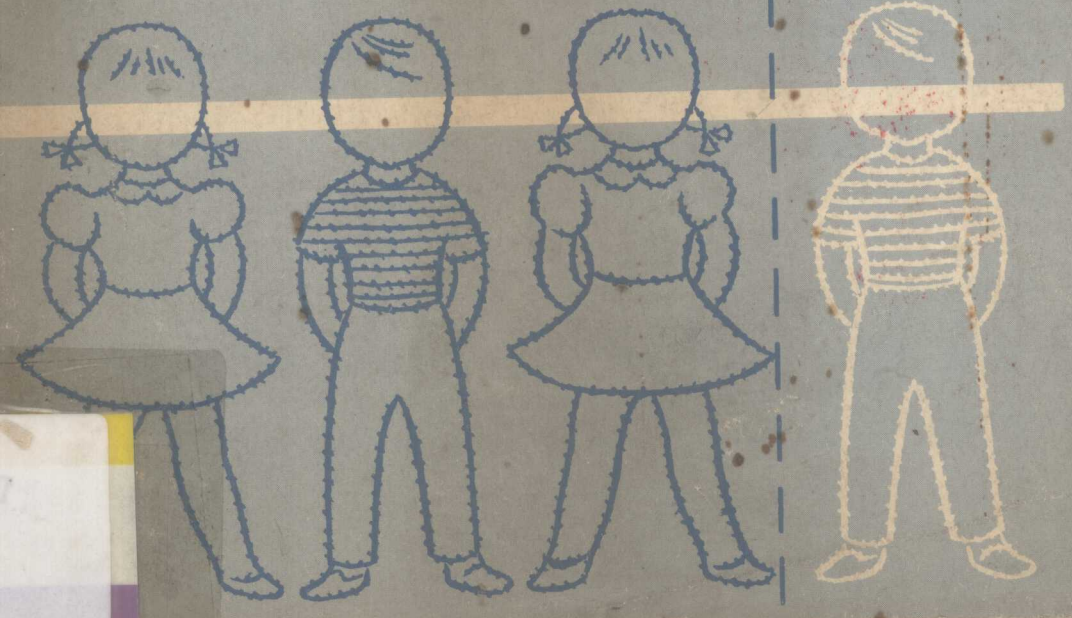
vision screening of the preschool child



vision screening of the preschool child

REPORT OF A STUDY

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ERRATA

Page 6. Picture caption should read "Allen Picture Cards."

Page 7. Picture caption should read "Osterberg Chart."

Page 15. Line 10, right column, should read "project at 962 Parker Street."

tables

figures

I. INTRODUCTION

This study was undertaken after an extensive review of the available literature on preschool vision. This is a body of literature which is often vague and inconsistent and leaves many questions unanswered. The present study is descriptive and limited to a small number of subjects. In order to define the present work within the literature and within the total subject of preschool vision screening, some basic questions are posed and discussed below.

What are the vision problems of preschool children?

The vision problem of the preschool child which has been the major impetus to the development of screening procedures is amblyopia ex anopsia (unilateral amblyopia of disuse, "lazy eye blindness"). This is considered a problem which cannot await later detection and treatment. Refractive errors and heterophorias in this age group have not been well-defined and generally screening programs have only aimed indirectly at detection of these problems by detecting their consequences like low vision.[1-9]

Even less well-defined are general developmental problems involving vision—problems which might bear some direct relationship to later difficulty, physical and educational. There is growing interest in normal visual development and the consequences of deviations from this normal. The Gesell Institute of Child Development has given considerable attention to this subject, and work in this area is being pursued by some optometrists, educators, and psychologists.[10-12] Medical and public health practitioners have not yet directed particular attention to this area in an organized way.

What are the vision tests available for preschool children which might be adapted for screening purposes?

Most of the vision tests recommended for children aged 5 years and younger are tests of distant visual acuity. These tests detect low vision, and the child is then given a professional examination to determine diagnosis and treatment.

Vision tests available for infants are based upon the elicitation of reflexes which, by their presence, indicate that visual pathways are intact.[13-18] The newborn is not blind if he demonstrates either ***pupillary reaction*** to light, the constriction of the pupil when light is shown into either eye, or ***vestibular reaction,*** the slow following of the eyes in the direction the infant is turned. The visual acuity of the newborn has been estimated by production of ***opticokinetic nystagmus,*** the response to seeing a moving series of lines. After 1 month, the presence of vision may be demonstrated by ***optically elicited movement,*** the movement of the eyes toward a peripherally appearing object. Experimentally, devices based on this reflex and using graded stimuli have been used to measure the vision present. These objective vision tests, however, seem to underestimate vision when the results are compared to subjective tests.

