CHILDREN'S NORMS FOR THE
VISUAL RETENTION TEST: MULTIPLE CHOICE FORM I

A Dissertation
Presented to
the Faculty of the Department of Psychology
University of Houston

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

By
Robert Monte Bobele
May, 1975

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ABSTRACT

Norms were developed for children on the Visual Retention Test: Multiple Choice Form I (VRT-MC). The VRT-MC is a 16-item multiple-choice test consisting of complex geometric figures. Two administrations were used: memory and form discrimination. Standardization sample was composed of 412 children aged 5-3 to 11-0. Children were tested in intact classrooms using slide projections of the VRT-MC items. Raw scores for both administrations showed a steady age increment through 9-0, the effective ceiling of the test. Test-retest reliability estimates were .56 for memory and .74 for form discrimination. KR-20 estimates were .73 for memory and .83 for form discrimination. Performance was not affected by ethnic background or seating arrangement. Performance was found to be significantly correlated with age and non-significantly correlated with IQ. Recommendations for future research included: further validity studies, use of machine-scorable answer sheets, qualitative analysis of errors, and replication in other geographic locations. A diagnostic model is presented for filtering visual perceptual disabilities. Study was described as first step toward development of a motor-free test of visual perception to be used in conjunction with Benton's Visual Retention Test.

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CHAPTER I

INTRODUCTION

Many psychologists and educators endorse the belief that visual perception is a requisite ability for the verbal learning that takes place in school. Oftentimes children who are not succeeding in school are administered a battery of psychological tests in order to identify the source of their learning difficulty. Some test of visual perception has become a standard component of a diagnostic battery for school children.

One of the major problems with paper and pencil tests of perceptual-motor abilities is that they fail to provide for assessment of the components necessary for an adequate performance. With specific reference to instruments that employ design copying as a measure of perceptual-motor ability, there are two questions that should be asked: First of all, does the subject perceive the stimulus design accurately (perceptual ability), and secondly, can he accurately reproduce the design with a pencil (motor ability)? Unfortunately, most popular, or frequently-used, perceptual-motor tests deal only with the latter issue. That is, a reproduction that is dissimilar to a stimulus design may be the result of inaccurate perception, poor motor ability, or some interaction of the two.

The issue of what is being measured is further compounded when a short-term memory component is introduced. Several instruments provide for an administration which involves stimulus reproduction from memory. Benton's Visual Retention Test is one such instrument, and Benton has aptly stated the problem:

> The Visual Retention Test is a task that involves the interaction of visuoperceptive, visuomotor, and visual memory factors. Consequently, failure under memory administrations sometimes raises the question as to whether visuoperceptive or visuoconstructive disability is the basis for failure . . . Some brain-damaged adults perform defectively on both the copying and memory tasks. In the case of some young children and some mental defectives, there is no doubt that it is a visuoconstructive disability, rather than immediate memory impairment, which accounts for observed failure on the memory task (1974, p. 67).

Multiple-choice versions of the VRT were developed for use with adult patients whose motor functioning had been substantially impaired and precluded use of the standard VRT. The multiple-choice format is a feasible approach to assessment of visuoperceptive and visual memory abilities while reducing the effect of motor skills on performance. Two administrations of multiple-choice versions have been developed: a memory task and a form-discrimination task. Use of the two multiple-choice administrations along with standard memory and copy administrations of the VRT may enhance the diagnostic power of the psychological assessment of perceptual motor abilities.

Children's norms have been developed for memory and copy administrations of the VRT. Normative data for multiple-choice administrations will enhance the diagnostic precision of the VRT with children. The purpose of the present study is to develop such norms for children in kindergarten through fifth grade.

CHAPTER II

LITERATURE REVIEW

The first section of this review is a theoretical justification for the present study; the second is a justification for employing group administrations of the VRT-MC to collect standardization data.

Theoretical Justification

Approaches to the assessment of visual perception in young children are, by and large, based on one or the other of two theories of perceptual development. The Gestalt psychologists claim that visual perception is an innate ability that is little-affected by learning or maturation. On the other hand, Piaget's work has supported the notion that perception is a developmental ability (Piaget & Inhelder, 1956). The Gestalt tradition has also represented the idea that visual perception and motor behavior are closely tied and hence referred to collectively as visual-motor integration.

According to Bender, "The motor behavior of the small child . . . adapts itself to resemble the stimulus perceived in the optic field" (1938, p. 9). The implication of this statement is that a child's perception of a stimulus is perfectly mirrored in his paper and pencil reproduction of the stimulus. The soundness or validity of a test like the Bender-Gestalt Visual Motor Test (BGT) rests almost entirely upon acceptance of Bender's above assertion. During the last several decades, considerable support has been offered for the notion that visual perception is reflected in motor behavior.

Berko (1954) investigated performance of normal and cerebral palsied children on such tasks as design copying and the Seguin Form Board. His work led him to believe that deficits shown by cerebral palsied children in such tasks enable the inference of perceptual defects. Berko advocated remediation of visual perception deficits through use of proprioceptive and kinesthetic training.

Ball (1962) reasoned that even though his research did not demonstrate a functional relationship between visual-perceptual and visual-motor development, the fact that they parallel each other developmentally supports the notion that such a relationship exists. Ball noted that visual-motor development lags behind visual-perceptual development and suggested that ways be found to determine just how this lag is reflected in motor performance.

Kephart (1971) discusses this idea in terms of a perceptual-motor match. According to Kephart, following the tradition of Gesell and others, eye-hand coordination develops out of the combination of visual and kinesthetic cues obtained when the child watches his own hand move. The eye, then, learns to see what the hand feels. As the eye becomes more adept at processing information it takes over because it can process faster and more accurately than the hand. At this point the hand follows the eye.

> As the perceptual information and the motor information become more closely correlated, however, the two types of information (visual and motor) mean so nearly the same thing that one can be substituted for the other . . . . The perceptual data and the motor data are so closely matched that one can be translated into the other . . . . Perceptual data are matched to motor data so closely that the two forms of information come to have the same meaning (p. 21).

