A New Method of Vision Care Delivery

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A NEW METHOD of vision screening and vision care delivery that we recently tested was made possible by the advent of an instrument that automatically measures the refractive characteristics of the eye. This measurement could formerly be made only by skilled practitioners. Using this instrument and paramedical assistants with little technical training, we conducted a study of grade school children in the East Harlem triangle in New York City.

This was a pilot project; the number of subjects tested was not very large, and our conclusions therefore are necessarily limited. Nevertheless, the results of this study are so encouraging that we believe them worthwhile to report at this stage in the work.

It is the purpose of vision screening of children to insure that no child with a remediable defect be required to attend school or perform other demanding visual tasks with that defect uncorrected. Although "the ideal goal is that every child should have a thorough professional eye examination before entering school" (*1*), it is unlikely that such an expensive goal will be reached in our time. A more realistic method of large-scale vision screening would employ, whenever possible, personnel with little specialized education. The scarce and highly paid practitioners should be reserved for patients who can be properly treated only by fully qualified professionals. To achieve these ends, we have designed a fairly simple scheme.

We measure the child's visual acuity and decide whether it is normal. If it is not, the child may then fit into one of two categories. The first, and by far the larger category, is comprised of those with poor acuity caused by a refractive error alone. In these people the optical properties of the eye are such that the image placed on the retina is not clearly focused. In nearly all such cases the prescription of suitable eyeglasses results in restoration of good acuity.

The second category comprises persons whose poor acuity does not result from refractive error alone. Until the refractive error has been measured and the visual acuity determined through suitable correcting eyeglasses, we cannot know whether the person belongs in the first or second category. This knowledge is crucial.

With rare exceptions, refractive errors are not disease states; thus, the detection and measurement of refractive errors and the prescription of eyeglasses to correct them cannot properly be classified as the diagnosis and treatment of disease.

Assisting in the Study

Dr. Alan Barnert, Dr. David Kimmelman, Dr. Joel Klayman, Dr. Edward Palmer, Dr. Edward Raab, and Dr. Stephen Rosenthal examined many of the children in this pilot study. Dr. Stanley Raines fitted them with eyeglasses. The daily protocol was conducted by Francis Edgerton, John Evans, Lucy Fortes, and Olga Lopez.

Refractive errors should be thought of as statistical deviations from the norm—the norm being that desirable and convenient state in which the eye, with little or no effort of accommodation, can create on the retina a sharply focused image of distant objects. Most eyes with refractive errors have tissues that are entirely normal. The refractive error is usually the result of an imperfect correlation of otherwise normal ocular elements, elements that might reasonably be expected to occur in an eye with no refractive error.

If a child's visual acuity cannot be restored to normal by eyeglasses, he belongs in the second category. These patients may have disease and need medical or surgical treatment.

Practitioners who provide vision care spend much of their time determining the refractive error of the patient. Usually the practitioner first forms his own estimate of the refractive error, the so-called "objective" testing. He then may enlist the aid of the patient and, using the patient's responses and opinions, perform the "subjective" testing. In the United States the "objective" testing is nearly always done with a retinoscope, which is a small, hand-held instrument, much like an ophthalmoscope. Quite a good estimate of the refractive error can be made by a practitioner using a retinoscope, but it requires a moderate amount of time and a great deal of skill. With a good objective measurement, the refractionist is better able to judge the reliability and relevance of the patient's responses in the subjective or "better one, better two?" type of testing. It is common practice to prescribe eyeglasses for young children directly from retinoscopic measurements, without subjective comparisons.

One of us (A.S.) has developed an optical-electronic instrument capable of performing the objective or retinoscopic part of the refraction with substantially the same degree of reliability as a practitioner. The instrument, called the Ophthalmetron (*A*) can be operated by a technician unskilled in refraction. The output is in the form of a graph drawn on paper, which can be read by the technician after brief instruction. The prototype of the Ophthalmetron has been validated in earlier studies (*2, 3*) which also supplied information about the precision and accuracy of both practitioners and patients (*4, 5*).

Screening grade school children is somewhat easier than screening adults because ocular disease is relatively infrequent in school-age groups. Tumors of the eye and congenital glaucoma, al-

