuals may have better overall acuity than light-eyed individuals (Karpinas, 1960). Color blindness, another problem area, is known to be more prevalent in males than in females due to an inherited recessive trait but only recently has it been correlated with eye color. Utilizing samples from various populations, it was found that color blindness is less prevalent among those populations where the eye color is dark (Specter, 1956). The idea that eye color may not be consistent throughout one's entire life was presented by Snell (1967) when he observed that the color of babies' eyes would gradually darken until they were approximately six months of age and then when the individuals reached middle age the eyes became lighter.

Most of the above cited research employs correlational techniques that make it impossible to have control groups. Therefore, no causal statements may be advanced in these studies. One study, that of Specter (1956) did not use any females although it is known that females can be color blind as well as males. The other studies used individuals who had been diagnosed as having the specific conditions that were correlated. It may be

possible that some of those individuals had been wrongly diagnosed such as the autistic children. Another problem could be experimenter bias such as in the studies done by Karpinas (1960) and Spector (1956). The researchers may have expected to obtain certain results and biased the data in the favored way.

In a study done by Bart and Schnall (1973), individuals with little pigmentation were less likely to develop diseases that required an excessive amount of pigmentation. The above statement appears to be little more than a logical statement.

Several of the studies such as the ones by Happy and Collins (1972), Berg and Stern (cited by Worthy, 1975), and Gates (1946) all seem to have a prospective hypothesis in either a genetic or physiological eitology. Although the connection is not known at this time, it seems possible that eye color genetic linkages may also have something to do with some medical disabilities.

Section IV

Eye Color, Learning, Perceptions and Susceptibility to Illusions

One area that has always been of interest to psychologists is the area of individual differences and abilities in learning and perception. There have been many tests (i.e. IQ and Projective tests) and devices

developed that psychologists had hoped would measure individual differences in learning capacities and perception. However, the obvious difference of the eye color has not been measured seriously in any study until recently. Eye color is an individual difference that may, according to some researchers, play an important part in the ability of one to learn and perceive.

Are eye color and social class related to perceptual motor and cognitive abilities? Jordan (1972) hypothesized that they could have an effect. He obtained 80 white college students between the ages of 18 and 24 who differed in sex, social class, and eye darkness. There were 4 groups with 20 students in each group. The groups were divided into dark-eyed males, light-eyed males, dark-eyed females and light-eyed females. Jordan used several standardized tests that measured perceptual motor and restructuring tasks, tests that measured cognitive ability, and tests that he felt would measure reactive and self-paced tasks. Examples of the tests used were as follows: for the perceptual motor tasks, he used a letter cancelling test, digit symbol subtest of the Weschler Adult Intelligence Scale (WAIS) and a color naming test; for the perceptual restructuring tasks, he used the object assembly subtest of the WAIS, Group Embedded Figures Test, and a mirror maze test. Cognitive

abilities were measured by unclustered and clustered word tasks. The unclustered word task consisted of words that had no apparent relationship to each other while the clustered words did have an apparent relationship such as objects of dress. In measuring either self-paced or reactive skills the dart throwing test was utilized with dart boards set up at the end of the room with a light over each of the three boards. For the reactive task, the subjects were asked to throw the dart at the board that was lighted. During the self-paced task all three of the boards were lighted and the individual could throw the dart at the board of his choice. Jordan failed to find any significant social class differences in cognitive abilities between dark-eyed or light-eyed individuals. The only conclusive evidence was found in the area of perceptual motor skills where it appeared that the females did better than the males regardless of eye color. Although it is stated that Jordan obtained subjects that differed in social class, it is not known how these subjects were selected and whether the rating of eye color was done by a rater or by self-report. A control group, had it been used, would have been useful in eliminating confounding variables and may have explained why no significant correlations were found.