Out of this tradition has come the idea that there exists a direct linkage between perceptual and motor development, and that defects in one should produce defects in the other. Several tests of visual perception (cf. Bender Gestalt, Graham Kendall Memory for Designs, and the Frostig tests) are based upon the assumption that defects in visual perception are reflected in defective copying behavior.

The tradition represented by Bender and Kephart, however, has been challenged by a growing body of research and opinion which stresses the measurement of visual perception independent of motor involvement. For Piaget and others, visual perception is a developmental ability. Chimpanzees raised in darkness (Riesen, 1947) as well as adults who were able to see following removal of congenital cataracts (Senden, 1960) required a considerable learning period before ordinary visual perception was achieved. Very closely tied to this research is the work of several investigators who have demonstrated that visual perception and motor ability are somewhat independent functions (Bortner & Birch, 1962; Ghent, 1960; Ghent & Bernstien, 1961; Ling, 1941).

Bortner and Birch (1960) investigated performance of left hemiplegic, right hemiplegic, and normal patients on the Block Design subtest of the Wechsler-Bellevue Intelligence Scale. Their findings demonstrated that the inability of brain-damaged patients to reproduce block designs was not based on an inability to perceive the model design, but the inability to translate the percept into an appropriately-organized pattern of motor behavior. Given the task of matching the original stimulus with three alternative solutions, brain-damaged patients demonstrated adequate perceptual skills. Bortner and Birch (1962) later repeated their investigation with cerebral palsied children to determine whether or not a functional distinction between perceptual development and motor development could be made as well for subjects whose motor ability had been impaired from birth. The results of the second study also demonstrated that the ability to discriminate block designs may be intact even though the ability to reproduce them is impaired.

According to Bortner and Birch (1960, 1962) the ability to discriminate perceptually and the ability to reproduce what is perceived may be discrepant due to different stages of ontogenetic development. The recognition function, or ability to make perceptual discriminations, may occur ontogenetically earlier than those functions involved in perceptual-motor activities. These investigators suggested that functionally autonomous systems may exist: a recognition-discrimination system which develops early and a perceptual-motor system which develops later. This hypothesis might support the lag suggested by Ball and others, but the conclusion reached by Bortner and Birch is that:

> Intactness of perception at the level of recognition and discrimination does not permit the inference of perceptual-motor intactness--nor, conversely, does a disturbance in perceptual-motor performance permit valid inference about the intactness of perception in general (1962, p. 109).

Following the work of Bortner and Birch, several other investigators have lent considerable support to the opinion that perceptual ability might be more precisely assessed in the absence of motor involvement (Birch & Lefford, 1963; Colarusso, 1972; Colarusso & Hammill, 1973; Newcomer & Hammill, 1973; Rosenblith, 1965). The work of these authors supports that of Piaget and Inhelder (1956) concerning development of visual perception, and stands in direct opposition to work previously cited which supports the perceptual-match theory of Kephart and others. It is not unreasonable to assume that there is some interaction between visual perception and visual-motor development. When there is a need, however, to assess visual perception, we are on firmer ground if visual perception is measured independently of perceptual-motor integrative abilities.

A large number of tests which purport to measure visual perception actually require considerable motor ability (cf. Colarusso, 1972). Colarusso and Hammill (1973) have developed a test which minimizes motor ability by using a multiple-choice response format. The Motor Free Test of Visual Perception has been found to be a valid instrument for assessment of visual perception in young children in the few studies which have been done by the authors (Colarusso & Hammill, 1973; Newcomer & Hammill, 1973). It should be possible, however, to filter motor involvement from an existing perceptual-motor test in order to make more explicit the contribution of perceptual ability to performance.

Most surveys of visual perception in children with learning disabilities also refer to visual memory functioning in these children (Monroe, 1932; Silver & Hagin, 1970; Wechsler & Hagin, 1964). The Revised Visual Retention Test (VRT) is frequently used to assess visual memory as well as visuoperceptive and visuoconstructive abilities (Benton, 1974). The VRT consists of 10 geometric designs of increasing difficulty. Two popular administrations of the VRT are reproduction of the stimulus designs from memory (memory) and simply copying the designs (copy). A less commonly used multiple-choice administration of the VRT was developed by Benton for use with subjects who have serious motor defects that preclude, or significantly impair their drawing ability (Benton, 1950, 1961; Benton & Stone, 1970).

Several studies with memory and copy administrations of the VRT have demonstrated that the VRT is a developmental task for children (Beames & Russell, 1970; Benton, 1974; Bobele, 1973; Spreen & Beames, 1970). The relationship between the VRT and reading ability has been explored with unremarkable results (Benton, 1974; Symmes & Rapoport, 1972). The ability of the VRT to discriminate between brain-damaged and emotionally-disturbed children has been demonstrated (Rowley & Baer, 1964). The VRT has been found to have its greatest utility in identification of children with brain damage. General clinical experience has shown that children with cerebral disease or injury often show relatively well-developed verbal abilities, while visuoperceptive and visuomotor abilities are impaired (Benton, 1962; Taylor, 1959).

Research with multiple-choice forms of the VRT has largely been confined to adults. The first multiple-choice form of the VRT described by Benton consisted of 14 geometric designs from forms A and B of the VRT (Benton, 1950). Later, multiple-choice forms were published in Switzerland

(Forms F, G, and H) which consisted of a multiple-choice administration of forms C, D, and E. Recently, Benton and Stone developed a more complex 16-item multiple-choice form of the VRT (Benton & Stone, 1970). The new form was developed with two sample items to orient the subject to the task.

A study by Heilbrun (1960) using brain-damaged adults and normal controls found a correlation between the copying task and the multiple-choice task of .45 for controls and .61 for patients with cerebral disease. Heilbrun concluded that for these groups the VRT measures the same thing under both administrations. Silverstein (1962) found that copying and multiple-choice tasks measured not only different functions in a sample of mentally-retarded adults (ages 15 to 39 years), but that the multiple-choice task primarily measures something other than visual memory. Several other studies with adults have obtained correlations between drawing and multiple-choice administrations ranging from .47 to .83 (Adams & Rushton, 1971; Breidt, 1970).