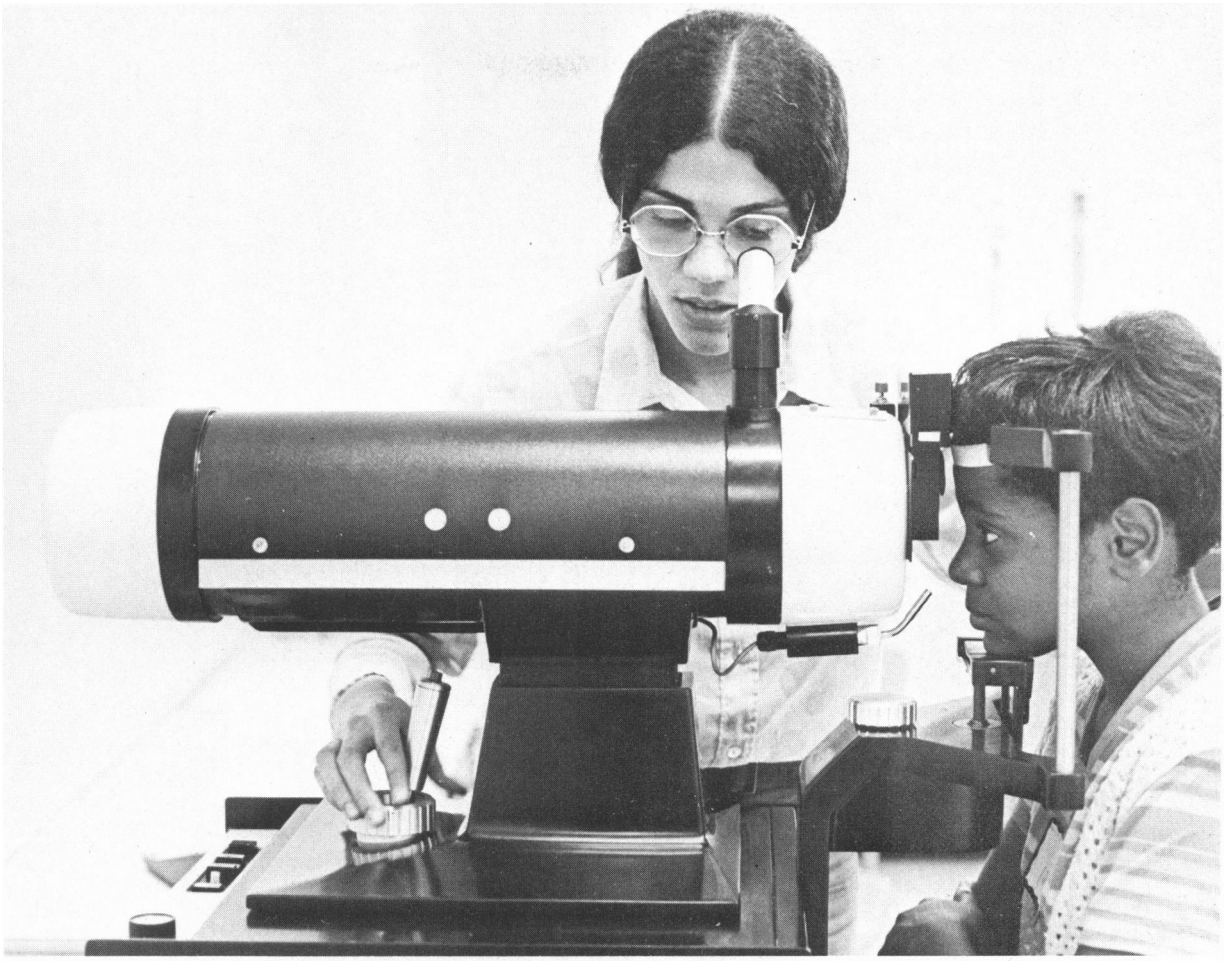

Figure 1. Refractive error measured by the Ophthalmetron. The operator views the alignment target and the eye through the viewfinder on the top of the instrument. She adjusts the position of the instrument relative to the subject's eye by manipulating the control lever and ring with her right hand. The record paper is inside the black cylindrical section of the upper part of the instrument. The electronic circuits are housed in the rectangular base which rests on the table top.

though matters of concern in pediatric ophthalmology, are relatively rare and usually present in infancy rather than in the school-age group. Strabismus, however, is common, can cause serious visual defects, and should be searched for in any good screening program.

In this paper we describe our method of using paramedical personnel to measure visual acuity, detect strabismus, determine the refractive error, correct the refractive error with eyeglasses, and refer to ophthalmologists those children requiring consultation.

Materials

The Department of Community Medicine of the Mount Sinai School of Medicine has established several programs in conjunction with the East Harlem community adjacent to the Mount Sinai Hospital. One of these programs involved the training of neighborhood people as school health assistants (SHAs).

In the 5 weeks preceding the school summer vacation of 1971, we trained several SHAs and screened for visual defects the fourth grade of Community School 31. This was an experimental

grade school operated with considerable guidance from the local community, an economically depressed area inhabited almost exclusively by Negroes and Puerto Ricans.

An Ophthalmetron was supplied by Bausch and Lomb for these tests. This is a self-contained, tabletop device at which the subject is seated, with forehead and chin resting against adjustable supports (see figure 1). The operator inserts a fresh record sheet in the instrument, aligns a color photograph as the subject's visual fixation target, and adjusts the instrument's position in relation to the eye being measured. The correct instrument position is achieved by superimposing a bull's-eye target on the image of the subject's eye as seen through the operator's viewfinder. Alignment usually requires approximately 30 seconds. Following the alignment, the "operate" but-