Visual acuity of the child from 10 months to 2 years has been estimated with various subjective tests such as *Worth's marble balls* [19, 20] and *Bock's Candy Bead Test.*[21-24] Ambulatory infants and toddlers are expected to retrieve small, standard-sized objects from varying distance using each eye in turn.

Communicative preschool children are usually requested to give a subjective response, to indicate in some way that the test object is perceived. In picture tests, the child names or shows a similar picture or object to the examiners [25-36]. In direction tests, the child names or indicates with his hand the direction of the test object [37-40]. Several types of visual acuity tests were included in this study, and these will be described in detail in Section II.

Tests of eye muscle balance are those used for adults; [41-43] techniques of administration and superficial apparatus changes make these tests more suitable for children.

Vision test batteries for preschool children have been established to detect abnormalities of vision as they relate to general development.[12] Several of these functionally oriented tests, e.g. tests of performance and eye dominance, were included in this study and again will be described later.

Whatever vision tests are suitable for screening must be fairly nontechnical. Subjective vision tests, however, are also part of the professional examination; they cannot be replaced by the cycloplegic examination which does not serve the same purpose of indicating what use the child is making of his eyes.

Have the available vision tests been used for testing large numbers of children and adapted for screening purposes?

Several of the visual acuity tests, e.g. "Stycar", Allen pictures,[25-27] and Osterberg chart,[28] have been used over a period of years for testing many children. The Snellen E test [38-40] is the only test so far which has been standardized for use by nonprofessional personnel as a screening tool.[44] Most acuity tests have never been used in controlled settings by impartial observers.

Other vision tests are administered to large groups of children, but not necessarily in the context of an easily reproduced screening program. For instance, British orthoptists give routine cover tests to children entering school; [45] there are not enough professional orthoptists in this country to establish a similar program.

The functional vision tests [10, 12] have been given to many children as individuals on an experimental basis. These have not been adapted for screening.

How reliable are these tests when administered at different times, by different personnel, in different places?

Carefully controlled studies of the reliability of the available preschool vision tests have not been done. The reliability of school vision tests has been investigated more thoroughly,[46] but this information cannot be generalized.

In most screening programs a certain lack of reproducibility is expected and children are retested under new circumstances before referrals are made.

How valid are the results of the screening tests when compared to professional findings on the same child?

Any screening test should bear some definite relationship to a more refined procedure from which it is derived. The referrals from vision screening tests should, for the most part, be those children whom professional eye doctors would select for specialized treatment if they had examined all the children screened. This is a particular problem in vision testing where the number of concerned professions and the variation within each profession make the definition of a correct referral very difficult. This variation in standards of referral was clearly demonstrated in the study by Lancaster *et al.*[47] Variation in the findings of even a single professional examiner is demonstrated by Sloane.[48] In the extreme situation, one person might be considered a needless referral by one professional consultant, and a correct referral by another. When standards are set arbitrarily for the purposes of a screening program, the validity of the screening procedures can be de-

termined. This determination has not been made completely for a large population of preschool children. In general, clinical follow-up of referrals has been inadequate, and the number of under-referrals has not been determined.

What is the expenditure of time and money involved in screening preschool children?

There is no definite answer to this question to be found in the literature. Only when there is agreement about screening procedures, can the expense incurred by such programs be determined. Then, screening expenditure will have to be justified by proven vision conservation. This will be the subject of further investigation.

At what age are preschool vision tests applicable?

The vast majority of authors state that age 3 years is the optimal time to screen for amblyopia. One reason offered is that 3 years is when retinal reflexes are established and that disuse at this age frequently precedes unilateral amblyopia.[49] Another pragmatic reason to test at age 3 is because subjective tests first become possible at this time. However, the most frequently employed, and the best standardized "preschool test", the illiterate E, is frequently not successful before age 4 years.[50]

Variations on the E continue to appear as "new tests", but the basic principle, a subjective response to direction, is unchanged and young 3-year-olds are still nontestable. The Snellen E is an excellent acuity test for an older child or illiterate adult, but may be too abstract for the young child. Pictures of toy animals, on the other hand, are not too interesting to adults and are very appealing to preschool children.

Age-appropriateness of vision tests warrants some attention. If age is considered an important factor in prognosis, then perhaps children 3 years old and even younger should be screened; this would necessitate the development and standardization of some testing method for this age group. If children 4 years old can be as successfully treated as younger children, then there is no need to develop new methods for testing visual acuity. Since there seems to be general agreement that prognosis is related to age and children should be tested as young as possible, the subjects chosen for this study were around 3 years old.

The aims of the present study were:

(1) To test several visual functions with available procedures.

(2) To clarify the abilities and preferences of young preschool children with respect to these procedures.

(3) To detect vision problems in the population studied.

