VISION SCREENING OF CHILDREN WITH THE RANDOM DOT E STEREOGRAM

by

DONALD W. MITCHELL
Ferris State University
College of Optometry

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Michael T. Cron, O.D.

ABSTRACT

Eighty-one children, ages five to eight had their vision screened utilizing both the Modified Clinical Technique (MCT), which includes visual acuity, retinoscopy, cover test and health evaluation, and the Random Dot E (RDE), a vectographic test of stereopsis.

Recent studies have indicated that the RDE (used as a screening device) displayed a strong correlation with the MCT for identifying children in need of referral.

This study, while attempting to reproduce the previously reported results, indicates that the sole use of the Random Dot E was not as effective as the Modified Clinical Technique nor was there evidence of a strong correlation between the two methods.

INTRODUCTION

The vision screening of children is a well recognized and an advantageous technique for detection and referral of children who have visual problems, either present or potential. To insure normal visual development and encourage optimum school performance, an effective method of screening needs to be employed. Recently the use of the Random Dot E, (RDE)(a test of stereopsis) has been reported to be an effective and an economical screening device, comparable to the Modified Clinicial Technique (MCT) which is a long standing screening standard among eye care professionals.

In this study, 81 children were screened both with the RDE and subsequently with the MCT. These procedures, including methods, results and conclusion are detailed in the following pages. An extended comment on vision screenings for children supplements the main body of work.

Method

The MCT was developed via the Orinda Study (1959) and agreed upon by ophthalmologists and optometrists from faculties at Stanford University School of Medicine and the University of California, Berkely, School of Optometry, respectively. The impetus for the study originated with the Contra Costa County, Department of Education seeking a recommendation from the County Health Department on state mandated vision screenings. The ultimate result of this was the MCT; a screening method designed in agreement between eye care professionals, that would find essentially all children with significant eye problems, and would minimize over-referrals. This was a three year longitudinal study of approximatily 1000 elementary children. It was described as remarkably efficient, economical and had the fewest over or under referrals as compared to three other techniques. (California State Recommended Procedure, Telebinocular, and Massachusetts Vision Kit)[1]

The MCT includes visual acuity, refractive error, eye coordination and a health assessment. Although the MCT is a well accepted standard in the field of vision screening and still holds favor in the American Optometric Association it is no longer recommended by the American Academy of Ophthalmology.[2]

Furthermore, due to the need of a professional in the administration of some tests it is rarely used.

In this study, 81 children ages five to eight were screened secondarily with the MCT which was used as the standard for correct and incorrect referrals. The referral criteria were identical as in the Orinda Study. (Table I)

The RDE stereogram, a relatively new test for amblyopia[3] and recently used as a screening device, consists of two eight by ten centimeter random dot, vectographic stereograms. Also included are polaroid glasses and a demonstration model. Of the two random dot stereograms one is blank while the other presents a " floating E " when viewed with polaroid glasses provided binocularity and adequate stereopsis. The demonstration model is a bas-relief construction which simulates the random dot stereogram and is used prior to testing to familiarize patients with the task of identifing the " floating E."

The administration of the RDE screening was performed as follows.

1. The demonstration model was presented with the explanation that the patient was to be given a forced choice between the two stereograms and that they were to simply point to the E. Example:

" This is an E. (presenting the demonstration model) Now I am going to show you two more cards. One of them is blank and the other one has an E like this one (pointing to the demonstration model) I want you to point to the card with the E."

2. The polaroid glasses were then put on the patient with further encouragement. Typically, " You need to put on these special glasses to help you see the E."

3. The stereograms were then presented at a test distance of 1.5 meters from the patients eyes which is equal to 168 seconds of disparity.(Table II) The stereograms were simultaneously presented, one in either hand with the patient being instructed to " point to the E. "

4. Following the patients choice the stereograms were placed behind the examiners back for the <u>appearance</u> of position alteration. (Actual position alteration of the sterograms was done randomly at the discretion of the examiner) This was repeated with a second presentation and request to, " point to the E. "

5. Step 4 was repeated until: (a) four consecutive

correct responses were given or (b) a maximum six presentations were made.

RDE referral criteria for the test distance of 1.5 meters was: less than four correct consecutive responses of a maximum six presentations.