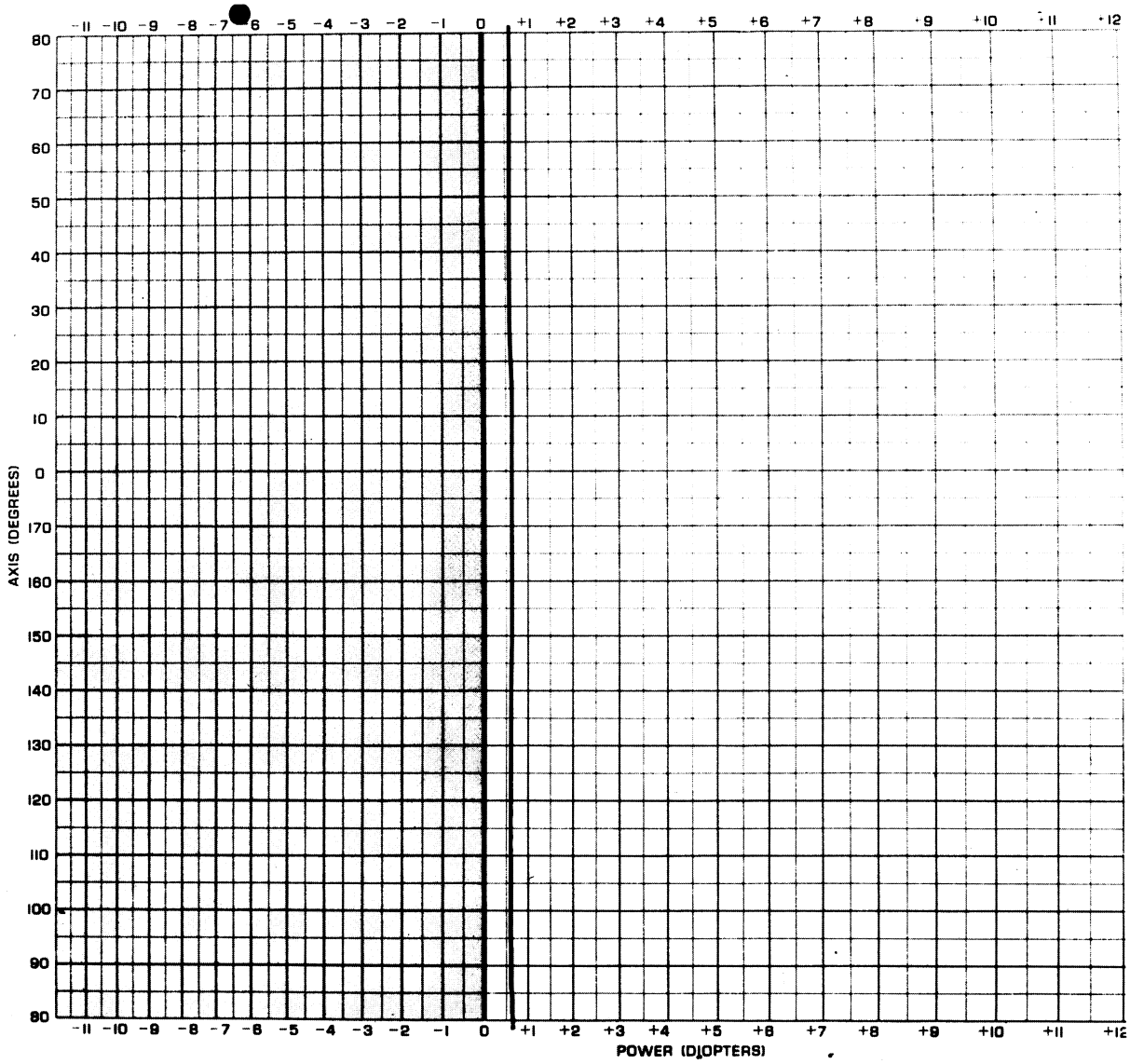

Figure 2. Tracing from a subject. Along the abscissa are listed dioptric values of spectacle lenses necessary to correct the eye under study. Along the ordinate are shown the meridians that are used to characterize orientation of astigmatism. The heavy vertical line at zero diopters is printed on the paper as a reference. The vertical line at just above +0.50 D is the pen tracing for this subject, who manifested a hyperopia of slightly more than half a diopter. Small irregularities in the tracing are due to fluctuations of accommodation occurring during the 3 seconds the pen was writing.

ton is pressed, and the instrument performs its measurement of the refractive error in 3 seconds. The record sheet may then be removed for interpretation. Figures 2 and 3 show sample tracings.

Method

A brief ocular history was recorded for each child by a coordinating examiner. This history was restricted to questions about prior eye injury or disease and the prescription or use of eyeglasses. The cover-uncover test for strabismus was performed by one of the SHAs. This was followed by a test of visual acuity in each eye. Standard Snellen charts (*B*) were used. The results from each examination were recorded on separate sheets precoded for computer card keypunching. In order to avoid bias, each sheet when completed was placed face down in a separate compartment of