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II. MATERIALS AND METHODS: background and description

Tests

Visual acuity—"Stycar"

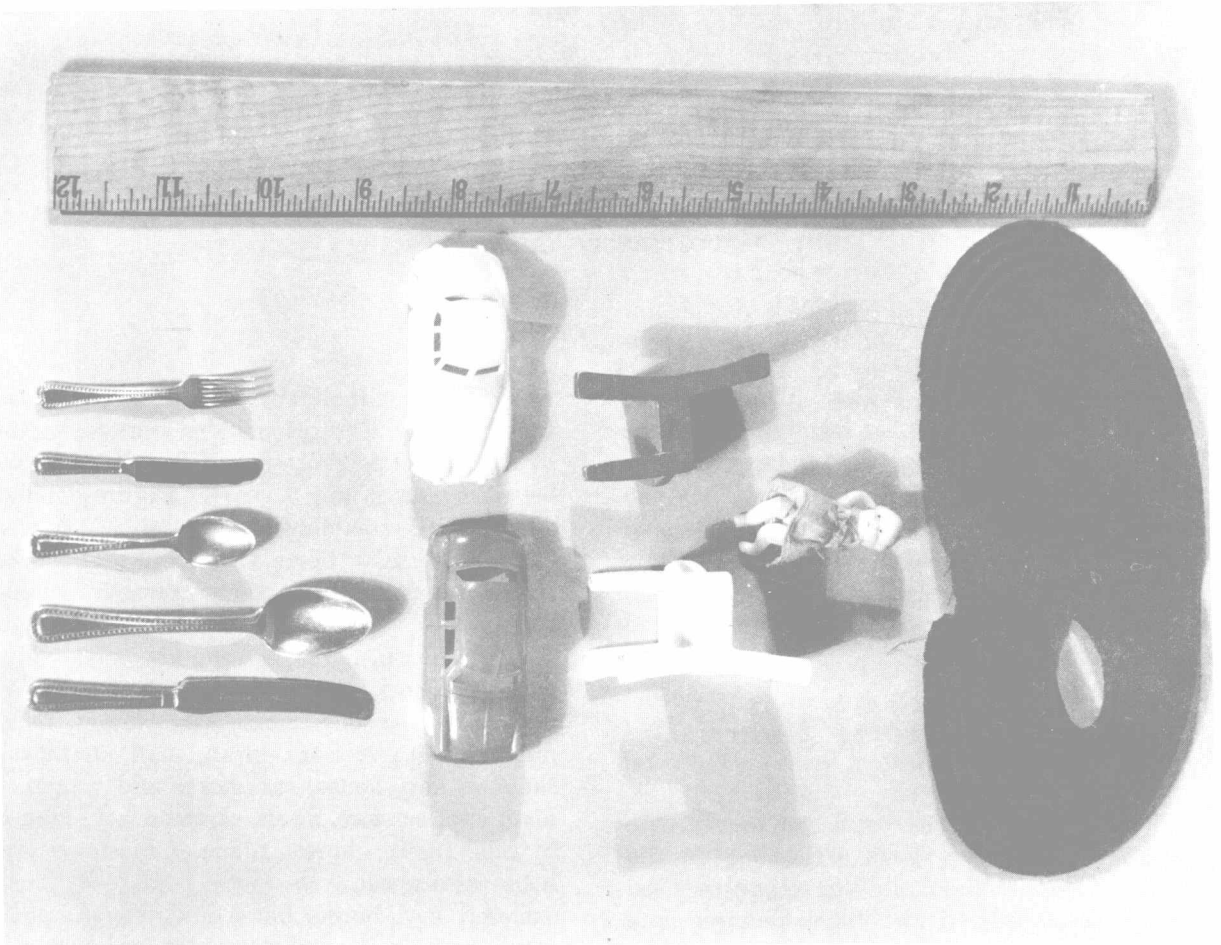
Screening Tests for Young Children and Retardates or "Stycar" [29-32] is a set of acuity tests designed by Sheridan (a medical officer) and Pugmire (an ophthalmologist), which are not well known in this country, but have been used successfully in Britain for almost 25 years. These tests were designed, unlike previous tests, with facts of normal child development in mind. In addition to high validity for visual acuity, they were to provide information about the child's meaningful visual abilities, those involved in comprehending the environment. The tests were to be applied to young children or handicapped children including the partially sighted, deaf, cerebral palsied and mentally handicapped.

