1984

The effects of color reversal on the maze performance of learning disabled and normal children

Susan Ramsay Knaysi

THE EFFECTS OF COLOR REVERSAL ON THE MAZE PERFORMANCE OF LEARNING DISABLED AND NORMAL CHILDREN

BY

SUSAN RAMSAY KNAYSI

Approved by:

Bernard M. Chirico, Ph.d
Committee Chairman — Date

James L. Tromater, Ph.d
Committee Member — Date

William E. Walker, Ph.d — 3/25/84
Committee Member — Date

Acknowledgements

Gratefully, I acknowledge the thinking, analyzing, and editing minds of my committee members: Dr. Bernie Chirico, Dr. William Walker and Dr. James Tromater, who helped shape my research, my analyses, and in the process, me. A special thanks goes to Bernie Chirico for his honesty and confidence. Thanks to my husband, George, for his enduring patience and his acceptance of a less than perfect year; and to my children, Melissa and Ashley, for their wonderful enthusiasm despite "store-bought" cookies and a succession of leftovers. Lastly, thanks to the Isemans: Carter, Ken, "CC" and Kenzie for their support and constant encouragement.

Abstract

Recent studies examining the performance of brain-injured children (specifically, cerebral palsied children) reported improvement of perceptual-motor abilities on graphic tests with figure-ground reversals (Uhlin & Dickinson, 1970; May, 1978). A pilot study was done to ascertain whether this facilitative effect of color manipulation would be demonstrated with hyperactive children also classified as perceptually impaired. A significant difference in performance was found between the white background/black figure manipulation and the black background/white figure manipulation by age (5-10 year olds). Normal children did not demonstrate this facilitative effect. It was postulated that this effect would generalize to learning disabled children. In the present study, twenty-four children between the ages of 9 and 12 years served as subjects. Twelve children made up the control group of normals and twelve children, diagnosed as learning disabled, comprised the experimental group. A three factor Latin square design was utilized. WISC-R mazes were used to measure performance. It was hypothesized that learning disabled children would perform better when presented with a task on the black background and that there would be no difference in the performance of normal children on either background. Homogeneity of variance was not satisfied so subsequent results were viewed with caution. Two findings of significance were noted as hypothesized, normal

and learning disabled children did not exhibit performance differences on the black background. In addition, a significant difference between performance on the black background versus white background was found for both groups when the black background was presented on the second trial.

THE EFFECTS OF COLOR REVERSAL ON THE MAZE PERFORMANCE OF LEARNING DISABLED AND NORMAL CHILDREN

Visual perception is a complex function which depends upon higher level processes for organization and interpretation of environmental stimuli (Atkinson, Atkinson & Hilgard, 1981; Bootzin, Loftus & Zajonc, 1983). Figure-ground perception constitutes part of the organizational aspect of visual perception and is defined as "the ability to perceive and isolate a relevant stimulus figure from an irrelevant background" (Ritter & Ysseldyke, 1975, p. 319). Basic theoretical explanations have prevailed concerning the organization and discrimination of figure-ground perception in a visual field. Normal figure-ground perception has been found to be dependent on figure constancy, relative brightness of the figure-ground properties, as well as the existence of an irrelevant background (Bartley, 1962). There is also thought to be a definite innate basis to figure or form perception which does not necessarily preclude the effects of recognition (Rock, 1975; Rose, Birke, Katz & Rossman, 1977; Ritter & Ysseldyke, 1976).

For the perceptually impaired child, the fundamental rules of perception are confused under normal figure-ground conditions. The child, it seems, is unable to respond solely to the figure (Werner & Strauss, 1941; Dolphin & Cruickshank, 1951; Canter, 1966). This impairment may be manifested at times in the visual (receptive) aspect of perception and/or in the visual and motor (expressive) aspect.

Historically, perceptual motor problems have provided the main diagnostic criteria for a group of neurologically impaired syndromes that are often referred to as brain-damage, brain-injury, and brain dysfunction (Ross & Ross, 1976; Dolphin & Cruickshank, 1951). The etiology of these syndromes is unknown except in the case of overt trauma. Some childhood dysfunctions, most notably hyperactivity, minimal brain dysfunction, and learning disabilities have also been classified under the rubric of brain syndromes. This has been done without the benefit of physical evidence, but instead has been based on shared perceptual symptomatology. This shared symptomatology includes visuomotor symptoms, excessive motor activity, short attention span, impulsivity and inability to discriminate the figure from the ground properties.

