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Computer-Assisted Eye Examination. VII. Final Evaluation of the Refractor III System for Subjective Examination After Reducing Software and Hardware Errors

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Abstract

Eighty patient-volunteers were refracted by the computer-assisted Refractor III system and the results were compared with those obtained by the usual manual method. For the distance prescription 95% of the results were satisfactory. For the near add all were satisfactory. Relative validity of the system was also measured objectively by repeatability data. System test differences and test-retest manual-examination data were found comparable, indicating that the validity of the system is similar to that of the manual method. Further developments are expected to improve reliability, simplify maintenance, and extend testing so that the system will be an economical and useful instrument in eye clinics.

Key words: refractive error, subjective examination, computer assistance, measurement errors, prescription evaluation

Within the series of seven papers on computer-assisted eye examination,[1-6] this is the third of the subseries that deals with the evaluation of the Refractor III system. The first paper in this subseries[5] provided a preliminary evaluation of the system and found approximately 83% satisfactory agreement between the computer-recommended Rx and that obtained by the usual manual method. The second paper[6] disclosed the major hardware and software errors and their causes, and the present communication reevaluates the system after most of these errors have been minimized or eliminated.

Previous publications have covered automated eye examination,[7] automated visual case-history interviews,[8] and automatically determined visual acuity.[9] Of the series of seven papers, the first four were a treatment of computer-actuated refractors,[1] an evaluation of visual-evoked-poten-

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tial refraction,[2] an evaluation of physiological indices,[3] and a treatment of their optical effectivity.[4] The current clinically useful model, based on the third model of a computer-actuated refractor, is called the Refractor III system and includes ancillary equipment in addition to the refractor, such as the computer, interface, and other input/output equipment, including the voice encoder and loudspeaker, slide projector, and pushbutton response box. For details of the system, the first and fifth papers[1,5] are particularly cogent.

METHODS

Subjects

The patient-volunteers were drawn from regular patients at the Letterman Army Medical Center Optometry Clinic as they appeared. Of the 80 patients examined with the Refractor III system, 47 were male and 33 female. Their ages ranged from 12–77 yr, with a mean of 34. Ametropias were divided as follows: myopes, 55; hyperopes, 25; and astigmats, 72. The near test was administered automatically to the 23 patients aged 40 or older.

Hardware and Software Improvements

An attempt was made to eliminate all the hardware and software problems, most of which had been discovered and described in a previous publication.[6] The installation of the "initial edge detector circuit" eliminated one of the major errors, in which the patient pressed the answer button correctly but held it down so long that it registered erroneously for the next test. This error is no longer physically possible, because of the circuit design. Once this change was accomplished, the improvement was immediate and dramatic.

Improvements in the organization of the software allowed the ready tone, or "beep" signal, to be sounded immediately after the audio instructions were provided or the lens slide displayed. This not only eliminated a major source of delay but made discrimination easier in that sequential lenses can be judged more rapidly and directly.

An initialization, or exercise, routine which makes each mechanical function of the system perform at the beginning of the day has reduced hardware warm-up problems. However, it has been found that a small amount of axis chatter—that is, oscillation of the cylindrical axis within a 1–2 deg range—sometimes persists. It appears that a redesign of the axis control may be necessary for complete elimination of this chatter. The microprocessor control to take over this function from the hardwired interface control is in an advanced state of development and is expected to be installed soon. The design of the microprocessor control is such that axis chatter should be eliminated. Aside from the slightly annoying noise, the only effect axis chatter has on the results of the refraction is that it slows down the presentation of subsequently compared lenses and thus lengthens the examination.

The delta modulation voice encoder, which provides the short messages, has functioned flawlessly since its installation during this series of tests. The older cassette tape deck, which plays the longer messages, also functioned without problems. We plan to put the long messages in the delta modulation voice encoder system, however, since any tape deck is subject to mechanical problems and requires more maintenance than does an entirely solid-state system.

The slide projectors proved to be very reliable during the current tests as long as the software controlling them was correct. Like the cartridge tape deck, slide projectors are part of a mechanical system, and in the interest of high reliability and low maintenance it is desirable to eliminate them. A new design is under construction to meet this goal.

Changes in the near-test flow chart have made it more reliable. In order to increase its flexibility in the future, it may be desirable to include in the initial entrance of the patient's data to the computer file the working distance at near if it is different from the usual assumed distance of 40 cm. In that way the program can provide a near add for a distance other than the standard one.

Future Improvements Planned in System

A number of improvements can be made in the system to extend its use and increase

its accuracy and reliability. Most of these improvements have not been undertaken because they were not essential to the primary goal of demonstrating the basic successful operation of the computer-assisted eye-examination system. As higher-priority problems are solved, resources become available for the solution of the remaining problems. The following improvements are planned.

Binocular Testing. All the hardware exists for various binocular tests, including heterophoria, prism duction, and similar testing. Flow charts have been devised, and these tests will be available once the necessary programming has been accomplished.