Matching letter test. For the older preschool child (3 years on), a ***letter test*** is used; the child matches the letter shown to him with the same letter on a key card he holds in his lap or reproduces the letter seen by drawing it. In this study, children were sometimes asked to cover the letters with pennies instead of pointing; this technique was used in a Lotto acuity test in France,[33] which is basically like the Stycar letter test. Single letters are presented to 3–5 year olds; a letter chart is used for children more than 5 years old. The youngest group, about 36–48 months, match 5 letters (O, X, V, T, H), presumably easily recognized because of shapes that can be drawn and are frequently used in mass media. When five letters are used, there are five possible responses, or four if V and X are confused; thus the same number of choices is available as with the E when direction sense is well developed. Older children 5–9 years match seven letters (A and U added) or nine letters (C and L added).

Near letter test. A near vision test (12–14 inches) is included for those children who may have defects at near but test normally on distant tests, and for those whose maturity is not great enough to conduct a test at any distance. Acuity is graded from N36 to N6, about equivalent to type sizes 36 point to 6 point.

Distant letter test. This test is administered at 20 feet; with the younger child the distance is established without loss of contact by testing in a mirror placed 10 feet away, permitting examiner to sit with the child. Acuity is graded from 6/36 to 6/4.

Miniature toy test. The Miniature Toy Test is used for children between 20 and 36 months. The child receives a set of 10 toys consisting of familiar objects and is asked to name them if he can; these include a car (2-inch, colored plastic), plane (2-inch, metal), doll (2-inch, plastic with colored cotton dress), chair



MINIATURE TOYS AND MASK OCCLUDER

(2 x 1 inch, colored wood), knife (3½-inch, metal), fork (3½-inch, prongs 8/10 inch, metal), spoon (3½-inch, bowl 1 x ¾ inch, metal), small knife (2¼-inch, metal), smaller fork (2¼-inch, 4 prongs 1/16 inch apart, metal), smaller spoon 2¼ inch, ¾ x ½ inch bowl, metal).*

He then must match or name his toys to duplicates shown him by the examiner on a dull black background 10 feet away. This is done first with both eyes, then with each eye. There is no numerical Snellen equivalent determined for this test. It is, rather, a comparison of the two eyes. The best acuity detectable is the ability to distinguish the small fork from the small spoon, and this is said to approximate 6/6. A comparable near test for these young children is their ability to detect small threads and toys close at hand (about 20 inches).

In this study, black cloth Hallowe'en masks were used as occluders. An eye on each was covered with adhesive tape and black paper to serve as an occluder for one eye while the other peeked through a 1 x 1½-inch hole. There was no consistent occlusion of one eye first, but the order of occlusion was noted.

The Stycar Vision Test is distributed by the National Foundation for Educational Re-

*These measurements are based on the set of toys used in this study, and differ slightly from those stated in the test manual.

OSTERBERG CHART

search in England and Wales. The tests were *not* originally designed for large scale routine screening, but rather they were to be given by a medical examiner or psychologist.* They can and have been easily given by nonprofessional personnel, but in such situations the authors advise over-referring (any doubtful cases) and frequent checks on the testers by the concerned medical officer.

Visual acuity—Naming pictures and toys

Picture tests. Several commonly employed visual acuity tests are based on the ability of the preschool child to recognize somewhat schematically drawn black pictures on a white background. These tests depend for their success upon the child's verbal ability; recognition is indicated by an appropriate and consistently used name. Many pictures are things one might not expect a child to recognize because of lack of experience with similar things; others seem to be poor reproductions of the actual object.

In this study, the children were asked to identify pictures in three different picture series, usually only at reading distance and with both eyes open: The ***Osterberg chart*** [28] (4th and 5th editions made by Nyrop and Maag, Copenhagen, Denmark) consists of pictures inspired by children's drawings, drawn in black on a white background to subtend a visual angle of one minute at appropriate distance, and found recognizable with increasing distance, are used for his chart. Figures included were recognized by at least 80 percent of Danish children tested between ages 2 and 5 years. Figures include swan (6/60), steamboat and house (6/36), man, car, and horse, or horse, train, and skeleton key (6/24); skeleton key, horse and wagon, scissors and boat or swan, steamboat, horse and wagon (6/18); house, horse and wagon, man, plane, Christmas tree, man on bicycle—or man on bicycle, Christmas tree, horse and wagon, house, man (6/12); scissors, swan, man on bicycle, skeleton key, house, car, horse and wagon, or man, cup, scissors, swan, skeleton key, man on bicycle (6/9); horse, plane, Christmas tree, house, steamboat, scissors and boat (6/6); man, skeleton key, house, horse and wagon, plane, swan, scissors, car and steamboat, or house, scissors, cup, Christmas tree, horse and wagon, skeleton key and man (6/4). The Standard Wall Chart was shown and also a photographic reduction (1 x 1½-inches) of this chart. This small chart, obtained from Dr. Trygve Gundersen, is a near vision test; the figures are comparable in size to the standard Jaegar types.