Most of the research cited suggests that visual perception and motor ability develop at different rates in young children. The implication is that by adulthood, perceptual-motor integration is complete. The utility of the multiple-choice version with children rests on the assumption that perceptual and motor skills are not yet fully-integrated. It might be useful to conceptualize performance on a memory administration of the VRT as comprised of a memory component, a visual perception component, and a motor component. The copy task is comprised of a visual perception component and a motor component. The multiple-choice memory task involves visual memory and visual perception, and the multiple-choice form discrimination task involves only visual perception. Figure 1 illustrates how these three components are tapped by the four administrations and illustrates how the use of all four administrations of the VRT might be useful in discriminating among visuoperceptive, visuoconstructive, and visual-memory abilities.

Rice and Benton (1973) have provided VRT norms for children from ages 5-0 to 11-0. The Rice-Benton norms are available for both memory and copy administrations of the VRT in age scores, scaled scores, and percentiles.

The purpose of the present study is to develop normative data for memory and form discrimination administrations of the 1970 version of the multiple-choice VRT. Norms include standard scores, percentiles, and age equivalents for children from ages 5-0 to 11-0.

Procedural Justification

In recent years there have been several studies which have demonstrated that tests designed to be individually administered may be validly administered as group tests. The Peabody Picture Vocabulary Test has been given in groups using photographic slides (Norris, Hottle, & Brooks, 1960),

FUNCTIONS	VRT ADMINISTRATIONS: Memory	MC-Memory	Copy	Form Discrimination
Visual Perception	******	******	******	******
Visual Memory	******	******		
Motor Ability	******		******	

Figure 1

Functions Tapped by VRT Administrations

using an opaque projector (Tempero & Ivanov, 1960), as well as using television presentations (Fargo, Crowell, Noyes, Fuchigami, Gordon, & Dunn-Rankin, 1967).

The Bender Gestalt Test is similar in format and presentation to the VRT. Attempts have been made to determine the validity of a group administration of the BGT. Keogh and Smith (1961) provided one group of kindergarten children with booklets containing reproductions of the BGT designs in the upper third of 8½" x 11" pages. The children were instructed to copy the design in the lower portion of the page. In a second group of children, each design was presented on a large (11" x 16 3/4") white card. Several groups of 10 children each were tested using the two types of group administration. When compared with a control group of children who had received the standard individual administration, no significant differences were obtained between administrative methods. The investigators suggested that the method employing enlarged designs was easier to administer in a group and required less supervision.

Howard (1970) tested 21 third-grade children simultaneously by projecting 35mm slide reproductions of the BGT designs onto a screen. Each child was provided with a single sheet of 8½" x 11" paper. Half the subjects received an individual administration of the BGT prior to group testing and half afterwards. She found that children who received the group administration first made more errors on the group than the individual administration, while those tested individually first did not differ on the group and individual administrations.

The reliability of a group BGT using slide transparencies was investigated by Becker and Sabatino (1971). Both the copy and 15-second delayed-reproduction administrations were given to subjects ages 5-1 to 9-11. Fifteen days later, individual administrations were given all subjects. Test-retest reliability coefficients ranged from .51 to .76 for the copying task, and the coefficients ranged from .68 to .77 for the memory task.

Norfleet (1973) analyzed the relationship between group BGT scores and reading. The BGT was administered to groups of 10 beginning first-grade children at a time. Each child was provided two sheets of 8½" x 11" paper along with a set of BGT cards. The group BGT was found to have little value in identifying poor readers.

Research with the BGT suggests that group administration of a heretofore individually-administered perceptual-motor test may be reliable and valid for children as young as age five. The feasibility of a group presentation of memory, copy, and multiple-choice administrations of the VRT has been demonstrated with children in the first three grades (Bobele, 1973). Because research evidence supports the validity of group administrations of perceptual-motor tests, such an administration was used for the present study.

CHAPTER III

METHOD

Subjects

The subjects were 441 children attending regular classes in grades K through 5 at Hidden Valley Elementary School in the Aldine Independent School District, located on the northern fringe of Harris County. The Hidden Valley student population was representative of urban, suburban, and rural areas characteristic of the Aldine district. Ethnic groups represented in this sample were 5% Black, 10% Spanish-surnamed, and 85% other, primarily Anglo with a small representation of Oriental-surnamed. Four kindergarten, four first-grade, and two second-, third-, fourth-, and fifth-grade classrooms were randomly selected to participate in this study. No subjects had been diagnosed as brain-damaged or mentally retarded.

Examiners

Group testing was supervised by the author. An undergraduate assistant and classroom teacher were present to monitor testing and were instructed to help children manage booklets and to find proper pages. They were also instructed to encourage children to do their own work and keep their eyes on the screen and test booklet only.

Test

The VRT: Multiple-Choice Form I (VRT-MC)(Benton & Stone, 1970) is a 16-item test. Each stimulus item consists of three complex geometric designs: two major figures and a smaller peripheral figure. Multiple-choice responses are constructed so that items are balanced for position of various foils and types of error. Each multiple-choice card includes the correct foil, and inaccurate choices consisting of a displacement or rotation of the peripheral figure, a distortion of a major figure, and a rotation of a major figure. Each type of foil occupies each of the four positions (1, 2, 3, 4) four times.

The test is introduced by two demonstration items (A and B). Nature of the demonstration depends upon type of administration, memory or form discrimination, to be given. In the memory administration (M), the stimulus design is presented to the subject for 10 seconds. The multiple-choice card is then exposed to the subject. The subject responds by pointing to or calling the number of the foil selected. In the form discrimination administration (FD), both stimulus design and multiple-choice cards are exposed to the subject. The M and FD administrations were modified for the group presentation procedures to be discussed presently.