The proponents of behavior modification principles,

believe that as an individual observes "a model's behavior, he may learn a response without actually performing it. This helps to learn new responses as well as altering the frequency of previously learned responses" (Craighead, Kazdin, & Mahoney, 1976, pp. 106). Gary and Glover (1975) developed an experiment to test the effects of an audio model and to determine any differences between the light- and dark-eyed individuals in learning a modeled response. Students were asked to describe a picture of Neil Armstrong standing on the moon. The number of the adjectives that the students used in this description was considered as the base-line data. A tape recording of someone else describing the same picture was then presented and the students were asked to redescribe the same picture. The experimenters used the number of adjectives as their dependent variable. They found that after hearing the tape presentation, the dark-eyed individuals used more adjectives in writing their descriptions than they had used in their first attempt. The subjects were 19 graduate students from Tennessee State University. There were 6 students with light colored eyes and 13 students with dark eyes. The students were seperated into two main groups, those with dark eyes and those with light eyes, and then into two sub-groups in each group, male

and female. During the base-line measure the light-eyed group had on the average more descriptive adjectives than the dark-eyed group (7.3 vs. 7.0). However, after the presentation of the tape the dark-eyed individuals had significantly more adjectives on the average than the light-eyed individuals (14.6 vs. 9.1). This yielded a t of 2.57 (df = 17, $p<.05$).

The next project of Gary and Glover (1975) was to ascertain whether or not there is a difference in both acquisition and extinction rates of a modeled behavior between the light- and dark-eyed individuals. Twenty-three subjects were used and the relevant behaviors of the subjects and experimenter were carefully monitored by six different observers. The reliability coefficients between the observers and the relevant behaviors ranged from .73 to .98. The results indicated that the dark-eyed individuals were able to learn and unlearn modeled behavior faster than the light-eyed individuals(Acquisition Behavior: $p<.05$; Extinction Behavior: $p<.01$). This tentatively demonstrates that individuals with dark eye colors are more responsive to external stimuli than are light-eyed individuals.

The speed with which one answers open questions in the classroom was the next question Gary and Glover (1975) attempted to answer. This experiment included a

total of 2,894 fifth, sixth, and seventh grade children, both male and female, in the Southeastern Tennessee Educational Cooperative. The experiment was designed so that intern teachers could record the data. The regular classroom teacher was asked to teach on a new topic. After the intern teacher had noted the sex and eye color of each student, the teacher began questioning the students about the previously presented topic. The observer noted who the first student was to respond and the correctness of the answer.

The tabulation of the results produced an unique feature. Although it had been hypothesized that the dark-eyed female students would answer the most questions with the dark-eyed males running second and the light-eyed females third with the light-eyed males last, the light-eyed males and females were much more responsive than the dark-eyed males or females ($\underline{x}^2 = 57.26$, $\underline{p} < .0001$).

The results obtained by Gary and Glover seemed to be the result of learning. The same experiment was performed on a much smaller scale at two church-operated nursery schools. This time when the results were tabulated, the hypothesis was verified. The dark-eyed females answered more questions with the light-eyed females being second, dark-eyed males third, and the light-eyed males answering

significantly fewer questions than the other three groups. (The chi square was much smaller but it was still significant).

After a great deal of thought was given to the matter, Gary and Glover advanced a few hypothesis as to why the results had come out the way they had. They noted that the correlation between raising one's hand in the classroom and being called on was very low, especially if there were a lot of children with their hands raised. Secondly, due to a lack of reinforcement, initial responsiveness may be extinguished. Third, if the children had answered first and had given the wrong answer when grades were pending, they may have had a devalued grade.

Perception, may be defined, as the "process of being aware of objects; consciousness" (Thomas, 1973, pp. 45). Markle (1972) became concerned as to whether the perception of colors was different for the light-eyed person than for the dark-eyed person. The Rorschach protocol numbers 1-3, 5 and 8-10 were administered to a group of college students. The protocols were scored by another individual who was blind as to the reason of the experiment and used the Klopfer method of scoring. The within subjects measure when computed showed that the light-eyed group had an average of 2.72 form responses

and 1.04 color responses. The dark-eyed group averaged 2.48 form responses and 1.21 color responses. The interaction found between eye color and response indicates that light-eyed individuals respond more to form while the dark-eyed individuals respond more to color. This finding was consistent with the idea that Worthy had advanced concerning one's perception of the visual spectrum (Worthy, 1974).