Results

The RDE screening method was applied to the following population which consisted of 81 children ages five to eight. This population can be divided into three smaller groups: 36 kindergarten (44.4%), 23 first grade (28.4%), and 22 second grade children (27.2%). The screening generated 71.6% correct referrals and 28.39% incorrect referrals when compared to the criteria of the MCT.(Table I) The incorrect referrals can be divided into two groups. One of over-referrals, 14.81% and the other of under-referrals, 13.58%.

The above data is commonly referred to in terms of true positives, true negatives, false positives and false negatives. Positive findings have an anomaly while negative findings are without an anomaly.

True positives (TP)--a referral which proves accurate.

True negatives (TN)--a nonreferrel which proves accurate.

False positive (FP)--a referral which proves inaccurate.

False negative (FN)--a nonreferral which proves inaccurate.

The over-referrals or FPs display a definite trend if the population studied. Of the 12 FPs, 9 were from the kindergarten subgroup. Although this subgroup consists of 44.4% of the population, the group generated 75% of the FPs. This would suggest that the younger patients had more difficulty understanding the test instructions or in attending to the task or perhaps maturity was a factor. Furthermore, this over-referral rate is significantly greater than those reported in other studies.[3,4] (8% FP, Hammond and Schmidt, in a population of 483 and 0%, Rosner, in a population of 60)

The under-referrals or FNs also displayed an age variation with a bimodal distribution. The distribution by subgroup for FNs was 36.4%, 9.1% and 54.5% for kindergarten, first and second grades, respectively. Table IV illustrates the specific anomalies associated with each FN.

The data indicates the RDE was not sensitive to reduced acuity in the younger subgroup and in the oldest group sensitivity was poor for ocular alignment anomalies. There were no clear indications as to specific insensitivities to refractive error in

this population even though both hyperopia and myopia were the basis for a few FNs.

Some particular areas of insensitivity with the RDE are in identifing organic problems, low myopia and hyperopia. This screening device has no provision for the detection of organic problems not involving central vision. This population did not generate FNs due to this deficiency but this is a weakness of the RDE. In hyperopia, the usual ample accommodative ability found in children is a strong compensating factor which enables some hyperopes to go undetected. In the case of the myope, the testing distance is such that the far point of some referrable myopes is at or beyond the test target leaving them undetected.

In this study, the RDE failed to identify a number of ocular alignment problems. This contributes another source of FNs. If a patient has good vergence ranges their phoric anomaly may go undetected and more importantly intemittent tropias likewise.

A phi coefficient was determined for this study which was equal to +.195. This is a validity value[5] which ranges from -1.00 to +1.00. Validity increases as +1.00 is approached. (Table V) Hammond and Schmidt[2] reported a phi coefficient of

+.52 for the RDE. In an unpublished work by Fox and Woltjer[6] using the RDE as a screening device (population 146, performed in 1987) a phi coefficient was determined to be equal to +.24. This study, concurs well with the work by Fox and Woltjer[6] yet significantly differs from Hammond and Schmidt[2] and also Rosner.[4] Also, comparing this study and the Fox and Woltjer study the TPs, TNs, FPs and FNs are all in close agreement and are proportionally identical. In both studies, the TNs make the largest portion followed by the FPs, FNs and finally the smallest portion being TPs.

Conclusion

This study significantly departs from the data reported by Hammond and Schmidt[2] and also Rosner.[4] At the same time, it shows strong correlation to Fox and Woltjer.[6] Data from this study indicates a poor correlation between the RDE and the MCT. This technique (RDE) may show distinct advantages, i.e. cost, ease of administration, ect., yet validity has not been confirmed via this work. This study is not to be construed as conclusive but it strongly suggests that for the accurate detection of ocular disorders which can cause irreversible damage, the Random Dot E should not be used as a screening device regardless of its economic or other advantages.

COMMENT

VISION SCREENING OF CHILDREN

Although the vision screening of children is a well-documented, meritorious procedure, there are a few unsettled issues surrounding this topic which have inhibited the establishment of a single, acceptable screening method for all those involved. As disease prevention and health promotion continue to take a larger part in the health care delivery system, a solitary vision screening method may soon become a sought after necessity. The following analysis is presented to familiarize the reader with the specific issues of unrest with the hopes of stimulating further studies specifically oriented to their resolve, and ultimately for the development of a single, peculiar vehicle for the delivery of vision screenings for children.