Apparatus

VRT-MC stimulus and response cards were reproduced on 35mm slides in such a manner as to preserve the design-to-card size ratio in the projected image. Slides were projected onto a screen with a Kodak 600H carousel projector. Kindergarten and first-grade children were tested in the same room. The projector was mounted on a stand approximately 4' high and 18' from the screen, resulting in a projected card image 38" x 57". The remaining four grades were tested in their home rooms with the screen placed 24' from the projector, resulting in a projected card image 52" x 76". Electric lighting was extinguished, and natural lighting from windows was sufficient to enable children to see their work.

Procedure

Children were seated in rows between the screen and projector, no closer than four feet and no farther than 26 feet from the screen. Each child was provided an 18-page booklet containing 8½" x 11" pages numbered in the upper right corner for both M and FD. The booklet cover contained spaces for the child to write his name, grade, and teacher's name. The pages contained numerals 1, 2, 3, and 4 corresponding to numerals present on the slide image containing the four alternatives. The location of numerals on the page in the test booklet corresponded as well to the location of design choices on the slide images.

Children were tested in groups of intact classrooms, with the teacher present to aid in supervision and to help put the children at ease. The general nature of the test was explained to the children as a game to determine how well they could remember things that they saw. Children were assured that the results would not affect their report cards, and were told that if they tried their best they would receive a surprise when testing was completed.

Each child was then handed a test booklet and a pencil. The following instructions were given:

> Each of you now has a test book. Do not open it until I tell you to do so. On the front cover there is a place for your name and grade. Does everyone see that? . . . Please write or print your first and last name on the line provided . . . Now everyone put a 2 (or 3 or 4, etc.) on the line next to where it says "Grade" because you are all in the second (or third or fourth, etc.) grade. (The teacher and author prepared the test booklets with this information prior to testing the kindergarten and first grade.) . . . Now on the next line is a place for your teacher's name . . . Copy your teacher's name from the blackboard . . .
>
> Everyone put your pencils down now and listen carefully to the instructions . . . In a minute I'm going to show you a picture on this screen. Look at the picture carefully because I'll take it away after 10 seconds. When I take the picture away you will see four new pictures. Each picture will have a number 1, 2, 3, or 4 under it. You are to pick the picture that is just like the one you saw before. Now turn the page and let's do one for practice to see how it goes . . .

> There should be a letter A in a circle up in the corner if you are on the right page (examiners watched very closely throughout the testing to be sure the children were on the right page) . . . Is everyone ready? . . . Put your pencils down . . . Here is the first picture . . . (Advanced carousel to first M sample, design A; after 10 seconds advanced carousel to slide containing four choice designs) . . . Now circle the number in your book that goes with the picture that is just like the one you just saw . . . Is it number 1, or 2, or 3, or 4? . . . That's right, it is number 3. Number 3 looks just like the one you saw before.
>
> Now let's try one more . . . Is everyone ready? Turn to the next page, page B, and get ready to look at the screen . . . Alright, here is the next picture . . . Now circle the number in your book that goes with the picture that is just like the one you saw before . . . Now does everyone understand what we're going to do? . . . O. K. then, let's go on. Put your pencils down, turn the page, and get ready to go on.

After each slide, the children were reminded to turn the page. After every other slide they were reminded that their task was to find the picture that looked like the one they had just seen. For children in kindergarten and first grade, a short rest period was taken after item 8 and item 16. After the rest period following the sixteenth memory item, the following instructions were given:

> Now everyone get ready to start working again . . . This time we're going to see some more pictures, but they will be different. Everyone be sure that the page you are on has a little A in a circle up in the corner . . . Now let's look at the screen (advanced carousel to first FD sample item) . . . You see a picture up at the top and four more pictures below. One of the pictures down here (pointed) looks just like the one on top. Is it 1, or 2, or 3, or 4? . . . That's right, number 3 on the bottom looks just like the picture on the top, so draw a circle

> around number 3 in your book . . . Is everyone finished? Good! Let's do another one . . . (Advanced carousel to sample B) . . . Now find the picture on the bottom that looks just like the one on top, and draw a circle around the number in your book that goes with it. . . . Has everyone finished? . . . Does everyone understand what we're going to do? . . . Each time find the picture on the bottom that looks just like the one on the top and draw a circle around the number that goes with it. When you have finished, turn the page and wait quietly for the next slide. Alright, now let's look at this one . . .

The remaining FD items were presented with appropriate reminders as before. A rest period was given also, as before, for the younger children. Test booklets were collected following presentation of the last FD item. Since the purpose of the test was not to determine how well children can follow instructions, and because there are unique problems associated with testing young children in groups, every effort was made to see that each child understood the task at hand. The presence of the examiner and two assistants facilitated supervision of the children and aided in keeping them on the proper page. Children were instructed, as needed, to change their answers, if they found they had erred, by crossing out rather than erasing the wrong answer.

Additional Data

Birthdates for all children were obtained from permanent record folders and recorded on the test booklet covers. Ages were then computed in months.

Classroom teachers were provided with a roster of their children and asked to indicate which children were Black. Mexican-American children were identified by Spanish surnames.

Each teacher was also asked to indicate which of her students she suspected of having perceptual, motor, or perceptual-motor problems. In general, criteria for this designation was left up to the individual teacher. Children sitting in the first and last rows were identified at each testing session to investigate whether or not seating arrangement affected performance.

Scoring

Responses in each child's test booklet were transferred to optical-scanning sheets by the author. The use of optical scanning for scoring increased accuracy in scoring and facilitated analysis of the data. Scoring was accomplished with an OpScan 100 Optical Reader.

It has been suggested elsewhere that scoring multiple-choice versions of the VRT incorporate a correction for guessing (Briedt, 1970; Silvestein, 1962). A review of the literature on the correction-for-guessing procedure found that it did little to improve reliability or validity and that it might even be unethical to make the correction when subjects are not given the option of omitting items (Diamond & Evans, 1973). For the present study a correction for guessing was not employed because instructions necessary would have been too involved for young children. *M* and *FD* scores were the total number of correct responses.