Researchers have attempted to explain and define the etiology of neurologically impaired syndromes in terms of their own orientations and research. The neurologic approach, the most widely accepted, explains these syndromes as the result of either a chemical imbalance or destruction of brain tissue (Bootzin, Loftus & Zajonc, 1983). Developmental theories explain this enigmatic situation by pointing to a developmental lag in selective attention (Owen, Adams, Forrest, Stolz, and Fisher, 1971). More recently, results of studies of ocular dominance in figure-ground perception have been used as an explanation. Ruggieri, Ceridono, Cei & Bergerone (1982) for example, have suggested that in normal vision, the dominant hemisphere analyzes the figure while the nondominant one examines the background.

Theories about figure-ground perception with impaired children have been as varied as the experimental results. Researchers have historically concentrated on two specific areas in figure-ground studies. The first of these two areas related problems in figure-ground perception to background interference and distractibility (Werner & Strauss, 1941; Rubin, 1969; Dolphin & Cruickshank, 1951; Canter, 1966). The second area related problems in figure-ground perception to organizational and integrational aspects of visual perception (Urmer & Wendland, 1963; Werner & Thuma, 1942).

Ambiguous measurement techniques, however, as well as lack of diagnostic uniformity have made it difficult to separate distinct perceptual skills and the impairments they are supposed to measure. Ritter and Sabatino (1974) for example reported that current tests seem to correlate highly because of method variance alone. Further, inadequate validation and overlapping trait variance have also been major criticisms of the perceptual skills research to date (Ritter & Ysseldyke, 1976; Rohr & Ayers, 1976).

Werner and Strauss conducted the initial research with brain-injured children in 1941, testing for figure-ground discrimination (the ability to distinguish the figure from the background). Their methodology required the subject to emit the perceptual act of seeing and to respond with a motor movement. Consequently, the term perceptual-motor disturbances became associated with brain-injured children. Werner and Strauss tested these brain-injured children on four different measures of perception. These measures included two visual tests, a visuomotor test, and a tactual kinaesthetic test. The results demonstrated that brain-injured children repeatedly focused on the background stimulus rather than the figure itself. With a confusing background, the lines constituting the figure were distorted as they became part of the background. This was true whether the perception was visual or tactile. Werner and Strauss described this perceptual impairment generally as a defective reaction manifesting itself in one of two ways:

1. As an organizational problem where the child was unable to organize the fields into figure and ground.
2. As a distractibility problem where the child was unable to attend solely to the relevant stimulus.

Rubin (1969) revised Werner and Strauss' study to determine whether the figure-ground pathology discovered by Werner and Strauss was an outgrowth of the subjects' inability to express themselves verbally and/or the distractible nature of the background. Rubin minimized the distractions by using a hooded tachistoscope, reduced the competitive effects of the new testing situation and allowed subjects a practice period.

The performance of brain-injured children under these conditions was not significantly different from that of normal children. These results were not necessarily contradictory to Werner and Strauss' research but instead, in a subtle fashion, emphasized the distracting effects of background interference on performance with perceptually impaired children.

Dolphin and Cruickshank in their 1951 studies reported similar findings as Werner and Strauss and attributed their results to forced responsiveness to the extraneous stimuli. Cantor (1966) reported on a background interference procedure (BIP) that he developed to extend the sensitivity of the Bender Gestalt test in order to differentiate the perceptual deficits related to organic brain disorders from that related to psychiatric disorders without the involvement of organic brain dysfunction. Subjects were required to complete a graphic task on a background designed to be distracting. This background interference procedure required integrative behavior from the subject and demonstrated once again that brain-injured subjects were unable to ignore the distracting quality of the background.

More recently, Campbell, Douglas and Morgenstern (1971) studied perceptual impairments using a field dependence paradigm with hyperactive children. Global responses to the figure-ground properties in this study indicated field dependence while specific responses were evidence of field independence. A similar study done by Witkin, Dyk, Paterson, Goodenough, and Karp (1962) reported that field independent subjects were able to ignore the irrelevant confusing background when separating the figure from the ground. The research done by Campbell et al also demonstrated that hyperactive children tended to be more field dependent and were less able to respond specifically to the figure than normal children.