VISION SCREENING GOALS

Ten general guidelines for an effective screening program have been listed by Wilson and Junner. (Table VI) These guidelines are comprehensive, from inception through implementation and for perpetuation of the screening. Essentially, there are three basic goals that are common to all screenings --validity, effectivity and cost. I choose to make issue

pertaining to these goals in three manners. First of all, of the basic goals, there are two in direct opposition. Secondly, these basic goals seem to be arbitrarily added to by the authors of the independent vision screening studies. And finally, I take issue with the nonuniformity and/or ill-defined basic goals.

When the basic goals of validity, effectivity and cost are considered, we are immediately confronted with an inherent problem. The components, effectivity and cost are opposing goals, and as such have a covariant nature. As effectivity increases, cost increases and vice versa as cost decreases so then does effectivity. A standard, effective equilibration of these components is a considerable challenge and remains an issue for all vision screening designs.

The apparent arbitrary addition of goals to a vision screening study creates confusion for the reading audience and makes difficult the direct comparison of other vision screening studies. For example, " To be universally accepted, a screening method must be ... easily administered, of short duration, and inexpensive."[a] I question whether a screening has to be easily administered or of short duration or inexpensive and certainly not all of these need be satisfied in a single design? Independently, these criteria do not seem too demanding yet when united they form a contingency

that is likely to compromise the screening effort. Furthermore, I question whether a vision screening must be conducted "by persons with a minimum of training",[7] or as "some eye professionals insist...is feasible only when done by lay volunteers?"[4] Todays optometrists spend four years in graduate training. Does it then make reasonable sense to seek individuals who are minimally trained to perform a task as important as vision screenings? Cost considerations are a high priority yet this end must not be overly weighed merely to satisfy the governmentally expected "lowest bid."

Cognizant that the audience interested in vision screenings encompasses a wide variety of groups (educators, government officials, ophthalmologists, optometrists, public health officials, parents, and school administrators), care should be taken in differentiating "goals" from a "persuasion" one may have for a particular screening method. For example, if a screening method is inexpensive, let that advantage stand for itself rather than incorporating it into the design of the screening as a proposed necessity.

In an effort to achieve comparable data, finite and uniform goals need to be contrived. A uniform set of goals will enhance the data base, rendering it more meaningful and useful. This

issue, considering future decisions, which may have national proportions, is one worthy of further investigation.

The use of defined, uniform, specific and appropriately equilibrated goals will encourage the attainment of a single, effective vision screening design.

VISION SCREENING METHODS

The issues with the available screening methods include their wide variety, the differences in the visual skills they address and the fact that many of them are concurrently in use about the nation. First, I will give a short synopsis of the available screening methods followed by the forementioned issues.

The point of issue with the various screening methods is that of their sheer number; there are more than 10 different methods. Some are strictly acuity tests while most test more than one visual skill and still others are very comprehensive combinations of tests. Some require highly trained specialists while others may be administrated by minimally trained personnel. There are a number of instrument screening devices (stereoscopes) and of course the two formulating the basis of this study, the MCT and the RDE. The following is a list of some of the past and present screening techniques or methods.

Illiterate E, Massachusettes Vision Test Minnesota Modified Clinical Technique Modified Telebinocular (Keystone) New York State Optometric Association Ortho Rater Random Dot E Sight Screener School Vision Screener Keystone Visual Survey Test Titmus School Tester Snellen Letter Acuity

Granted some of these methods are much better than others and in spite of this some of the least effective methods are still used. Regardless of the reasons for the wide field of screening methods it is the duty of eye care professionals to contribute effective goal oriented studies to effectuate a narrower field of vision screening methods.

The Modified Clinicial Technique, the long standing, time honored, standard of vision screening presently takes a curious roll. This method is unsurpased in validity, (repeatedly above +.90 phi coefficient) yet the technique is over 30 years old and rarely used. Out moded, one might ask?

In the past 30 years since the Modified Clinicial Technique's inception many things have changed...the computerization of our world, the information glut, 24 hour

television to name a very few. Each of these have had a direct impact on the way we use our eyes. But in the last 30 years the fact is that the eye has not changed and still lends itself well to examination via the Modified Clinical Technique. The technique is not out moded.

Other methods of vision screening may require less time and may be less expensive but these will inevitably inflate incorrect referrals. The time has come to recognize the serious liability of incorrect referrals not only to morbidity but also to economics. On these grounds the Modified Clinicial Technique should be carefully reexamined for wide scale use.