CHAPTER IV

RESULTS

Subjects

During administration of the VRT-MC, the examiner and proctors made note of subjects who were observed not to be attending to the screen or staying on the proper page of their test booklet. Twenty-nine subjects were thus identified and eliminated from the final sample of 412 subjects. There existed no systematic bias in subjects eliminated with regard to race, sex, or age. The analyses described below were performed to investigate effect of race and seating arrangement on VRT-MC performance.

Of particular concern in development of any new psychometric instrument is that results be free from the influence of sex or racial origin. There exists no evidence that there are differences on VRT performance attributable to sex (Alley, 1969), hence the relationship between sex and VRT-MC performance was not investigated. An analysis of variance was performed to determine whether ethnic (Anglo, Black, Mexican-American) differences existed. No significant differences were obtained on M, F (2, 411) = 1.36, $p > .01$, nor on FD, F (2, 411) = .50, $p > .01$.

To investigate effect of seating arrangement on performance, scores of subjects seated in the first row were compared with those in the last row. Analysis of variance obtained a non-significant effect, F (1, 411) = .96, $p > .01$ and F (1, 411) = 1.02, $p > .01$, for M and FD respectively.

The final sample of 412 subjects was divided into 18 age groups spanning three-month intervals from 5-3 to 7-11, and six-month intervals from 8-0 to 11-0. Performance by age groups was analyzed to determine the most appropriate points to partition the sample in order to develop norms. Final age groups were based on practical and empirical considerations. Seven age groups were ultimately selected on which to base standard scores. Table 1 presents means and standard deviations for age, M, and FD raw scores. The youngest age group spanned three months from 5-3 to 5-5. From 5-6 to 6-11 six-month intervals were used, and from 7-10 to 11-0 twelve-month intervals were used. M and FD scores reflected a steady age progression, and standard deviations for equal age intervals were comparable.

Norms

In the absence of additional interpretive data, raw scores are meaningless and of little use. Raw scores are usually converted to a scale derived from a representative

TABLE 1

Means and Standard Deviations of

CA, M, FD by Age Groups

		CA		M		FD	
Age Group	N	$\bar{X}$	Sd	$\bar{X}$	Sd	$\bar{X}$	Sd
5-3 to 5-5	27	64.11	0.79	4.74	1.84	6.89	2.90
5-6 to 5-11	40	68.05	1.43	5.30	1.86	8.45	2.97
6-0 to 6-5	36	74.58	1.66	6.86	2.46	10.36	3.69
6-6 to 6-11	45	80.62	1.91	7.78	2.72	12.04	3.16
7-0 to 7-11	72	88.35	3.26	9.06	2.71	13.12	2.48
8-0 to 8-11	58	102.28	3.55	11.09	2.53	14.17	1.70
9-0 to 11-0	155	122.20	8.82	11.72	2.20	14.57	1.55

sample or normative group to provide an indication of an individual's relative standing compared to a normative sample, and comparison of an individual's performance on different tests. Three commonly derived scores are used to provide this information: standard scores, age scores, and percentile ranks. All three types of scores were derived for _M_ and _FD_, and are given in Table 2 and Table 3.

Standard Scores. Normative tables developed by Rice and Benton (1973) report VRT standard scores for memory and copy administrations of the VRT. Standard scores have a mean of 100 and a standard deviation of 15 which facilitate comparison of an individual's performance with other common psychological tests such as the Wechsler intelligence scales and the Wide Range Achievement Test. VRT-MC scores for _M_ and _FD_ were converted to standard scores using a linear transformation to produce a set of scores with mean of 100 and a standard deviation of 15.

Age Scores. Age scores were computed for _M_ and _FD_ in the following manner. Mean _M_ and _FD_ scores for each of the original 18 age groups were used along with the mean age of each group to generate a second-degree polynomial equation whose curve provided the best fit to the 18 pairs of points for both _M_ and _FD_. From the equation thus derived, age scores were obtained by placing each integral unit score on _M_ or _FD_ in the respective equation and solving for chrono-

TABLE 2

Memory Norms

Raw Score	Age Score	Standard Scores 5-3 5-5	5-6 5-11	6-0 6-5	6-6 6-11	7-0 7-11	8-0 8-11	9-0 11-0
1		69	65	64	63	55		
2		78	73	70	68	61	BN	
3		86	81	76	74	66	52	
4	BN	94	89	83	79	72	58	BN
5	5-6	102	98	89	85	77	64	55
6	6-3	110	106	95	90	83	70	61
7	6-5	118	114	101	96	89	76	68
8	6-7	127	122	107	101	94	82	75
9	7-0	135	130	113	107	100	88	81
10	7-11	143	138	119	112	105	93	88
11	9-2	151	146	125	118	111	99	95
12	10-2	159	154	131	123	116	105	102
13	AN	AN	162	137	129	122	111	109
14			AN	143	134	127	117	115
15				150	140	133	123	122
16				156	145	138	129	129

TABLE 2 (Cont)

Memory Norms

Raw Score	Percentiles 5-3 5-5	5-6 5-11	6-0 6-5	6-6 6-11	7-0 7-11	8-0 8-11	9-0 11-0
1	2	1	1	1			
2	7	4	2	2	BN		
3	18	18	5	4	1		
4	35	23	13	8	3	BN	
5	54	45	23	16	6	1	BN
6	75	66	37	25	13	2	1
7	89	82	48	39	23	5	2
8	96	93	68	47	34	11	5
9	99	98	81	68	50	21	18
10	AN	99	90	79	63	32	21
11		AN	95	88	77	47	37
12			98	94	86	63	54
13			99	97	93	77	73
14			AN	99	96	87	84
15				AN	99	94	93
16					AN	97	97