The ***Allen picture cards*** [25] are original drawings borrowed from Massachusetts Eye & Ear Infirmary Ocular Motility Clinic. These are bound in a booklet, unlike the single cards of the commercially produced test, but could be presented singly. Pictures included were: teddy bear, plant, flower, clown, birthday cake, Xmas tree, steamboat, telephone, and horse with rider. The test now is available from Ophthalmix, LaGrange, Ill.; it includes a car, and the plant, flower, and clown have been omitted. Cards measure 4 x 4 inches and pictures are within an area of 1 square inch, approximately

*The test kit was obtained through Dr. Lenin Baler of the Harvard School of Public Health, who provided supervision in the use of "Stycar" materials.

ALLEN PICTURE CARDS

the size which subtends a 1-minute arc when viewed at 30 feet.

The *American Optical Kindergarten Chart (1946)* consists of pictures which include a sailboat (20/200); circle and cross (20/100); flag, star, and heart (20/70); heart, cross, and sailboat (20/50); star, moon, circle, and flag (20/40); circle, hand, star, cup, cross (20/30); star, cross, circle, heart, flag (20/20); and moon, heart, cup, star, and cross (20/10).

Toys. Children were also asked to name some three dimensional toys, from a dime store, which were representations of the same objects as those in the picture tests, e.g. house, tree, horse, telephone, teddy bear, scissors, man. The purpose of this was to see if recognition could be enhanced by a more realistic representation than that in the picture. Recognition could be indicated verbally or by pantomime play with the toys. This test was included to to see if verbal ability might be significantly improved by this change from picture to toy targets, and if those children who did not respond verbally might indicate recognition by play.

Visual acuity—Indicating directions

The most widely used preschool vision tests depend upon the child's perception and imitation of direction as a response; if the child responds correctly, it is assumed that he not only saw the stimulus, but he interpreted it as well. With such tests, if the response is incorrect, it is not known if the child failed to see the stimulus or failed to interpret or communicate what he did actually see. There has been much work in child development and psychology [51-64] based upon conceptualization of the directionality of figures. The findings in this work point to a tenuous grasp of the direction concept in the preschool child. It is common even for first graders in school to demonstrate some right-left confusion as evidenced by frequent reversals, e.g. letters or words like "b" and "d", "was" and "saw". Young children who have difficulty recognizing abstract forms might appear more visually acute when familiar concrete forms are used.

In contradistinction to these findings of psychologists and educators, the direction-based tests have remained the tests of choice for preschool children. The Snellen E test has been standardized and is used frequently by the National Society for the Prevention of Blindness.[44-50] Perhaps because mainly older preschool children, 4 and 5 years old, have been included in these studies, and probably because of a concretization of the E figure into a table, these programs have met with some success.

Drawing. Children were asked to copy lines, geometric forms and letters after demonstrations were drawn in front of them. This was done on a pad of paper with crayons. The hand used and manner of holding the crayon were noted. Lines were vertical, horizontal, two obliques, a cross. Forms were a circle, triangle, diamond, and square. Letters were an E (in one or more directions), C, U, and D.

Hand and "E". An attempt was made to teach the Sjogren hand [39] and the Snellen E,[40] in order to elucidate the learning procedure in-

volved and the comprehension attained. A 20/40 size hand card, and then a 20/20 E card were shown at conversation distance, and the child was asked to match his hand to it as it appeared in different directions. Usually no attempt was made to test actual acuity by doing this at 20 feet and occluding each eye; children who learned successfully were asked to repeat the test after stepping back a few paces. The E card was also matched by a cutout E figure (3 x 3 inches) made of white cardboard, and held by the child. Notations were made of the way the child responded and the duration and amount of interest was estimated.

Visual acuity—Eliciting opticokinetic nystagmus (OKN)

Opticokinetic nystagmus (OKN) is a nystagmus which can be used to objectively measure visual acuity; it is produced when a simple repetitive moving pattern is seen by the eyes.[66] The stimulus is usually vertical lines (stripes) moving horizontally; the eyes follow a line (slow phase), then jerk back to fixate a succeeding line (rapid phase). Also known as "train nystagmus", this is the response of the eyes to multiple passing telephone poles. Vertical opticokinetic nystagmus, the response to a horizontal pattern moving vertically, is more difficult to elicit. This nystagmus differs from vestibular nystagmus in that it continues as long as the eliciting stimulus is present. The eye must see the stimulus in order for the nystagmus to be produced, and if one eye perceives the stimulus, both eyes will show the nystagmus. The stimulus must be presented to one eye at a time or to a visual field not shared by the two eyes in order to be sure that each eye sees. As the basis of a test of visual acuity,[67] more acuity vision is measured when lines and spaces are narrower and the distance from the subject is greater. A technique to produce nystagmus has been used to test newborn infants for blindness and to determine how well normal newborns see.[14] A more refined test has been used for adult acuity testing, but its use has been limited to detection of malingerers and hysterical blindness; subjective tests are more accurate than this when subjects are cooperative.[67] Precise measurements of nystagmus with recording electrodes for the extraocular muscles has been used as a test of ocular dominance.[68]

There is at present no workable objective measure of visual acuity for preschool children. Such a test might answer some of the problems of administration and cooperation with these young subjects. Possibilities for an opticokinetic nystagmus test with preschool children have never been fully investigated, and this will be the subject of a further study.