Finally, any study of vision screening must be compared to the standards of the Modified Clinical Technique. Its accuracy, sensitivity and effectivity demand this. To compare a screening device to anything but the standard of vision screening, is to no avail.

The meritorious vision screening procedure, with such far reaching consequences is worthy of more investigation, and is worthy of an effort to resolve the issues of defining goals, and of finding a balance between cost and effectivity. And in the final analysis, should a national health care policy necessitate

a single vision screening method, and the Modified Clinical Technique prove unfeasible, let the method be qualified as compared to the rigorous standards established by the longstanding, standard of vision screening, the Modified Clinical Technique.

TABLE I

MCT Clinical Criteria for Correct Referral

A. Visual Acuity	20/40 or less, either eye
B. Refractive Error	
1. Hyperopia	+1.50 D.S. or more
2. Myopia	-0.50 D.S. or more
3. Astigmatism	+/- 1.00 D.C. or more
4. Anisometropia	+/- 1.00 D or more
C. Coordination Problems	
1. At Distance (20 feet)	
a. Tropia	Any tropia
b. Esophoria	5 p.d. or more
c. Exophoria	5 p.d. or more
d. Hyperphoria	2 p.d. or more
2. At Near (16 inches)	
a. Tropia	Any tropia
b. Esophoria	6 p.d. or more
c. Exophoria	10 p.d. or more
d. Hyperphoria	2 p.d. or more
D. Organic Problems	Any pathology or anomaly

D.S., diopters-sphere; D.C., diopters cylinder; D., diopters; p.d., prism diopters.

Table II

Random Dot E Stereoacuity Thresholds

Target Distance	Disparity
50 cm	504"
100 cm	252"
150 cm *	168" **
200 cm	126"
300 cm	84"
400 cm	63"
500 cm	50"

cm, centimeters; ", seconds of arch; *, test distance used in this study; **, disparity at the test distance.

TABLE III

Statistical Analysis

Screening Status	Number of Children	% of Total Number of Children
Passed Both MCT and RDE (TN)	51	62.96%
Failed Both MCT and RDE (TP)	7	8.64%
Passed MCT - Failed RDE (FP)	12	14.81%
Failed MCT - Passed RDE (FN)	11	13.58%

Table IV

RDE underreferrals as defined by MCT failure

Subject Age Years-months	Snellen Visual Acuity	Cover Test	Refractive Error
5-10	O.D.,O.S.		
6-3			Hyperopia
6-4	O.S.		
6-6	O.D.,O.S.	Strabismus	Hyperopia
7-4	O.D.,O.S.	6 p.d. EP'	Myopia
7-4	O.S.		
7-6	O.D.	6 p.d. EP'	
7-11		6 p.d. EP'	
8-0			Myopia
8-0		6 p.d. EP'	
8-1		6 p.d. EP'	

RDE, Random Dot E; MCT, Modified Clinicial Technique; O.D., right eye; O.S., left eye; p.d., prism diopters; EP', esophoria at near. Absence of a column for organic problems is due to the fact that no pathology or anomaly of the eye or adnexa was detected in the study population.

Table V

Phi Coefficient

Formula:

$$\text{phi} = \frac{(a)(d) - (b)(c)}{\sqrt{(a+b)(c+d)(a+c)(b+d)}}$$

a - number of correct referrals (TP)

b - number of over-referrals (FP)

c - number of under-referrals (FN)

d - nonreferrals (TN)

This formula renders values in the range of -1.00 to +1.00 with increasing validity indicated as the phi coefficient approaches +1.00.

TABLE VI

Guidelines for an Effective Screening Program:

1. The condition sought should be an important health problem.
2. There should be an accepted treatment for patients with recognized disease.
3. Facilities for diagnosis and treatment should be available.
4. There should be a recognizable latent or early symptomatic stage.
5. There should be a suitable test or examination.
6. The test should be acceptable to the population.
7. The natural history of the condition, including development from latent to declared disease, should be adequately understood.
8. There should be an agreed policy on whom to treat as patients.
9. The cost of case-finding (including diagnosis and treatment of patients diagnosed) should be economically balanced in relation to possible expenditures on medical care as a whole.
10. Case-finding should be a continuing process and not a "once and for all" project.

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