TABLE 3

Form Discrimination Norms

Raw Score	Age Score	Standard Scores 5-3 5-5	5-6 5-11	6-0 6-5	6-6 6-11	7-0 7-11	8-0 8-11	9-0 11-0
1		69	62	62	BN			
2		75	67	66	52			
3		80	72	70	57			
4		85	77	74	62	BN		
5		90	83	78	67	51		
6	BN	95	88	82	71	57		
7	5-4	101	93	86	76	63		
8	5-8	106	98	90	81	69	BN	
9	5-10	111	103	94	86	75	54	BN
10	6-0	116	108	98	90	81	63	55
11	6-3	121	113	103	95	87	72	65
12	6-9	126	118	107	100	93	81	75
13	7-5	132	123	111	105	99	90	85
14	8-9	137	128	115	109	105	98	95
15	10-10	142	133	119	114	111	107	105
16	AN	147	138	123	119	117	116	114

TABLE 3 (Cont)

Form Discrimination Norms

Raw Score	Percentiles 5-3 5-5	5-6 5-11	6-0 6-5	6-6 6-11	7-0 7-11	8-0 8-11	9-0 11-0
1	2	BN	BN				
2	5	1	1				
3	9	3	2				
4	16	6	4	BN			
5	25	13	7	1			
6	37	21	11	3	BN		
7	53	32	18	5	1		
8	65	45	25	10	2		
9	77	58	34	18	5	BN	
10	86	70	45	25	10	1	BN
11	92	81	58	37	19	3	1
12	96	88	58	50	32	10	5
13	98	94	77	63	47	25	16
14	99	97	84	73	37	45	37
15	AN	98	90	82	77	68	63
16		99	94	90	87	86	82

logical age.

Percentiles. Percentile ranks were obtained by computing the z-score equivalents for M and FD and determining the corresponding percentile rank using a table of areas under the normal curve.

Reliability

Reliability coefficients are used to provide an estimate of precision of a test as a measurement device and to provide an estimate of consistency of a subject's performance on a test. Two reliability estimates were obtained on the VRT-MC: test-retest and internal consistency. Due to objective scoring procedures, interscorer reliability was not investigated.

Test-Retest. Temporal stability of the VRT-MC was determined by test-retest methods. Pearson product-moment coefficients were computed on scores of 95 subjects in grades K, 1, 3, and 5 who were randomly selected from the standardization sample. This reliability sample was retested 15 days after original testing. Subjects in grades 2 and 4 were excluded from retesting for the following reasons: administrative policies and practical considerations within the school providing subjects limited testing to one grade at a time; there was no reason to believe sampling from children in grades 1 through 5, exclusive of 2 and 4, which spanned the age range of the normative sample, would unduly affect the reliability coefficient. Test-retest reliabilities were computed by grade rather than age groups because division of the reliability sample into age groups was not feasible due to the composition of the sample. It was believed that grade groupings would provide a fairly approximate representation of ages for reliability purposes.

Internal Consistency. Internal consistency reliability refers to consistency in results obtained throughout a test in a single administration. Internal consistency reflects homogeneity of test items and may be considered an index of extent to which items measure the same function. Internal consistency coefficients were computed with Kuder-Richardson (1937) formula #20. Data on the total sample of 412 children were used in computing internal consistency coefficients.

Standard Error of Measurement. A factor closely related to test reliability is the standard error of measurement (SE_m). The SE_m reflects consistency of performance by estimating magnitude of errors of measurement expressed in the same units as individual raw scores. SE_m is an estimate of the standard deviation of obtained scores from their theoretical true score. SE_m is a function of the standard deviation and reliability of a test. There is an inverse relationship between SE_m and reliability; the higher a test's reliability, the smaller is the SE_m. SE_m's were computed on all reliability estimates of the VRT-MC.

Table 4 presents the following data for both administrations of the VRT-MC by grade groupings: size of groups, age means and standard deviations, test-retest coefficients, internal consistency coefficients, and SE_m's. Reliability estimates and SE_m's are also provided for the entire sample. Test-retest reliabilities by grade ranged from .25 to .47 for *M*, and from .32 to .76 for *FD*. Test-retest coefficients for the entire sample were .72 and .81 for *M* and *FD* respectively. Internal consistency coefficients ranged from .21 to .55 for *M*, and .41 to .77 for *FD* within grade groupings, and .73 and .83 respectively for the entire sample.

To an extent VRT-MC performance was a function of age (see Table 1). To investigate effect of age on magnitude of reliability coefficients, correlation coefficients were computed between age and the two test occasions for both *M* and *FD*. Obtained correlation coefficients are presented in Table 5. Correlations between VRT-MC and age were not significant at any grade level, but all correlations on the entire reliability sample were significant beyond the .01 level. The relationship between age and VRT-MC performance was underestimated when one grade at a time was considered. Selection of students within one grade simultaneously reduced the variability of ages and variability of test scores. Reduction in variability, or restriction of

TABLE 4

Reliability Estimates on M and FD by Grade

	Test-Retest							KR - 20						
		CA		M		FD			CA		M		FD	
Grade	N	$\bar{X}$	Sd	r_{tt}	SE_m	r_{tt}	SE_m	N	$\bar{X}$	Sd	r_{tt}	SE_m	r_{tt}	SE_m
K	24	69.75	5.33	.45	1.87	.74	1.62	87	68.39	4.35	.21	1.80	.62	1.85
1	18	83.89	6.16	.25	1.96	.76	1.49	95	81.84	5.05	.44	1.85	.77	1.46
2								53	92.66	5.81	.48	1.83	.49	1.22
3	27	104.26	4.44	.45	1.74	.53	1.32	56	104.62	4.38	.55	1.64	.53	1.14
4								61	116.80	4.93	.50	1.68	.41	1.05
5	26	130.04	5.87	.47	1.69	.32	1.01	60	130.23	4.91	.38	1.66	.66	1.05
Total	95	98.74	23.77	.72	1.99	.81	1.52	412	95.71	21.87	.73	1.78	.83	1.40
				.56[a]	2.50	.74[a]	1.78							

[a] Test-retest coefficients partialled on age

TABLE 5

Correlations Between CA, M, and FD

Grade	N[a]	M with CA Pre-test	M with CA Post-test	FD with CA Pre-test	FD with CA Post-test	M with FD Pre-test
K	24	-.07	.05	-.30	-.23	
	87	.02		.12		.59
1	18	-.09	-.08	.07	.27	
	95	-.03		.04		.38
2	53	.16		-.04		.57
3	27	.23	.15	-.06	-.02	
	56	.22		-.15		.54
4	61	-.05		.15		.43
5	26	.02	-.02	-.04	.29	
	60	-.10		.13		.03
Total	95	.66	.56	.62	.50	
	412	.68		.61		.71 .51[b]

[a] Smaller N represents test-retest sample, larger N represents total sample.

