The Relationship Between Figure-Ground Discrimination and Color Blindness in Learning Disabled Children

Joseph E. Justen III, EdD, and Robert Harth, EdD

The relationship of figure-ground discrimination to color blindness in learning disabled children was studied. The authors hypothesized that, because of the nature of many standardized tests of color blindness, figure-ground problems might interfere with such testing. Ninety-four learning disabled children were given the AO H-R-R Pseudoisochromatic Plates and the figure-ground subtest of the Frostig Developmental Test of Visual Perception. Results indicated that figure-ground problems did, in fact, confound color blindness testing.

Recently, much research has been conducted to determine the incidence of color blindness in various handicapped groups. While the majority of this research has been carried out with mentally retarded populations (Justen 1973), studies have also been conducted on the emotionally disturbed (Courtney & Heath 1971), on the deaf (Frey & Krause 1971), and on educationally handicapped children (Espinda 1973). Most of these studies have reported prevalence rates much greater than the 8% for males and the less than 1% rate for females exhibited in the normal population (Archer 1964, Espinda 1973, Frey & Krause 1971, O'Connor 1957). In addition, many of these studies found nearly equivalent prevalence rates for males and females. Several authors (Justen 1973, Salvia 1969, Schein & Salvia 1969) have suggested that this generally higher incidence rate combined with a like rate for males and females is difficult to explain in light of the fact that color blindness is a sex-linked recessive trait. There would be no reason to expect a greater incidence of color blindness in handicapped children unless they showed greatly increased aberrations of the sex chromosomes. Thus, Schein and Salvia (1969) have suggested that a "confounding variable" must be interfering with the results in these studies.

The most common means of assessing color blindness is by use of pseudoisochromatic plates of one sort or another – most of the data on the prevalence of color blindness have been derived from these tests (Krill 1972). These plates use printed dots to form figure-ground designs. The testee is required to identify the figures (usually a numeral or a geometric design) on the basis of color differentiation. Since many exceptional children may exhibit problems in figure-ground discrimination, the authors hypothesized that perhaps part of the reason that more than the expected number of children show up as color blind may be a function of this factor. Hence, it will be the purpose of this study to investigate the relationship of figure-ground discrimination to the incidence of color blindness in specific learning disabled children.

SUBJECTS

The subjects selected for this study consisted of all the children placed in Phase 3 classes for the specific learning disabled in Special School District of St. Louis County, Missouri. Phase 3 programs include the more disabled children being educated entirely in self-contained classes. Phase 2 children are preparing to re-enter regular class, and Phase 1 children are placed in regular class and receiving itinerant or resource services. Since the philosophy of Special School District is to integrate learning disabled children into regular class if it is at all possible, special classes are reserved for only the most disabled.

Prior to being considered for placement in Phase 3 classes, all children receive a comprehensive psychological/educational evaluation. Included in this evaluation are the following tests: the Wechsler Intelligence Scale for Children (Wechsler 1949), the Illinois Test of Psycholinguistic Abilities (Kirk, McCarthy & Kirk 1968), the Developmental Test of Visual-Motor Integration (Beery & Buktenica 1967), and the Wide Range Achievement Test (Jastak & Jastak 1965). The criteria for placement in Phase 3 classes include: (1) A WISC full scale IQ of 79 or above. In addition, the subtests of the WISC must present a spiked profile; (2) achievement at least two grades below that expected for age level as determined by the WRAT; (3) a VMI age score on the Beery-Buktenica at least two years below that expected for the child's chronological age; and (4) a language score on the ITPA of 2 SD below the mean. Again, as with the WISC, the subtests on the ITPA must show a spiked profile.

For this study, all of the Phase 3 children in Special School Districts who were present on the dates of testing were included. The total sample was 94 students: 75 boys (79.8%) and 19 girls (20.2%). Mean CA for all was 9 years, 9 months.

MEASURES

The instrument used to assess color blindness in this study was the AO H-R-R Pseudoisochromatic Plates (Hardy, Rand, & Rittler 1957). The AO H-R-R was chosen for this study for several reasons. First, this instrument uses geometric designs as stimulus figures instead of the numerals used by the majority of other tests. Second, the test has several trial plates to insure that the subject understands test directions. Finally, this measure has been shown to be relatively effective in assessing the color blindness of mentally retarded and emotionally disturbed subjects (Courtney & Heath 1971, Justen 1973). The instrument used to assess figure-ground discrimination was the figure-ground subtest of the Frostig Development Test of Visual Perception (Frostig et al. 1964).

PROCEDURES

Subjects were administered the AO H-R-R according to procedures adapted by Justen (1973) from the methods developed by Courtney and Heath (1971). Basically, these procedures differ from those given in the AO H-R-R instruction manual only in that the 2-second response requirement is eliminated and the plates are presented in a reordered fashion so that easier ones are given first and the harder ones last. Subjects were also allowed to trace the designs with a brush instead of naming them. All testing of color blindness was conducted in a darkened room using the recommended Standard "C" luminant (the MacBeth-Easel Lamp) as the major source of illumination. The senior author of this paper administered all of the tests for color blindness.

The figure-ground subtest of the Frostig was administered according to the standardized group procedure. No group was larger than ten children and the test was given by a test administrator and a proctor. Prior to the beginning of the study, both the test administrator and the proctor were given extensive instruction in the administration of the Frostig.

The data were analyzed by computing a point biserial correlation coefficient between color blindness and figure-ground. A point biserial correlation computes a coefficient between a nominal dichotomous variable and a continuous variable (Glass & Stanley 1970). In this study, the dichotomous variable was color blindness (color blind/non-color blind) and the continuous variable was Frostig figure-ground.