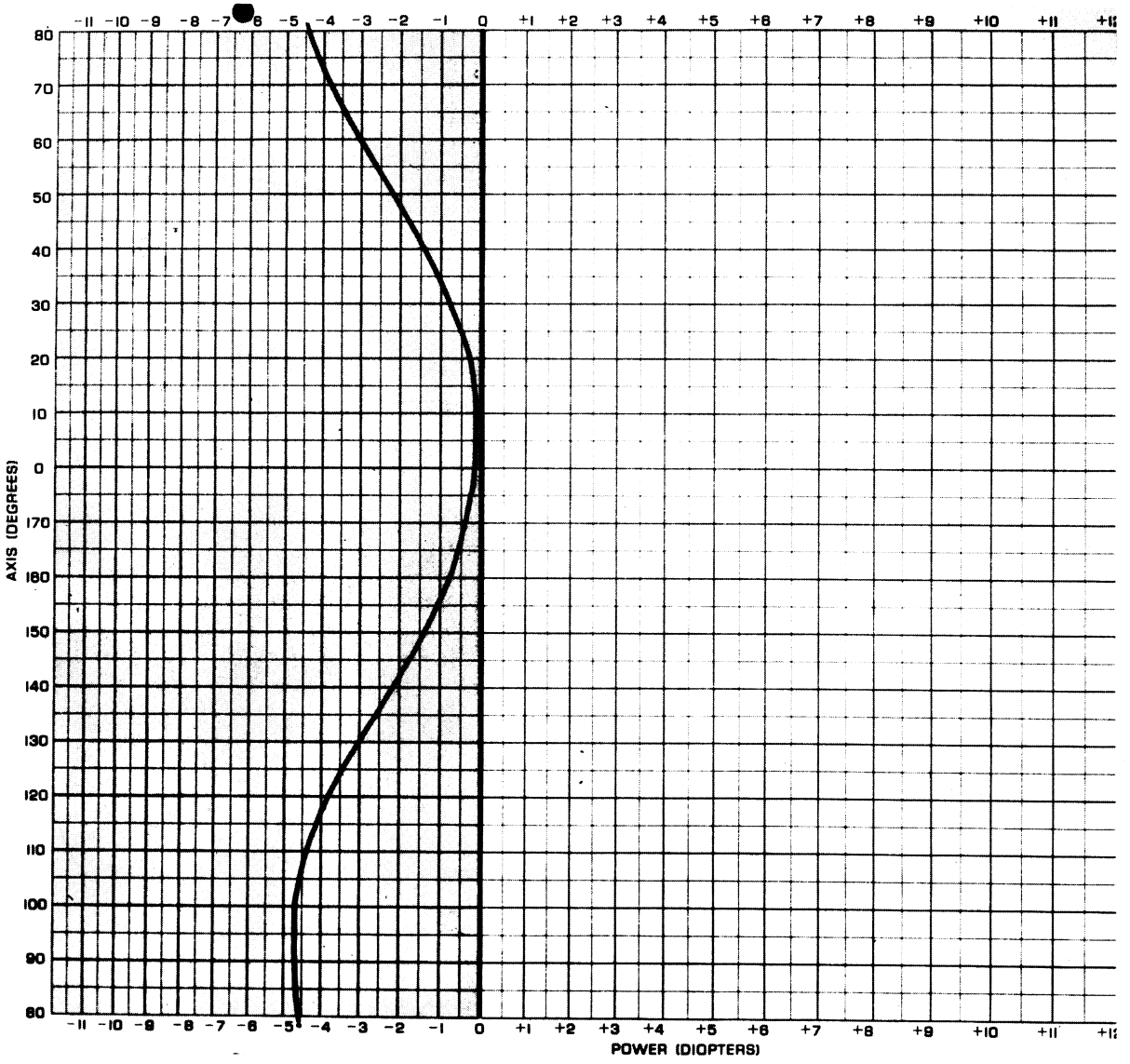

Figure 3. Tracing from a subject with astigmatism. This person has a moderate amount of myopia and a large astigmatism. The most myopic meridian is at −4.75 D, and the least myopic at approximately −0.25 D. The difference between the two extremes equals 4.50 D and is the amount of astigmatism present. The extremes of the curve occur at 5° and 95°, the two principal meridians. This is expressed in an eyeglass prescription as −4.75 D Sph. + 4.50 D Cyl. × 95° or, the equivalent, −0.25 D Sph. −4.50 D Cyl. × 5°.

the child's record folder, not visible to subsequent examiners.

The first measurement with the Ophthalmetron was made by an examiner who had not previously seen the child. After a satisfactory tracing was obtained, it was interpreted by an SHA who also had not seen the child before. The SHA interpreted the tracing by recording the position and dioptric power of the extremes of the curve. The power of the cylinder was obtained as the difference between these extremes. By convention, this difference was always expressed as a positive cylinder for eyeglass prescription. A printed protocol had been issued to the technicians, specifying those refractive errors for which trial eyeglasses would be prescribed: myopia of 0.50 diopters or more, hyperopia of 3.00 diopters or more, astigmatism (cylinder) of 1.50 diopters or more, or spherical equivalent (sphere + ½ cylinder) of at least 0.50 D of myopia or 3.00 D of hyperopia.

If the tracing from either eye of a child satisfied the prescription criteria, trial eyeglasses based on the Ophthalmetron reading were assembled by the SHA, using ordinary ophthalmic trial lenses. Another SHA tested visual acuity with these trial eyeglasses. Snellen charts with different sets of letters and numbers were used in the two acuity tests made without and with trial glasses in order to avoid the possibility of memorization.