In other studies, where background interference was not an obvious problem, integrative abilities were measured. Urmer and Wendland (1963) looked at the elements of time and the complexity of figure components as having possible effects on visual perception. Their results suggested that performance on visual organization tasks was related to the complexity and number of components, with brain-injured children performing significantly poorer than normal children. Werner and Thuma in their 1942 study also noted that in addition to difficulty organizing stimuli, brain-injured children lacked the ability to integrate various stimuli into meaningful forms. In this study, real and apparent motion was used to show that although the recognition of real motion with these children is not defective, the brain-injured child was not able to perceive apparent motion. Werner and Thuma demonstrated this same defect again using continuous and discontinuous elements which the children were asked to reproduce graphically. In a visual field, brain-injured children were not able to replicate the discontinuous elements, although they were able to reproduce the continuous elements. Werner and Thuma attributed this to forced responsiveness to the background stimuli which caused the child to miss the motion in the foreground.

More specific to the present study, two visuomotor studies have been done which manipulated the color of the figure-ground relationships to see what facilitative effect, if any, the color manipulation might have on performance. Instead of a physical stimulus being perceived, a projective stimulus was elicited. These studies evolved from Carlson's 1937 research which described a figure-ground reversal phenomenon. In Carlson's study, it was demonstrated that cerebral palsied children, who walked with difficulty under normal circumstances, were able to attain an almost normal gait when wearing white shoes and walking in almost dark. Carlson theorized that the element of darkness reduced the visual acuity, therefore removing extraneous and interfering sensory background stimuli. This allowed the children to focus on the specific and most apparent stimulus, the white shoes. Carlson suggested that excessive irrelevant stimuli appeared to be stressful for the brain-injured child and were a possible explanation for a decrease in performance in such situations. In numerous stressful and anxiety provoking situations, Carlson demonstrated increased motor activity and decreased concentration. Schmidt's 1980 findings support the early work of Carlson. In this study, Schmidt reported that stress demands on concentration and attention, differentiated brain-injured subjects from normal subjects.

Uhlin and Dickinson (1970) also reported that brain-injured (specifically cerebral palsied) children performed better on graphic tasks when the figure-ground properties were reversed thus reducing the visual stimuli. Normal children did not demonstrate this facilitative effect. Figure-ground reversal in this study was accomplished through the use of black paper/white pen and measured on the House-Tree-Person test. The visual stimulus, in this test, was an internal stimulus requiring a graphic response. When the background property was reversed using black pigmented paper, little light was reflected, and the consequent distracting quality of the background was reduced. According to Atkinson, Atkinson, and Hilgard (1983) the black paper absorbs wavelengths while the white pigmented paper reflects equally the stimuli in the environment.

May, in her 1978 study, revised Uhlin and Dickinson's research by utilizing different measurement techniques which were not dependent on the subjective judgment of the viewer. May demonstrated that brain-injured (cerebral palsied) children performed better on the Goodenough-Harris Draw-a-Person test when the figure-ground qualities were reversed from white to black. Again normal children did not demonstrate this facilitative effect when the figure-ground properties were reversed.

In a pilot study conducted at the Virginia Treatment Center for Children, this author hypothesized that the facilitative effects found by Uhlin and Dickinson, and those of May, regarding better performance on a black background would also be apparent with other children considered perceptually impaired. The Bender Gestalt test was used to measure the performance of twenty hyperactive and learning disabled children who ranged in age from 5 to 15 years. No differences were apparent between the black and white backgrounds initially. The data were then regrouped by age (below 10 years and above ten years old), and an ancillary analysis of variance was done. A significant difference was found between the performance of the 5 - 10 aged children on the black background versus their performance on the white background, with fewer errors being made on the black background. There is support in the literature for age as an important variable in visuomotor performance (Patel & Bharucha, 1972; Bogard, 1974; Vurpillot, 1968). Patel and Bharucha for example, reported that regardless of grouping, normal and cerebral palsied children demonstrated fewer errors as age increased, (1972).

In the present study, it was hypothesized that perceptually impaired children, tested and classified as learning disabled, would demonstrate a facilitative effect when the figure-ground properties were reversed, while normal children would not demonstrate this effect. The independent variables in this experiment were color of figure-ground properties, order of treatment, and grouping according to learning disabled or normal.