In this study the nystagmus is elicited by pulling a striped tape, e.g. a tape measure, in front of the subject's eyes. This simple technique was used because the purpose of including this test was only to see if children this age would be interested and respond with nystagmus; there was no effort made at that time to actually measure acuity. No attempt was made to occlude one eye during the test. A 5-foot tape measure, white plastic ribbon with markings in black separated by $\frac{1}{16}$ inch, was used. The child was instructed to look at the examiner; the rolled tape was then held at eye level off to the left side of the child's face and the end drawn across in front of the eyes from left to right. This was done quickly and frequently with much verbalization, "Look at it, look at it, etc." The reverse side of the tape with a light green background was presented to some children as well. Notation was made of the parallelism of response between the eyes and any difference in response between the two directions in which the stimulus was presented.

Muscle balance

Tests of extraocular muscle coordination between the eyes themselves and the eyes and hands were included in an attempt to detect external pathology, latent strabismus, nystagmus, immature eye-hand coordination, and subclinical cerebral palsy.

Nearpoint of convergence and penlight following. Following a penlight as it moves out to and in from the peripheral visual fields gave an indication of child's attention as well as an opportunity to find field defects. Nearpoint of convergence (N.P.C.) was determined with the light, and the distance and deviating eye at the near point were recorded. Touching the

light at several distances and threading it with the rings of the toy scissors gave an indication of hand coordination, and behavior on these tests could be compared to expected behavior based on many such examinations by Apell and Lowry.[12]

A Hirshberg test or "corneal reflection" test, the observation of the relative positions of the corneal reflections was done incidentally during observation of the extraocular movements. Relative eccentricity of one reflection indicates a possible deviation of that eye. This test was not systematically used as an absolute indication of muscle imbalance because of the view that disparity between the position of corneal reflections may frequently be a normal finding. Any positive finding, however, was considered when recommending followup for a particular child.

Cover test. A cover test, the most frequently used and criticized test for eye muscle balance, was attempted. The examiner's hand was used as an occluder and the lighted penlight, 12 inches away, was the focus. A rough distance cover test was done without a standardized target; the child was directed to look at some small object outside the window approximately 20 feet away.

Red glass test. The red glass test for diplopia was attempted. A 2 x 2 inch red plastic square was placed before each eye in turn; the penlight held about 16 inches away was the target. The child was asked how many lights he saw and what color they were. "One red light" indicates fusion of images is occurring; "two lights", one white and one red, indicates some degree of muscular imbalance is present.

Stereoscope. A hand stereoscope equipped with three cards was used to determine reactions to such an instrument and detect failure of fusion. The cards used were:

Bird and cage (colored, Kroll A1).

Pumpkin with one eye on each side (Hale O2).

Jumping dog and lion holding a hoop (Kroll A3).