All children were then given one drop of cycloplegic drug instilled into each eye. The drug used was cyclopentolate hydrochloride (*Cyclogyl*) (*C*), either 1 percent or 2 percent depending on skin pigmentation. All students had been classified according to skin pigmentation by the coordinating examiner. To offset the well-known insensitivity of darkly pigmented people to cycloplegic drugs, the more pigmented subjects were given the more concentrated solution.

After at least 30 minutes, the patient, his pupils dilated, was reexamined by either of two procedures. Half the children were retested first with the Ophthalmetron and then examined by an ophthalmologist. The other half followed the reverse procedure. The second Ophthalmetron tracing was interpreted but not used to make trial eyeglasses.

The examination by the ophthalmologist was not complete. Because of limitations of time and equipment, the examination was restricted to a determination of the refractive error. Streak retinoscopy was done on all subjects, and the results were recorded before the examiner was permitted to give subjective tests or to view the remainder of the subject's record. The cross cylinder was used for subjective testing. For practical reasons, more time and effort were spent in subjective testing of subjects with significant refractive errors than on those with trivial errors.

In all instances the ophthalmologist reviewed the completed chart and decided whether to prescribe eyeglasses. By prior agreement, his criteria for prescription were identical to those cited for trial eyeglasses, but he did not prescribe eyeglasses for patients who barely met the criteria in only one eye.

Subjects requiring eyeglasses were sent to a nearby optometrist who filled the prescriptions, using frames chosen by the subjects themselves. These eyeglasses were paid for by the grant supporting this project.

Thirty percent of the subjects were brought back a second time for a repetition of the entire procedure. This was done to obtain an estimate of the reproducibility of each of the measurements. Such replication of measurements was made for all subjects for whom eyeglasses had been prescribed and for 16 percent of the others.

Results

Records sufficiently complete for analysis were obtained for 141 of the 143 students tested. The 141 were about evenly distributed by sex: 54.6 percent boys, 45.4 percent girls. There was a preponderance of Negro (63.8 percent) over Puerto Rican (36.2 percent) students. Most of the children were 9 years old.

Only nine (6.4 percent) were wearing glasses at the time of the examination. Of these, seven were girls and two were boys. An additional 38 students (26.9 percent) claimed to have had vision defects diagnosed sometime before, but were not using corrective lenses. Three students gave a history of eye injury. Two cases of strabismus were found on examination.

Visual acuity of the naked eye was measured in all cases. About seventy-five percent of the eyes tested had an acuity of 20/40 or better. Right eye-left eye differences were insignificant. However, the data from both eyes of each subject show that 90 percent of the students had vision of 20/40 or better in at least one eye. Hence, 10 percent of the children had vision probably inadequate for schoolwork in both eyes, and an additional 15 percent had inadequate vision in one eye.

We compared the visual acuities of the naked eyes with those obtained with trial eyeglasses prescribed by SHAs directly from the instrument's tracings before cycloplegia. Again, we first compared changes in single eyes, and then changes in both eyes of individual children. We classified acuity into three categories: (A) serviceable or good, 20/40 or better; (B) moderately impaired, between 20/40 and 20/200; or (C) seriously impaired, worse than 20/200.

We have reliable acuities from 74 single eyes tested with machine-prescribed eyeglasses. Before glasses the distribution of acuities was (A) 73 percent, (B) 20 percent, (C) 7 percent. With the glasses this became (A) 89 percent, (B) 11 percent, (C) 0 percent. However, acuities in single eyes do not necessarily give a true indication of the ability of the person to see. A person's ability to function visually depends largely on the vision in the better eye. We have therefore classified our cases according to the visual acuity in the better eye when the two eyes had different acuities. There were 38 such cases. The results are: before machine refraction (A) 78 percent, (B) 16 percent, (C) 5 percent; after machine refraction (A) 94 percent, (B) 6 percent, (C) 0 percent.

Although significant improvements in visual acuity can be obtained with Ophthalmetron-prescribed eyeglasses, visual acuities in children are not reliable and should not be the sole criteria on which to base comparisons. We have therefore attempted to compare directly the measurements made by machine with those made by the ophthalmologists.

A refractive error, and the lens necessary to correct it, can be characterized by three parameters: sphere power, cylinder power, and cylinder axis. Comparing two prescriptions, each with these three parameters, is extremely difficult, since the parameters do not have equal weight and are not independent of each other. We examined our tabulated data and found that, in the comparison of sphere power measured by the Ophthalmetron before eye drops and the ophthalmologist after eye drops, approximately half the measurements differed by 0.25 D or less, and two-thirds of the cases differed by 0.50 D or less. The same results were found for cylinder power.

Cylinder axis measurements cannot be compared in this simple way; the axis is a function of the cylinder power. The larger the cylinder, the easier it is to distinguish the axis. In our population, as in most, small cylinders are more common than large ones. Small cylinders are the most difficult to compare. For example, if one method of measurement gave cylinder power of 0.50 D, and another method gave 0.00 D, we could compare the two powers. However, the cylinder of zero power has no axis to be compared with the axis of the 0.50 D cylinder. Valid comparisons of axes can be made only between cylinders of like powers. A much larger sample than ours is needed for this type of analysis.