The dependent variables were TIME, ERRORS and a multi-point WISC score encompassing time and errors.

The specific hypotheses were:

1. Children classified as learning disabled would perform better on a black background than on the white background.

2. Normal children would not demonstrate a performance difference between white or black backgrounds.

3. No performance difference would be demonstrated between normal and learning disabled children on the black background.

4. A performance difference would be demonstrated between normal and learning disabled children on the white background.

METHOD

Subjects

Subjects were twenty-four children between the ages of 9 and 12 years old. Twelve children were selected from a suburban private school and twelve children from a private learning disabilities school. Children were of above-average intelligence (above 100) and were from about the same socioeconomic background. No reward was given to the children. Parents were asked to sign a consent form for their child (See Appendix A).

Apparatus

For this study, a sample maze, a #4 WISC-R maze and a #8 WISC-R maze were printed on black and white paper (See Appendix B, C, D, E). The black and white paper was the same weight and texture. Black and white Wings Over the World, Paint Pens were used by the subjects. The pens were of equal visibility and heaviness. The WISC-R maze was chosen because it would not confound the facilitative effect, if any, of the background by introducing a physical (external) stimulus. An external stimulus would have required first the perceptual act of seeing the stimulus and secondly, the motor response of graphically reproducing it. The WISC-R maze, therefore, required only a motor response to an internal stimulus. The maze also was chosen to reduce the possibility of method variance by using a measure that could accommodate children with fine motor problems, short attention span, and distractibility.

Stopwatches were used to measure performance time on the maze by the experimenter and a research assistant. ERROR scores and WISC scores were assessed by an independent judge after completion of all the mazes.

Procedure

The subjects in each group were tested individually and were given two trials a week apart, one with a black background and one with a white background. The trials were counterbalanced. Subjects were read the following instructions:

Today and next week, we'll be doing a special project with many of the kids in your class. I'm going to work with you for about ten minutes today and again next week. The experimenter then placed a sample maze in front of the subject and demonstrated the correct method on this maze following the guidelines from the WISC-R Manual (Wechsler, 1974). The experimenter then placed the #4 maze in front of the child saying "now see if you can get out of this one yourself. Start here (point) and draw the path you should take to get out without getting stuck. Don't lift your pen from the paper until you have finished. Go ahead."

This procedure was then repeated using the #8 maze. Performance on the #8 maze was timed and scored with the maximum time allowed being 120 seconds. Scoring was based on three different measures. TIME elapsed was recorded, although total time was also recorded regardless of whether it exceeded 120 seconds. Secondly, ERRORS made were recorded. Overlapping maze lines did not constitute an error, but passage into a blind alley, failure to start at the red person in the maze, or failure to complete the maze did constitute one error each. Thirdly, the WISC-R Manual's multi-point system combining TIME and ERROR accounted for the final measurement scale. When the children had completed the second trial they were asked whether or not they played video games frequently (more than three hours a week). A yes or no answer was recorded. The children were debriefed after they had all completed the task following the second trial.

DESIGN AND STATISTICAL ANALYSIS

A three factor Latin square design was employed for simplification and to counterbalance the order of treatment effects (Ferguson, 1981). A multivariate analysis of variance was utlized to analyze the data. Ancillary analyses consisting of t tests, a one-way anova, and two additional manovas were also carried out on the data.

RESULTS

Pearson Correlation for Inter-rater Reliability

Prior to the manova procedure, A Pearson correlation was performed on the dependent measure of time taken concomitantly by the experimenter and the research assistant. The results demonstrated a significant relationship between the times with an inter-rater reliability of $r = .99$ between the two groups of 25 time scores.

Manova

A Bartlett's test was performed to ascertain whether the assumptions of homogeneity of variance had been violated for any of the dependent variables at a .05 alpha level of significance. The Box M test for homogeneity was attempted, but could not be performed. The assumption of equivalent variances was statistically satisfied for the dependent variable described as WISC (on both black and white backgrounds) $F(1,1452) = .524$ $p > .05$ and $F(1,1452) = .382$ $p > .05$, as BTIME (measured on the black background), $F(1,1452) = .406$ $p > .05$, and as BERROR (measured on the black background), $F(1,1452) = .4069$ $p > .05$. Because the variances for the dependent variables of WTIME and WERROR (measurements taken on the white background) were not homogeneous, some caution must be used in interpreting the subsequent results.