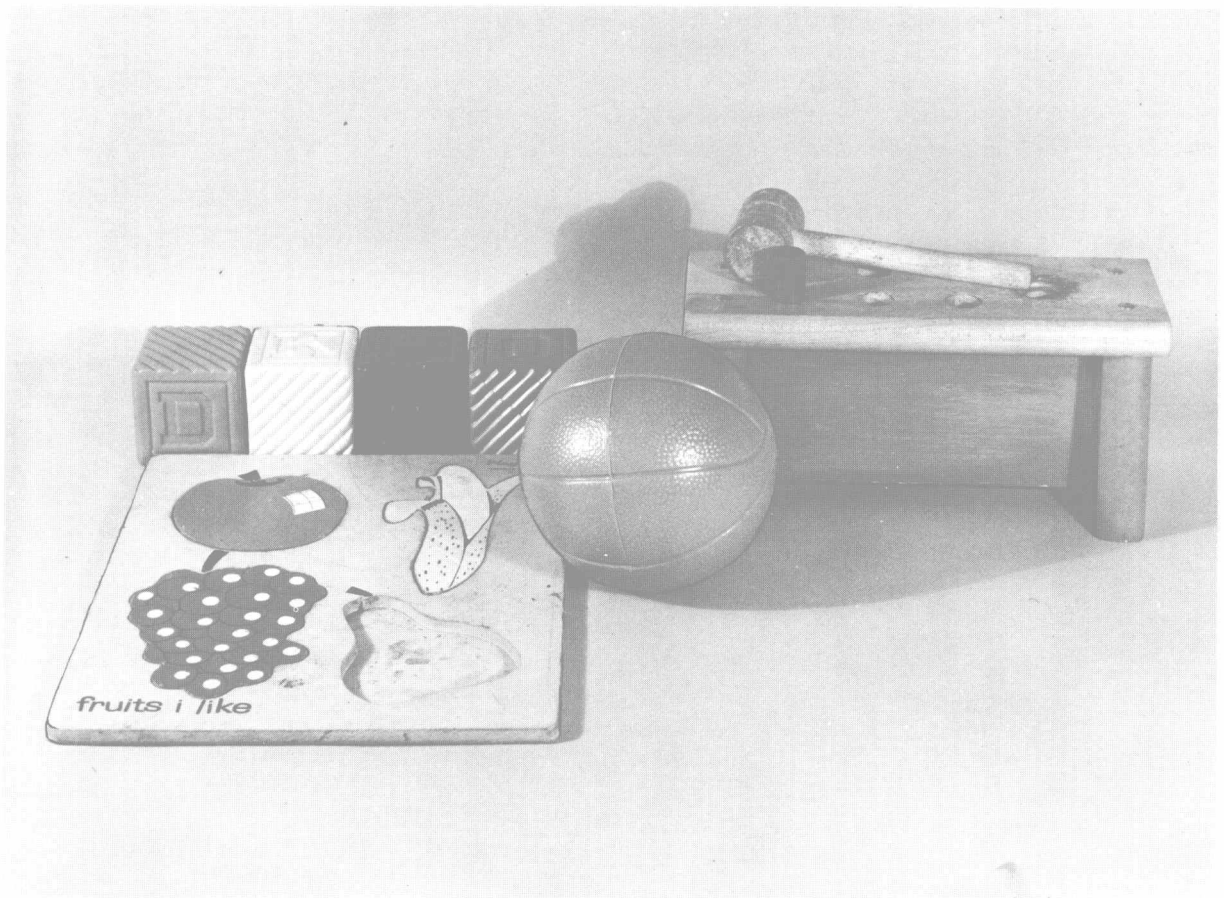
The cards were presented at a position 5 cm. from the lenses and moved out along the 15 cm. length when cooperation permitted.

Performance

Tasks which are appealing to preschool children as familiar games give an indication of how well they function visually in practical terms. All of the performance tests used were similar to tests in the child development and optometric literature,[10-12] but none was exactly the same. The tasks were comparable and the tools, if anything, easier than those used by Gesell. It is behavior in approaching these tasks which assumes comparable patterns rather than performance on the tasks themselves. This behavior comparison permits an estimation of maturity of the children tested. It was anticipated that these children would be performance oriented and might respond favorably to this type of task.

Blocks. Six colored plastic cubes (three red, one blue, one green, one yellow, 2½ inches on a side) were used. The child was asked to build a tower; this was demonstrated if there seemed to be poor comprehension. The number of blocks piled, the hand used to pile, and the stance of the child were noted. A bridge of three blocks was demonstrated and, with the demonstration intact, the child was asked to reproduce this with the other three blocks. A train (five horizontal blocks, and an engine) was demonstrated, and after the blocks were knocked askew, the child was asked to build such a train.

Peg bench. A commercial toy designed for 2 years and older, was purchased to serve as a test requiring coordinated aim, judgment of depth and awareness of a third dimension. The toy is composed of a red and neutral colored bench measuring 10 x 4 x 5 inches, 12 colored pegs (2 each of red, blue, purple, yellow, orange, and green) cylinders measuring 1⅜ inches long and ⅝ inches diameter, and a hammer with 5-inch handle ½ inch diameter, and a head 2¾ x 1½ inches deep. Six of the pegs sit in ½ inch deep holes on top of the bench, and a seventh



PERFORMANCE TESTS

hole can hold up to three pegs; when a fourth is hammered in this hole, a peg is ejected from the side of the bench. This method of hammer pegs "through the tunnel" was demonstrated to each child who was then permitted free play with the toy. The approach to the game, focus of interest, coordination and aim were noted. Particular note was taken of the development of an awareness of different depth holes and activity like probing holes during the game. Pegs also served as a color test (see below).