Table 1. Differences between Ophthalmetron measurements before and after cyclopegia and retinoscopy

Type of difference	T_1 versus T_3		T_2 versus T_3	
	Right eye (N= 113)	Left eye (N= 108)	Right eye (N= 107)	Left eye (N= 105)
Sphere difference ≤0.50 D.....	64.5	61.2	71.0	58.1
Cylinder difference ≤0.50 D.....	68.2	61.2	78.5	68.5
Spherical equivalent difference ≤0.75 D..	70.0	70.4	85.1	73.4

DEFINITIONS:
T_1 = Ophthalmetron measurement before cycloplegia.
T_2 = Ophthalmetron measurement after cycloplegia.
T_3 = Retinoscopy performed by ophthalmologist after cycloplegia.
N = Number of cases.

Table 1 shows the comparison of machine measurements, before and after cycloplegia, with ophthalmologists' measurements, always after cycloplegia. Note the tendency for measurements of right eyes to agree better than those of left eyes. The agreement of the two cycloplegic measurements is, as expected, slightly better than that between precycloplegic and cycloplegic measurements. The spherical equivalent is a commonly used method of attempting to deal with comparisons of sphere and cylinder simultaneously.

The sample was then divided according to sex and race. Tables 2 and 3 show the means and standard deviations for each of the measurements and the population subgroups.

A difference in the average value of sphere for the various types of measurements is evident. Thus, the Ophthalmetron before cycloplegia gives the most myopic readings on the average (—0.24 D), while after cycloplegia the average sphere is slightly hyperopic (0.38 D). Retinoscopy lies in between, with an average measurement of —0.04 D. The variances are large, reflecting the spread

Table 2. Sphere power: Means and variances for different population groups

Method	Black		Puerto Rican		Mean value	
	Boys	Girls	Boys	Girls		
Ophthalmetron tracings before cycloplegia:						
Right eye						
Mean	−0.0489	−0.3106	−0.7361	−0.3214		
Standard deviation	0.4848	2.1223	2.3475	1.1212	−0.2754	
Sample size	46	33	18	21		−0.2371
Left eye						
Mean	−0.3352	−0.0234	−0.6765	0.2143		
Standard deviation	1.7495	2.4100	2.1135	1.8596	−0.1974	
Sample size	44	32	17	21		
Ophthalmetron tracings after cyclopegia:						
Right eye						
Mean	0.2500	0.4697	0.1364	0.3690		
Standard deviation	1.8772	2.3417	0.7277	1.1225	−0.3287	
Sample size	43	33	11	21		0.3796
Left eye						
Mean	0.4419	0.5806	−0.3542	0.6250		
Standard deviation	1.6591	2.5904	3.6251	1.9315	0.4306	
Sample size	43	31	12	22		
Ophthalmologist retinoscopy:						
Right eye						
Mean	−0.1350	0.2014	−0.5714	0.2024		
Standard deviation	2.1406	2.1645	2.5352	2.0181	−0.0269	
Sample size	50	36	14	21		−0.0362
Left eye						
Mean	−0.1300	0.4306	−1.1607	0.0833		
Standard deviation	1.8366	2.0577	3.3117	1.8781	−0.0454	
Sample size	50	36	14	21		
Mean value for each sex	−0.0059	0.2251	−0.6017	0.1988	Grand mean	
Mean value for both sexes	0.0947		−0.1244		0.0270	

Table 3. Cylinder power: Means and variances for different population groups

Method	Black		Puerto Rican		Mean value	
	Boys	Girls	Boys	Girls		
Ophthalmetron tracings before cycloplegia:						
Right eye						
Mean	0.2553	0.6364	0.4722	0.5714		
Standard deviation	0.4054	0.7210	0.7013	0.9258	0.4492	
Sample size	47	33	18	21		0.5567
Left eye						
Mean	0.5170	0.8203	0.3971	0.9762		
Standard deviation	0.7141	0.7330	0.6907	1.3599	0.6689	
Sample size	44	32	17	21		
Ophthalmetron tracings after cycloplegia:						
Right eye						
Mean	0.4186	0.6591	0.2955	0.7381		
Standard deviation	0.5080	0.7827	0.5456	1.0939	0.5417	
Sample size	43	33	11	21		0.5556
Left eye						
Mean	0.3779	0.7823	0.2500	0.8182		
Standard deviation	0.5679	0.7296	0.2384	1.0356	0.5694	
Sample size	43	31	12	22		
Ophthalmologist retinoscopy:						
Right eye						
Mean	0.5350	0.8750	0.8393	1.0595		
Standard deviation	0.6814	0.9901	1.1033	1.1616	0.7624	
Sample size	50	36	14	21		0.7665
Left eye						
Mean	0.5500	0.7778	0.8036	1.2619		
Standard deviation	0.6720	0.8404	1.0705	1.5114	0.7707	
Sample size	60	36	14	21		
Mean value for each sex	0.4449	0.7600	0.5169	0.9035	Grand mean	
Mean value for both sexes	0.5774		0.7474		0.6298	