Examination of the results of the multivariate analysis using the Wilks' Lambda statistic did not reveal significant differences between the variables COLOR and GROUP, $F(3,9) = .20766$ $p > .05$ as hypothesized. The multivariate analysis using the Wilks' Lambda statistic for COLOR, $F(3,9) = .01043$ $p > .05$ was also nonsignificant, as was that for GROUP $F(3,9) = .76610$ $p > .05$.

Ancillary Tests

A one-way analysis of variance was performed on the variable, VIDEO, to ascertain whether children who frequently played video games would perform better on the dependent measures of TIME, WISC, and ERROR than those who did not play video games. Frequency of play was taken from the subjects' self-reports following the second trial by asking them if they played three or more hours of video games a week. The subjects responded with either a yes or no answer. The results were nonsignificant.

Ancillary t tests were performed to determine whether the variable ORDER (which was not included in the initial analysis) would demonstrate significant differences between the first and second trials. The results of two of the four t tests suggested that there were significant differences due to ORDER when color was held constant. Differences due to ORDER were found for the normal group on the black background on the dependent measure, ERROR, $\underline{t}(1,10) = 2.60$ $\underline{p} < .05$ and on the measure of WISC $\underline{t}$ $(1,10) = -2.60$ $\underline{p} < .05$. Signficant differences were also found for ORDER when the learning disabled group performed on the black background on the dependent measure of ERROR, $\underline{t}(1,10) = 2.32$ $\underline{p} < .05$ and on the WISC measure, $\underline{t}(1,10) = -2.54$ $\underline{p} < .05$. No significant differences were suggested on the dependent measure of TIME for either group. Results of the t tests with both normal and learning disabled groups using the color white as a background color did not suggest order differences.

Two ancillary manovas were then performed to confirm the above findings. Additional Box M and Bartlett's tests for homogeneity of variance were attempted. The Box M was unable to be performed on the data from the first trial, but the Box M was significant for the second trial, $\underline{F}(6,724) = 3.67$ $\underline{p} < .05$. Again, caution must be used in interpreting the subsequent results as the variances were not homogeneous.

These two manovas looked for color differences within one trial (either first or second). No significant differences were reported on the first trial, but the effect of COLOR was significant for the second trial where the Wilks' Lambda was $F(3,8) = .58$ $p < .05$. Univariate results on the second trial were also significant. All dependent variables demonstrated differences due to COLOR with TIME, $F(1,20) = 4.39$ $p < .05$; WISC, $F(1,20) = 14.04$ $p < .05$; and ERROR, $F(1,20) = 9.70$ $p < .05$. The mean time for the normal group on the black background was 33.16 seconds and for the learning disabled group it was 40.03 seconds compared to the means for the white background which were 45.86 seconds and 107.95 seconds respectively. On the WISC measure, the mean on the black background maze was 4.16 for the normal group and 3.3 for the learning disabled group. On the white background, they were 3.0 (normal) and 1.0 (learning disabled). On the ERROR measure the reported means on the black background were .83 (normal) and 1.66 (learning disabled) versus 2.16 (normal) and 5.5 (learning disabled).

DISCUSSION

The results of the analyses varied as to significance and varied also in support of the stated hypotheses. Three of the four hypotheses went unsupported in this study.

The first and second hypotheses asserted that learning disabled children would perform better on a black background and that normal children would not demonstrate a performance difference between white and black backgrounds. The results suggested, however, that there were significant differences due to COLOR for both groups not just the learning disabled group.

Performance as measured by TIME, then, was enhanced by the black background with less time needed for the children to complete the maze. Performance on the dependent measure of WISC was also facilitated when the background color was black with better performance indicated by increased WISC scores. On the dependent variable, ERROR, better performance was indicated by a decrease in the score. The results suggested that both groups made fewer errors on the black background. Even though both groups had a first trial, it would appear as though the differences were not due to practice effects because of the significant differences between white versus black backgrounds in the second trial. While it was originally stated that the black background would facilitate the performance of learning disabled children by reducing conflicting visual stimuli (Atkinson, Atkinson, and Hilgard, 1983), this may well be the case for normal children as well. The black background seemed to allow for a more intense focus on the figure (maze). When the black background was presented during the first trial, the anxiety on the part of the subject regarding the difficulty of the task coupled with the novel quality of the background stimulus, may have prevented optimum performance. This was also evidenced by self-reports during debriefing such as "boy was that a weird paper" or "wow, was I surprised by that paper".