One of the first studies to be done concerning color versus form perception in light- and dark-eyed individuals, involved students from universities in both Scotland and Africa. The prerequisite for the students to participate in the experiment was that they had to have taken at least one geography class. The experiment consisted of administering a map reading test that had changes in contours indicated by changes in the shades of coloring. It was found that the Africans (those with dark eyes) did better on the questions dealing with changes in the hues of red and yellow. However, the Scots did equally well on both sets of questions (those with both red and yellow shadings and blue and violet shadings). Although the Scots did better, they did not do significantly better on the blue and violet shadings (Jahoda, 1971).

If any significant findings had occured concerning

the ability to distinguish colors between dark- and light-eyed individuals these results could have proved significant in the classroom setting. However, it seems that the color of the teaching materials used in the classroom makes very little difference.

Gary, being interested in finding ways to help enable students of all abilities to develop to their fullest potential, became involved in a study that was concerned with color and form perception in children with learning disabilities (cited by Gary & Glover, 1975). The students who participated in the research were all from the Southeastern Tennessee Educational Cooperative and were between the ages of 16 and 18. They had been diagnosed as having either visual or visual-perceptual difficulties. There were a total of 36 students with 18 in the group of dark-eyed individuals and 18 in the group of light-eyed individuals. Each group consisted of nine males and nine females. Two experimental conditions were presented to each student individually. The task, in condition one, was for the students to observe a series of seven slides, one at a time, for a fixed length of time. At the end of each individual slide presentation, the student was asked to select the exact geometric form and color that they had just seen. The slides were increasingly complicated in that slide one only had one

shape and color in it while slide two had two shapes and colors, on up to slide seven which had seven different forms and colors. The second experimental condition was essentially the same as the first with the exception that the student was not required to attend to the slide for any particular length of time. They could choose to end the viewing time and proceed to the next step of selecting the appropriate reproductions. Once the data was analyzed, it was discovered that under both conditions, the dark-eyed students had made more form than color errors while the light-eyed students made more color than form errors. These results were significant at the $p < .05$ level. It was noted when the dark-eyed students were able to determine how much time they wanted to spend observing the slide, they used less viewing time and made fewer errors overall in their performance. The light-eyed students were more prone to use all of the time that they were given under both experimental conditions.

It appears, from this experiment, that the dark-eyed students are more receptive to the external stimuli than are the light-eyed students. This is consistent with Worthy's (1974) hypothesis that dark-eyed people are more reactive to their environment. They can respond to the environmental changes quickly and still be successful

in obtaining the desired results. The light-eyed individuals are better at obtaining the desired results when they are allowed to choose the appropriate time for their response.

An illusion may be anything that has a misleading appearance. With this idea in mind, two experimenters were concerned with the relation between eye pigmentation and a person's susceptibility to illusions (Pollack & Silvar, 1967). They obtained 35 children and determined the amount of iris pigmentation by using an ophthalmoscope. Using the Mueller-Lyer illusion under blue illumination, the researchers asked the children to point out which of the middle lines appeared longer to them. The researchers were trying to reduce the intensity of the contours by using the blue light. The results indicated that the more deeply pigmented the iris, the less susceptible to the illusion the child appeared to be ($p < .05$). It was noted that the older the child is the less susceptible to the illusion he becomes.

Berry (1971) tested almost 500 children from 10 seperate cultures for their susceptibility to the Mueller-Lyer illusion. The children had been ranked on Berry's estimation of skin pigmentation as an "index of retinal pigmentation" (Berry, 1971). He also found that the more pigment that one has the less susceptible he is