Table 4. Differences between first and second replicate measurements made by each of the 3 techniques

Type of difference	T_1		T_2		T_3	
	Right eye (N=32)	Left eye (N=31)	Right eye (N=33)	Left eye (N=30)	Right eye (N=38)	Left eye (N=38)
Sphere difference ≤0.50 D	62.5	74.3	81.8	83.4	71.1	68.5
Cylinder difference ≤0.50 D	68.9	74.3	85.0	76.8	73.7	73.7
Spherical equivalent difference ≤0.75 D	84.5	87.1	88.0	86.6	81.5	73.7

DEFINITIONS: T_1=Ophthalmetron measurement before cycloplegia. T_2=Ophthalmetron measurement after cycloplegia. T_3=Retinoscopy performed by ophthalmologist. N=Total number of cases.

of refractive errors of individuals in the population. The *t*-tests show that the only significant differences are between the Ophthalmetron tracings before and after drops. Neither of the Ophthalmetron tracings on its own differs significantly from retinoscopy.

A shift toward hyperopia is to be expected as the result of cycloplegia. The average shift for the Ophthalmetron readings, the only precycloplegic and cycloplegic measurements available, is 0.62 D. This is a gratifyingly small shift in view of the approximately 15 D of accommodation readily available to 9-year-olds.

There is also a significant difference in sphere between males and females. This is complicated by the important racial differences between males.

Differences between the sexes are particularly noticeable within the Puerto Rican population, where the males are myopic on the average (−0.60 D). The females are slightly hyperopic (+0.20 D) and differ little, on the average, from the Negro female group (+0.23 D). Negro males were almost perfectly emmetropic.

From table 3 it can be seen that for cylinder there are differences in the population means between Negroes (0.58 D) and Puerto Ricans (0.75 D). These proved to be significant at the 0.05 level of the *F*-test in the analysis of variance. Male-female differences are most significant (0.01 level): it is seen that females have, on the average, larger astigmatism than males (0.82 D versus 0.46 D). These differences are more noticeable among Puerto Ricans than Negroes, which show up as a highly significant race-sex interaction term in the analysis of variance. A statistically significant difference was also found between the types of measurement. This reflects the fact that, on the average, retinoscopy yielded larger cylinders than either of the Ophthalmetron readings (0.7665 D versus 0.5567 D and 0.5556 D). The latter were almost identical. Although left eyes appeared to have consistently larger cylinders than right eyes, the difference was not significant.

Data from the repeat visits of 43 students were available for calculating estimates of the precision of the Ophthalmetron measurements. Since not all data were complete at each visit, the number of samples for each of the types of measurements is different. As a measure of general replicability we take the standard deviation of the replicates about the pooled means. This is calculated as the square root of the mean value of the sum of squares of the differences of each member of a pair of replicates from the mean of the pair.

The measurements taken without cycloplegia have a slightly greater variability than those with cycloplegia. The standard deviation for right eyes was greater (0.44 D) than for left eyes (0.42 D) before cycloplegia as well as after (0.36 D versus 0.31 D).

A more clinical measure of replicability would be based on the percentage of cases for which the replicates differ in sphere and cylinder by 0.50 D or less. These data are shown in table 4. In comparing these data to those of table 3, it can be seen that a difference of 0.50 D or less in sphere and cylinder can occur almost as often in replicate measurements by either Ophthalmetron or retinoscopy as a difference of 0.50 D between the Ophthalmetron and retinoscopy measurements done at the same visit.

Most coincidences in replication occur for the spherical equivalent (over 80 percent of the cases usually differ by 0.50 D or less), and in this category the retinoscopy measurements agree less within themselves than the Ophthalmetron readings. This situation might be expected because in most cases different physicians saw the student on repeat visits. In addition, replication variability in retinoscopy has been found to be high in an earlier study (*4*). It can be seen that, in general, the ability of the Ophthalmetron to repeat its

measurements is comparable to that of the practitioners, as measured in this sample.

One good measure of a vision screening program is the percentage of appropriate referrals. Since ophthalmologists were present during the screening, we were able to determine whether the prescriptions and referrals resulting from the SHAs' interpretations of the instrument's tracings were appropriate.

The ophthalmologists prescribed eyeglasses for 26 children. Twenty-five (96 percent) of these were also given eyeglasses by the SHAs. The single disagreement was a borderline case; the ophthalmologist diagnosed 1.50 D of astigmatism in each eye, whereas the Ophthalmetron found 1.25 D in one eye and 1.00 D in the other. This child's visual acuity without eyeglasses was 20/30 in one eye and 20/50 in the other. This case was the only possible under-referral.

Applying binocular criteria identical to those the ophthalmologists used, we would have over-referred approximately 15 percent of the students based on SHAs' judgments alone. However, if naked visual acuity was taken into account, a great improvement resulted. If naked acuity of 20/30 or better in one or both eyes is present, despite an Ophthalmetron prescription just over the borderline, the patient should not realistically be considered a candidate for eyeglasses. Using these combined criteria, we would have had to refer two patients who were so uncooperative that no reliable data could be recorded from any test procedure.