The third hypothesis stated that no performance difference would be demonstrated between groups on the black background. The findings did support this hypothesis as neither group consistently outperformed the other. The hypothesis was predicated on the assumption that the matching of subject populations for IQ and socioeconomic background would diminish group differences in general and that the reduced visual stimuli of the black background would facilitate the performance of learning disabled children. It would appear that that was the case.

Hypothesis four asserted that there would be a difference between groups on the white background. Statistical analysis again did not reveal a difference. Normal and learning disabled children performed at about the same level on the white background. However, there could be other reasons for the lack of difference between the groups on the white background. For example, perhaps high variability caused by a small N prevented accurate differences from becoming apparent. Perhaps the white background is not discriminating, due to the fact that children have had lots of experience with white backgrounds. Finally, learning disabled children are remediated by learning processing skills for a normal world which includes a white background.

This study, by the complexity of its design resulted in difficulties in the analysis. In future research, the design would have to be altered to permit an adequate analysis. For example, a three by two repeated measure design without counterbalancing would be suggested. Each subject would be given two trials of the same color and then compared on a between color, group, and trials analysis. Practice effects would be assessable and informative. In addition, the numerous violations of the assumption of homogeneity of variance, could perhaps be overcome with a larger subject population.

Finally, although this study did not strictly differentiate between background COLOR and GROUP as hypothesized, it did demonstrate the facilitative effect of the black background when it occurred on the second trial for all groups. Anecdotal evidence suggests that this is the right tract. For example, at the Riverside School for learning disabled children, the chalk boards are dark brown. When I inquired about the reason for this, the director (herself learning disabled) replied that "I do not have a reason except I can see things better on this color board." It would appear from past research, anecdotal evidence, and the suggestion of differences due to color within this study, that color may well be valid as a variable in perceptual motor performance.

References

Abercromie, M. L., Visual, perceptual and visuomotor impairment in physically handicapped children. Perceptual Skills, 1964, 18, 583-94.

Atkinson, R. L., Atkinson, R. C., Hilgard, E. R., Introduction to Psychology. New York: Harcourt Brace Jovanovich, 1983.

Batley, S. H. Principles of Perception. New York: Harper & Row, 1958.

Bogard, D. A. Visual perception of static and dynamic two-dimensional objects. Perceptual and Motor Skills, 1974, 38, 395-398.

Bootzin, R. R., Loftus, E. F., Zajonc, R. B. Psychology Today. New York: Random House, 1983.

Bortner, M. & Birch, H. G. Perception and perceptual-motor dissociations in brain-damaged patients. Journal of Nervous and Mental Disease, 1960, 130, 49-53.

Campbell, S., Douglas, V., Morgenstern, G. Cognitive styles in hyperactive children and the effect of methylphenidate. Journal of Child Psychology and Psychiatry, 1971, 12, 55-67.

Canter, A. A background interference procedure to increase sensitivity of the Bender-Gestalt test to organic brain disorder. Journal of Consulting Psychology, 1966, 30, 91-97.

Carlson, E. Infantile cerebral palsy: Its treatment by selective inhibition of sensory stimuli. Annals of International Medicine, 1937, 11, 324-334.

Cobrinik, L. The performance of brain-injured children on hidden figure tasks. American Journal of Psychology, 1959, 72, 566-571.

Dolphin, J. E. & Cruickshank, W. M. The figure-background relationship in children with cerebral palsy. Journal of Clinical Psychology, 1951, 7, 228-231.

Ferguson, G. A. Statistical Analysis in Psychology and Education. New York; McGraw-Hill, 1981.

Ferguson, J. & Harris, S. Technique for evaluating stability of figures in a figure-ground pattern. Perceptual and Motor Skills, 19744, 45, 671-674.

Franken, R. Picture-recognition memory as a function of picture organization and age. Perceptual and Motor Skills, 1977, 44, 1151-1154.

Fulkerson, S. & Freeman, W. Perceptual-motor deficiency in autistic children. Perceptual and Motor Skills, 1980, 50, 332-336.