[b] Partialled on CA

range, had the effect of reducing correlation coefficients. On the other hand, the correlation between age and VRT-MC performance tended to enhance test-retest reliability on the entire sample. Test-retest coefficients on the sample for both M and FD were recomputed by partialling effect of age from the correlation between first and second administrations. First order partial correlation coefficients provide an estimate of the reliability of M and FD taking into account the effect of age. The first order partials are based on a larger sample and are thus more indicative of test-retest reliability. The partialled coefficients obtained were .56 and .74 for M and FD and are included in Table 4.

Validity

Validity refers to inferences about what is measured by a test. For the present study independent measures of visual perception and visual memory were not obtained. Three indirect measures of validity of the VRT-MC were obtained.

First, the relationship between age and VRT-MC performance was examined. To the extent such a relationship existed provided evidence of construct validity for the VRT-MC. Obtained correlation coefficients on the entire sample of 412 subjects were: .68 and .61 for M and FD respectively ($p < .01$). Evidence that VRT-MC scores measure a developmental function was demonstrated.

Secondly, the relative independence of VRT-MC performance as a function of intelligence was investigated. IQ's were available for 74 subjects. Subjects' mean age was 122 months; mean IQ was 105.81 with a standard deviation of 11.82. Standard scores developed in this study were used to investigate the relationship between IQ and M and FD. Non-significant correlation coefficients of .05 and -.12 were obtained between IQ and M and FD. Relative independence of IQ and VRT-MC performance adds support for construct validity of the test.

The correlations between M and FD are also presented in Table 5. The coefficients are significant at every grade level, but account for less than 36% of the variance in the two sets of scores at any grade level. The correlation coefficient of .71, based on the entire sample, when partialled on age reduces to .51. Thus only 26% of the variance in scores on one of the administrations is explained by variance in scores on the other administration.

Finally, psychometric characteristics of the VRT-MC were analyzed as a reflection of construct validity. Item validity refers to the point-biserial correlations between each item and the total score. Point-biserial coefficients for each of the 16 items for both administrations are given in Table 6. Median item validities ranged from .29 to .34 for M; from .22 to .50 for FD. Item difficulties were expressed in terms of the proportion of subjects passing an

TABLE 6

Point-biserial Correlations Between

Items and Total Score by Grade

	Memory						Form Discrimination					
Item	K	1	2	3	4	5	K	1	2	3	4	5
1	.26	.44	.44	.16	.41	.20	.21	.54	.34	.32	.45	.00
2	.17	.42	.22	.42	.25	.14	.60	.41	.21	.00	.17	.56
3	.42	.50	.03	.35	.28	.25	.54	.29	.11	.26	.16	.56
4	.48	.36	.28	.14	.26	.49	.51	.50	.40	.00	.16	.48
5	.08	.27	.48	.29	.30	.21	.10	.54	.16	.17	-.03	.47
6	.46	.13	.37	.38	.27	.46	.38	.41	.16	.18	.57	.51
7	.06	.30	.19	.37	.46	.36	.40	.53	.39	.41	.42	.44
8	.45	.25	.25	.29	.39	.28	.55	.24	.54	.46	.19	.05
9	.45	.32	.33	.34	.33	.42	.61	.49	.48	.14	.16	.55
10	.06	.25	.29	.23	.36	.39	.41	.55	.11	.27	.25	.55
11	.08	.36	.31	.33	.30	.11	.13	.61	.45	.56	.58	.46
12	.40	.24	.28	.38	.33	.30	.43	.51	.24	.33	.18	.55
13	.12	.41	.61	.43	.42	.43	.09	.45	.29	.47	.45	.56
14	.34	.32	.31	.48	.41	.24	.35	.55	.33	.51	.33	.13
15	.33	.42	.40	.37	.27	.42	.46	.44	.34	.43	.36	.43
16	.17	.13	.45	.55	.36	.27	.32	.45	.61	.51	.32	.05

item. Item difficulties for both administrations are given in Table 7. Item difficulty medians ranged from .33 to .66 for *M*; from .45 to .94 for *FD*. Summary information for item validity and item difficulty is presented in Table 8.

TABLE 7

Item Difficulties by Grade

	Memory						Form Discrimination					
Item	K	1	2	3	4	5	K	1	2	3	4	5
1	.34	.57	.81	.93	.88	.93	.77	.76	.87	.95	.85	1.00
2	.17	.57	.75	.77	.84	.80	.46	.83	.91	1.00	.95	.97
3	.35	.60	.74	.84	.67	.85	.50	.88	.96	.96	.98	.95
4	.56	.81	.77	.89	.90	.90	.59	.91	.96	1.00	.97	.95
5	.34	.50	.64	.66	.75	.78	.66	.75	.98	.93	.98	.93
6	.33	.65	.66	.79	.80	.80	.37	.88	.98	.95	.97	.97
7	.10	.44	.45	.55	.56	.60	.30	.55	.75	.77	.82	.82
8	.45	.62	.66	.84	.74	.88	.59	.87	.83	.91	.92	.95
9	.43	.66	.64	.91	.79	.77	.58	.84	.98	.96	.97	.93
10	.30	.33	.66	.79	.82	.60	.42	.81	.96	.95	.98	.93
11	.34	.38	.66	.64	.57	.40	.34	.55	.77	.68	.82	.52
12	.36	.45	.58	.62	.75	.73	.48	.86	.92	.93	.93	.93
13	.28	.42	.57	.61	.61	.63	.43	.53	.60	.68	.85	.73
14	.19	.38	.60	.64	.72	.75	.44	.83	.91	.95	.88	.93
15	.41	.29	.55	.55	.56	.67	.44	.77	.87	.89	.97	.93
16	.22	.18	.45	.61	.61	.50	.49	.69	.68	.75	.84	.95

Item difficulties are expressed as proportion passing an item.