Discussion

School is a sensory experience. When a child enters school he enters an organized program that society has designed to attempt to change and mold many aspects of his personality. In good schools these changes are beneficial; they add to the likelihood of a richer and more enjoyable life. School conveys nearly all its message through vision and hearing, the two channels of sensory input through which we learn most of what we know about the world at some distance from us.

To allow children with poor vision or hearing to participate in this intense and demanding visual-auditory experience is to preordain failure of the educational experience for a large number of them. Visual impairment is such an obvious detriment to success in school that attempts at vision-screening are nearly universal in the school systems of highly developed societies.

Unfortunately such school vision-screening programs have frequently achieved a poor record of success in improving the vision of those tested. It is a commonplace that some children may be screened and found defective in vision every year, and note after note sent home to the parents, but nothing is done to improve the child's vision. This story is most common in areas where the parents are poor and unschooled themselves, and the children in the home are numerous. An account of some of the complexities of vision-screening programs has recently been published (*6*).

In the fourth grade that we examined there was a class of 11 children designated as slow learners. Two of these children had large refractive errors. One girl had 4 diopters of uncorrected astigmatism in each eye. She probably could read nothing on the blackboard. Each year a note of her defective acuity had been sent home with no result. One boy had 13 diopters of myopia combined with 3 diopters of astigmatism in each eye. He had once in the past been given eyeglasses but had not worn them for several years. It is doubtful whether this boy could have recognized his teacher or any of his classmates beyond arm's length.

Because such conditions exist in many schools, even those in wealthy communities, we wished to attempt a screening program that would include important elements of the delivery of vision care as well as the diagnosis of the need for vision care. We gave prescriptions and informed the parents that eyeglasses could be obtained free from a nearby optometrist. Nevertheless, 3 months after the completion of our screening of the fourth grade 54 percent of those who had been prescribed eyeglasses had not yet obtained them.

It is our opinion that the most effective way to insure that the children needing eyeglasses receive them, is to dispense the eyeglasses at the school, at the time of the examination. We recognize that this proposed method of vision care may be contrary to traditional methods and therefore unwelcome to some, but we believe that the community should not tolerate the incalculable cost of attempting to educate children who cannot see.

It is not at all revolutionary to bring medical care into the school; it has been done in many other fields. What is new about our method is the use of an electronic instrument, the proposal that paramedicals with special but brief training do all the screening, and the prescription of eye-

glasses for young children directly from noncycloplegic refractions done by someone other than a highly skilled practitioner.

This pilot study was designed to validate this method of using the Ophthalmetron and paramedical technicians. It was not designed to test how rapidly or economically the procedure could be done. We hope to extend this study to younger and younger children until we find the earliest age at which it is applicable. It is quite possible that, along the way, we will find epidemiologic surprises such as we already have. We had no suspicion that we would find a high prevalence of myopia (in several cases very high degrees of myopia) among Puerto Ricans. The literature in this country is seriously deficient in studies of the refractive errors to be expected in various racial groups that comprise our population.

We wish to point out that our interpretations of the Ophthalmetron tracings by technicians were reasonable but necessarily arbitrary. We had no background of pediatric work with the Ophthalmetron upon which to draw. The experience of this pilot study should help us to be more precise and accurate in the refractions we do on school children in the future. That we obtained good results in spite of our lack of experience with these techniques is encouraging, and we look forward to being able to contribute to the improvement of eye care for many school children.

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(*1*) Vision workshop in Columbus. Sight Sav Rev 27: 35, 36 (1957).

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SAFIR, ARAN (Mount Sinai School of Medicine, City University of New York), KULIKOWSKI, CASIMIR, CROCETTI, ANNEMARIE F., KUO, MARIA I-HWA, and DEUSCHLE, KURT: *A new method of vision care delivery. A pilot study. Health Services Reports, Vol. 88, May 1973, pp. 405–415.*

Paramedical technicians using a recently developed automatic refracting instrument measured the refractive errors of 143 fourth-grade children. According to a written protocol they classified the children as either needing or not needing eyeglasses, based on the measurements made by the automatic instrument. Those needing eyeglasses were given test glasses "dispensed" by the technicians from ophthalmic trial lenses. Visual acuities were measured with and without trial eyeglasses. The technicians' prescriptions were compared to those determined by ophthalmologists using traditional methods of refracting.

The ophthalmologists prescribed glasses for 26 children, 25 of whom had also been identified by the technicians as needing glasses, based on machine refractions. Thus there was one under-referral.

If visual acuity without glasses is considered, and glasses are not given to any child having 20/30 or better in one or both eyes, there were no over-referrals.

Sixty-five percent of the prescriptions for spheres generated by the instrument agreed within half a diopter with those generated by the practitioners using retinoscopy under similar conditions. Astigmatisms compared the same way agreed in 74 percent of cases.

The protocol was repeated for about 25 percent of the cases. The precision of the automatic instrument was greater than that of the practitioners when measured under similar conditions.

An unexpected high prevalence of myopia was found among the Puerto Rican children. It is feasible to have properly trained and equipped paramedical technicians perform school vision screening, make appropriate referrals, and dispense satisfactory eyeglasses.