Gollin, E. A. Tactual form discrimination: Developmental differences in the effects of training under conditions spatial interference. Journal of Psychology, 1961, 51, 131-140.

Gregory, R. L. The Intelligent Eye, Great Britian: McGraw-Hill, 1970.

May, D. C. Effects of color reversal of figure and ground drawing materials on drawing performance. Exceptional Children, 1978, 44, 154.

Owen, F. W., Adams, P. A., Forrest, T., Stoltz, L. M. & Fisher, S. Learning disorders in children: Sibling studies. Monographs of the Society for Research in Child Development, 1971, 36.

Patel, S. & Bharucha, E. P. The Bender Gestalt test as a measure of perceptual and visuomotor defects in cerebral palsied children. Developmental Medicine and Child Neurology, 1972, 14, 156-160.

Ritter, D. & Sabatino, D. The effects of method of measurement upon children's performance on visual perceptual tasks. Journal of School Psychology, 1974, 12, 296-304.

Ritter, D. & Ysseldyke, J. E. Convergent and discriminate validation of trait of visual figure-ground perception. Journal of Learning Disabilities, 1976, 9, 319-325.

Rock, I. An Introduction to Perception. New York: MacMillan, 1975.

Rohr, M. E. & Ayers, J. B. Problems encountered in development of instrumentation to measure figure-ground perception among young children. Perceptual and Motor Skills, 1976, 43, 1221-1222.

Rose, S., Birke, M., Katz, P. A., Rossman, E. Visual following in newforns: role of figure-ground contrast and configuational detail. Perceptual and Motor Skills, 1977, 45, 515-522.

Ross, A. O. Psychological Aspects of Learning Disabilities and Reading Disorders. New York: McGraw-Hill, 1976.

Ross, D. M. & Ross, S. A. _Hyperactivity: Research, Theory and Action_. New York: John Wiley & Sons, 1976.

Rubin, S. A re-evaluation of figure-ground pathology in brain-damaged children. _American Journal of Mental Deficiencies_, 1969, _76_, 111-115.

Ruggieri, V., Ceridono, D., Cei, A. & Bergerone, C. Figure-background perception and cerebral dominance: Hypothesized integrated process of hemispheric specialization. _Perceptual and Motor Skills_, 1982, _54_, 435-440.

Schmidt, H. Psychology in the German Democratic Republic. _Annual Review of Psychology_, 1980, _31_, 195-209.

Uhlin, D. & Dickson, J. The effect of figure-ground reversal in H-T-P drawings of spastic cerebral palsied children. _Journal of Clinical Psychology_, 1970, _26_, 87-88.

Urmer, A. H. & Wendland, L. V. The organization and retention of geometric designs by brain-damaged individuals. _Journal of General Psychology_, 1963, _68_, 251-254.

Vurpillot, E. The development of scanning strategies and their relation to visual differentiation. _Journal of Experimental and Child Psychology_, 1968, _6_, 632-650.

Wechsler, D. _Manual for the Wechsler Intelligence Scale for Children-revised_. New York: The Psychological Corporation, 1974.

Werner, H. & Strauss, A. A. Pathology of figure-background relation in the child. _Journal of Abnormal Social Psychology_, 1941, _36_, 236-248.

Werner, H., & Thuma, B. D. Critical flicker-frequency in children with brain injury. American Journal of Psychology, 1942, 55, 394-399.

Werner, H. & Thuma, B. D. A deficiency in the perception of apparent motion in children with brain injury. American Journal of Psychology, 1942, 55, 58-67.

Witkin, H. A., Dyk, R. B., Paterson, H. G., Goodenough, D. R. & Karp, S. A. Psychological Differentiation. New York: John Wiley & Sons, 1962.

Appendix A

Consent Form

Dear Parents:

For my Master's thesis at the University of Richmond, I am studying figure-ground reversals in graphic exercises with children. I will be doing two exercises with your children in the coming weeks. These exercises will involve solving some mazes. The time should not exceed 20 minutes on each occasion.

In order to accomplish this, I need your consent. If at any time prior to or during the experiment you do not wish your child to participate, you may withdraw your permission.

Thank you for your assistance.

Sincerely,

Susan R. Knaysi

____

Child's Name

____

Parent's Signature