TABLE 8

Summary Statistics on
Item Validity and Item Difficulty
for M and FD

	Item Validity		Item Difficulty	
Grade	Median	Range	Median	Range
		Memory		
K	.29	.06 - .48	.33	.10 - .56
1	.32	.13 - .50	.47	.18 - .81
2	.31	.03 - .45	.66	.45 - .81
3	.34	.14 - .55	.72	.55 - .93
4	.33	.25 - .46	.75	.56 - .90
5	.29	.11 - .49	.76	.40 - .93
		Form Discrimination		
K	.40	.09 - .61	.45	.30 - .77
1	.50	.24 - .61	.76	.53 - .91
2	.33	.11 - .61	.91	.60 - .98
3	.33	.00 - .56	.93	.68 -1.00
4	.22	-.03 - .58	.94	.82 - .98
5	.47	.00 - .56	.93	.52 -1.00

CHAPTER V

DISCUSSION

There exists substantial support in the literature reviewed for the measurement of visual perceptual abilities independent of motor ability. Drawing tests which purportedly assess visual perception lend themselves to possible misinterpretation because it may not be clear whether deficiencies result from inaccurate perception, impaired motor ability, or poorly developed perceptual-motor integration. Development of normative data for multiple-choice administrations of the VRT-MC was seen as a step toward resolution of this diagnostic ambiguity. The purpose of the present study was to develop norms on the VRT-MC for use with children. Standard scores, percentiles, and age scores were derived from a sample of over 400 children 5 to 11 years old.

Raw scores showed a steady, uniform increment from age 5-3 through 8-11. Both M and FD reach an effective ceiling beyone age 9-0. The test, then, has too low a ceiling for older children. Raw scores were linearly transformed to standard scores comparable to the Rice-Benton norms as well as those of major intelligence tests. Standard scores with familiar parameters (Mean = 100; Sd = 15) were employed to facilitate intra-individual comparisons among scores obtained on other tests. Percentile ranks and age scores were derived to provide interpretable information to users in educational settings.

Reliability estimates obtained on the VRT-MC were moderate, ranging from .56 to .83. These coefficients compare favorably with those obtained on other perceptual-motor tests (cf. Colarusso, p. 17b, 1972). Several factors may have influenced the reliability coefficients obtained: the time required to administer the entire VRT-MC in one sitting may have been too long for young children; the format of the test booklet may have been awkward for young children to handle; and, a response set may have been generated with both sample items and the first test item having the same correct response.

Validation of the VRT-MC as a measure of visual perception and visual memory was not of primary concern in this study. Questions of validity were approached with data available to demonstrate: (1) that the VRT-MC measured a developmental ability; (2) for the most part, performance is independent of intelligence; and (3) the two administrations measure different abilities. Furthermore, neither ethnic background nor seating arrangement appeared to produce significant effects on performance. Although validity of group administration of this particular multiple-choice form has not been investigated, there is little reason to believe the results of the previous study (Bobele, 1973) are not generalizable to this form under the administration procedure described in Chapter II.

According to the diagnostic model presented earlier (see Fig. 1), children with visuoperceptual problems should obtain comparably low scores on all four administrations of the VRT-MC (drawing and multiple-choice). Children with visuoconstructive difficulties should obtain higher scores on the VRT-MC than the standard VRT. Visual memory problems would be indicated by poorer scores on the two styles of memory administration. The magnitude of interpretable differences between the VRT and the VRT-MC depends on the yet-to-be-determined standard error of the difference between the two administrations.

For the present, the norm tables presented in this study should be considered tentative pending further research. The normative sample employed was obtained from one elementary school representative of the Aldine Independent School District. Although there is no research which demonstrates geographic differences in perceptual abilities, this study should be replicated, preferably elsewhere, to resolve the issue of regional differences and to provide more stability to the normative sample as well as to the reliability estimates.

The issue of validity needs attention to substantiate the diagnostic filtering model described earlier. A study using all four administrations of the VRT as well as at least one independent measure of visual perception is recommended.

It has been suggested elsewhere (Ghent, 1960; Ghent & Bernstein, 1961; Maccoby & Bee, 1965) that young children do not use the same cues in visual matching tasks as those employed by adults. Orientation of stimulus figures and other topological and spatial attributes are not of prime consideration to youngsters, according to these studies. Since the foils on the VRT-MC are largely rotations and misplacements of figures, qualitative analysis of performance with respect to types of errors needs to be investigated.

The administration of the VRT-MC is deceptively simple, but should be attempted only by those with sufficient training and skills in testing who can be sensitive to the unique problems associated with test administration. Use of the VRT-MC in groups should be limited to skilled examiners who have available to them at least one responsible proctor for every ten children to be tested at a time. Scores of children tested in groups larger than 30, or with less than the recommended number of proctors, may be affected in unpredictable ways.

It is further recommended that when the VRT-MC is administered to groups of kindergarten and first-grade children, the testing be done in at least two sittings instead of one, with the prescribed rest periods observed to guard against fatigue and distractability. The memory administration should always preceed the form discrimination task, regardless of the number of testing sessions.

The use of machine-scorable answer sheets greatly facilitates scoring and increases accuracy of results. The use of such answer sheets requires responses to be transferred from the test booklets for scoring by machine. A study by Cashen and Ramseyer (1969) indicated that children from grade three up can manage machine-scorable answer sheets with a minimum of practice. Further research is needed to investigate the feasibility of such an approach with the VRT-MC.

This study is best viewed as a starting place in the development of a motor-free test of visual perception to be used in conjunction with the original Visual Retention Test in the identification and diagnosis of children with visual memory, visuoconstructive, or visuoperceptual disabilities.

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