Some children were asked to play this game while wearing occluder masks; these were the same Hallowe'en masks as used in the toy test above. The purpose of this was to see if aim was significantly different with one eye alone, and whether there was any consistent deviation to either side. This idea of marked and consistent deviation from a central line was used in the next two performance tasks as well, line walking and ball rolling. It was thought that significant eccentric fixation, i.e. extramacular fixation might be suspected by such simple performance tasks. Actual determination of fixation necessitates a specialized ophthalmoscope-like instrument, the Visuskop.[69-71]

Walking lines. Walking lines was attempted in some children as a measure of the general eye-foot coordination, and a possible means of detecting eccentric fixation. With both eyes open, and then with each eye occluded in turn, the child was asked to walk a straight

line made by the tiles on the living room floor when these were available. This was demonstrated as a heel-to-toe walk which might also detect ataxia.

Ball playing. Ball playing had several purposes. A bright orange rubber ball with a 7-inch diameter was used. General coordination and aim were noted; the manner of spontaneous throwing and catching were compared to patterns expected at the age of the child. The child was asked to roll the ball straight looking with both eyes, and then with each eye occluded. While each eye was occluded, the ball was rolled toward the child's side, and he was asked to fetch it. Observing the child's behavior in searching for this very large object gave an impression to compare with his behavior with two eyes open. Thus it was possible to judge whether he was normally binocular, i.e., the child who functioned well enough and equally with each eye alone but not as well as he did with two. The functionally monocular child could be detected by good function equivalent to that shown with both eyes in one eye and distinctly poorer function in the second eye.

Puzzle. A commercial puzzle graded "18 months on" was used in lieu of a geometric form board. It is wood and consists of a chartreuse background board and four separate pieces shaped to resemble types of fruit: purple grapes, red apple, orange pear, and yellow banana. This was chosen over a form board for its concretely represented form variation and its appeal as well as for its availability. The puzzle was taken apart and put together once in front of the child, and he was then asked to do the same; his motions were noted and timed. Reinstruction with verbal description was given when necessary, usually after 3 minutes of trial and error. Ability to match forms, distinguish landmarks of forms, and the right from the wrong side of a puzzle piece were noted.

Dominance

Interest in eye dominance and its relation to handedness and hemispheric dominance, and the correlation of these factors with reading disability, speech disorders, visual acuity, have been the subject of much discussion and much controversy periodically. Numerous more or less complicated tests have been devised, and the literature is full of testimonies to the significance of one or more tests, and also to the worthlessness of almost all of them.[72-93]

The tests used in this study are subject to much of this criticism. They were performed to determine at what age dominance started to be established, and what the fact of having a dominant side meant. The eye dominance tests were three, all simple sighting tests: (1) an $8\frac{1}{2} \times 11$ inch gray cardboard with a 1 inch center hole was handed to the child who was asked to peek through the hole while holding the cardboard with both hands; (2) a cardboard paper-towelling tube, with a $1\frac{1}{2}$-inch hole, was used to sight while held in both hands, the apparently dominant and the apparently nondominant hand; (3) a lorgnette-type occluder,[25] with a 1 inch hole, made of black paper was used to sight while held in each hand. The influence of eye dominance on effective occlusion especially with the lorgnette has not been determined.

Handedness, first of all, was not determined in any standardized manner; rather it was inferred from the child's use of one hand to write, indicate directions, hammer, and play ball, to the exclusion of the other hand, and, on the mother's statement made with certainty, that the child strongly preferred to use one hand for eating. When there was any use of the second hand for these activities, and when the mother expressed any doubt, handedness was judged "not established." Children who were ambidextrous with good dexterity, however, were judged to be left-handed, particularly when they seemed clearly left-eyed and there was a family history of left-handedness since left-handed people often tend to be ambidextrous. Secondly, none of the factors entering into the judgment of handedness was influenced by eyedness, i.e. the child was never totally blindfolded (except perhaps those severely amblyopic children who, with the good eye occluded, were functionally blind). The influence of handedness on eyedness was accounted for by notation of which hand was

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used while sighting.

Foot dominance was determined in some children by consistent use of one foot kicking a ball.

Color

Color awareness was observed in an attempt to judge when this becomes a factor in the child's dealings with his environment both for normal learning and growing and for design of vision tests. Children were asked to find another peg the same color as one the examiner picked up—usually red, yellow, or blue. If this was done successfully, the child was asked to name colors. This was done during the peg game and/or the block building. Ishihara series [94] were not used because they require that the subject identify a figure usually a number, within a mass of colored dots, and this task was considered beyond the capability of these children.

Questionnaire

Questions asked the mother concerned the child's development, his preference for current activities and his current abilities, past history of general medical illness, symptoms and signs suggestive of visual disorders. This afforded an opportunity to learn about the child himself past and present and to compare him to his peers. But it also gave some indication of the mother's awareness of the child, her concerns about his health, and her willingness to seek preventive medical care. It served to place any visual findings in the total framework of the child's medical and social background.