RESULTS

These tests for color blindness showed 19 (20.2%) of the 94 children to be color blind: 16 boys (21.3%) and 3 girls (15.8%). Even using the modified testing procedures, the percentage of subjects identified as color blind is substantially greater than would be expected on the basis of rates generally reported in the normal population. In fact the rate was roughly 2½ times that expected in males and 16 times that expected in females.

The sample in this study consisted of a ratio of approximately four males for every female (75 males, 19 females). With this ratio, based on incidence figures in the general population, one would expect a prevalence rate for color blindness of approximately 6.67%. This means that almost three times as many color blind children than would be expected were identified in the learning disabled population.

Part of the explanation for these results may be explained by the obtained point biserial correlation coefficient between color blindness and figure-ground discrimination. The coefficient obtained was 0.50, indicating that figure-ground discrimination accounted for approximately 25% of the variance in color blindness score on the AO H-R-R. This was consistent with the original prediction of the study.

DISCUSSION

The results of this study lend support to the contention that confounding variables do influence the results of color blindness testing in learning disabled children. Furthermore, figure-ground discrimination ability appears to be at least one variable affecting performance on pseudoisochromatic tests of color blindness. This factor alone accounted for approximately 25% of the variance. It would appear, from this study, that children with figure-ground discrimination problems could be identified as color blind even if they were, in fact, not color blind.

Many learning disabled children identified as color blind may, in fact, have normal color vision. Where this is the case, these children could undoubtedly benefit from color coded curriculum materials. To eliminate color-emphasized materials from a child's instructional program on the basis of a single color-blindness test would not appear to be a wise move for teachers, especially if the child improves while using these materials. It should be noted that even a color blind child can often benefit from color coded materials – if the color blindness is mild and the colors being used are not in the child's confusion zone. Some of these children, after treatment with visual-motor and perceptual therapy, will be able to accurately respond to tests of color blindness using pseudoisochromatic plates.

It is interesting that Schein and Salvia (1969) noted that in Archer's (1964) study, less color blindness was found in older subjects than was found in younger subjects. The increased visual perceptual integrity of older subjects coupled with an increased understanding of test directions might account for much of this difference.

Because of the importance of color coding and color cueing in curricular materials for the learning disabled child, it is suggested that other types of measures of color blindness be studied for their adequacy with this population of children. Potential instruments might include: lantern tests, the various wool-matching tests, and perhaps the Farnsworth Dichotomous Test for Color Blindness (Farnsworth 1947). This test uses one permanent and 15 movable color caps in a sorting format. If children with figure-ground problems were given these tests, undoubtedly their responses would be more accurate. However, some caution is in order. While pseudoisochromatic plates may over-identify (identify false positives), many of the other tests fail to identify the milder forms of color deficiency. At any rate, unless there is evidence other than that obtained by means of pseudoisochromatic tests, special educators and other practitioners should view assessed color blindness in learning disabled children with extreme caution. – *Department of Special Education, University of Missouri, 515 S. Sixth Street, Columbia, Mo. 65201.*

ACKNOWLEDGMENT

Special thanks are due Mr. Earle Hollis, assistant superintendent, Special School District of St. Louis County, Missouri, for his help with this study.

REFERENCES

Archer, R.: Color discrimination and association of educable mentally retarded children. EdD dissertation, Colo. State College, 1964.

Beery, K.E., and Buktenica, N.A.: Developmental Test of Visual-Motor Integration. Chicago: Follett, 1967.

Courtney, G., and Heath, G.: Color vision deficiency in the mentally retarded: Prevalence and a method of evaluation. Amer. J. Ment. Defic., 1971, 76, 48-52.

Espinda, S.: Color vision deficiency: A learning disability? J. Learning Disabil., 1973, 6, 163-6.

Farnsworth, D.: The Farnsworth Dichotomous Test for Color Blindness. New York: Psychol. Corp., 1947.

Frey, R., and Krause, I.: The incidence of color blindness among deaf children. Exceptional Child., 1971, 37, 393-4.

Frostig, M., et al.: The Marianne Frostig Developmental Test of Visual Perception. Palo Alto, Calif.: Consulting Psychologists Press, 1964.

Glass, G., and Stanley, J.: Statistical Methods in Education and Psychology. Englewood Cliffs, N.J.: Prentice Hall, 1970.

Hardy, L., Rand, G., and Rittler, M.: AO H-R-R Pseudoisochromatic Plates. Buffalo, N.Y.: Amer. Optical Co., 1957.

Jastak, J.F., and Jastak, S.R.: The Wide Range Achievement Test. Wilmington, Del.: Guidance Associates, 1965.

Justen, J.: The effects of color blindness on academic achievement and discrimination learning in special class retardates. EdD dissertation, Univ. of Fla., 1973.

Kirk, S.A., McCarthy, J.J., and Kirk, W.D.: Illinois Test of Psycholinguistic Abilities. Champaign, Ill.: Univ. of Ill., 1968.

Krause, I.: A study of the relationship of certain aspects of color vision to educable mentally retarded children. United States Office of Education. Grant No. OEG-6-068528-1593, 1967.

Krill, A.: Abnormal color vision. In A.M. Potts (Ed.): The Assessment of Visual Function. St. Louis: C.V. Mosby, 1972.

O'Connor, N.: Imbecility and color blindness. Amer. J. Ment. Defic., 1957, 62, 83-87.

Salvia, J.: Four tests of color vision: A study of diagnostic accuracy with the mentally retarded. Amer. J. Ment. Defic., 1969, 74, 421-427.

Schein, J., and Salvia, J.: Color blindness in mentally retarded children. Exceptional Child., 1969, 35, 609-613.

Wechsler, D.: Wechsler Intelligence Scale for Children. New York: Psychol. Corp., 1949.