Retroilluminated Display Chart. A half-century ago, before slide projectors were commonly used in the examination room, refractionists often used a retroilluminated chart—that is, one that consisted of black letters on white opal glass (or the reverse), illuminated from behind. With certain modifications, this scheme can be used in our system and computer-controlled. Such a display would eliminate the moving parts of the slide projector and would not depend

```
NAME:
ADDRESS:
PHONE:
PATIENT'S SEX: F
PATIENT'S AGE: 40
OCCUPATION:
IDENTIFICATION NO.:          5628
REFERED BY: DR RUTLEDGE
LAST EYE EXAM: 1977
PLACE OF LAST EYE EXAM: LAMC

DATE OF R3 EXAM: 27-JUN-77 14:26:58
DATE OF PRINTOUT: 20-APR-78 13:56:53


OD                                  OS
VA    SPH     CYL     AX   TIME     VA    SPH     CYL     AX   TIME

VA W/O RX:
400   PLANO                 0:57     400   PLANO                 0:33

VA   OLD RX:
20    -2.75   -0.50   67   0:58     20    -2.75   -0.75   91   0:55

SEQUENTIAL SPHERICAL CORRECTION:
      -2.75   -0.50   67   1:45           -2.75   -0.75   91   1:04

FINAL X-CYL AXIS:
      -2.75   -0.50   64   1:56           -2.75   -0.75   35   0:53

CYLINDRICAL POWER:
      -2.37   -0.25   64   1:24           -2.37   -0.50   35   0:42

FINAL SPHERICAL CORRECTION:
      -2.37   -0.25   64   1:19           -2.37   -0.50   35   1:10

FINAL CORRECTION:
25    -2.12   -0.25   64   1:43     20    -2.37   -0.50   35   2:02

SUGGESTED RX:
20    -2.75   -0.50   67   0:00     20    -2.37   -0.50   35   0:00

NEAR TESTS:

VAAE AE       TIME        NRA      VAAF AF       TIME      PRA        VA40 TIME
     +0.25                +1.25    25   +1.37    0:23      +1.00      25   0:52

EFFECTIVE RX:
+?3   -2.62   -0.50   67   0:13           -2.37   -0.50   35   0:00

  TOTAL TIME FOR ENTIRE COMPUTER AIDED RX: 18:54
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Fig. 1. Examination printout of a patient, #34 in the appendix.

TABLE 1. Computer-assisted determinations of the distance prescription and near add evaluated in relation to values obtained by conventional manual methods.

Committee Evaluation	Distance Prescription		Near Add	
	No.	%	No.	%
Satisfactory	76	95.0	28	100.0
Good agreement	(67)	(83.8)	(24)	(85.7)
Agreement	(9)	(11.2)	(4)	(14.3)
Unsatisfactory	4	5.0	0	0
Totals	80	100.0	28	100.0

TABLE 2. Distribution of errors that occurred during the computer-assisted determination of the distance prescription for 80 patients.

Type of Error	No.	%
Hardware (axis chatter)	1	1.25
Fundamental error	2	2.5
Unknown error	1	1.25
Totals	4	5.0

on a single lamp for its light. Thus it would be even more reliable and require less maintenance than the currently used slide projectors. A prototype display is now being built.

Microprocessor Interface. The interface currently in use consists of hardwired logic circuits. Since it was designed, the development of microprocessors has made this approach obsolete. Microprocessor perform the same function with greater economy of cost, size, and weight and provide greater flexibility and better control. Our interface is now being redesigned and built for microprocessors.

Floppy-Disc Storage System. The present system uses dual DEC digital tapes for mass storage. Since the original design with magnetic digital tape, the floppy or flexible disc has been developed and is now the standard of the industry. Flexible discs have approximately the same storage capacity as tapes, with access times of a fraction of a second, whereas the tapes may take several minutes. With flexible discs, therefore, the use of the mass storage would be speeded up, and the examination itself would be faster. We are in the process of replacing the digital tapes with floppy discs.

Stepping Motors. Motors are necessary to drive the discs and set the axes. A design that provides lower friction in the bearing surfaces of the refractor allows smaller stepping and/or direct current motors to be used, especially when the motors are under microprocessor control. A design using photoelectric rim encoders is being planned.

Redesign. Refractor III was constructed on a "hobby shop" basis. Some structures and aspects can be made smaller and lighter. The system is being redesigned to produce an instrument that is more economical to manufacture with fewer than half of the current number of parts.

RESULTS

A typical printout is seen in Fig. 1. As may be seen in Table 1, the errors were drastically reduced. In the initial validation, judgments of agreements between the measures were made by a clinical committee consisting of the clinically qualified authors, as described in the previous two papers.[5,6] Table 1 shows a 95% satisfactory result for the distance prescription and 100% for the near add. The breakdown of errors for the distance prescription is shown in Table 2. Of the 5% errors in the distance prescription, 1.25% were caused by axis chatter (which has since been virtually eliminated), 2.5% by fundamental error (mental or physical disability of the patient, which can be reduced by prostheses or a training session), and 1.25% by unknown causes (which can be reduced or eliminated when identified).

Also as described in the previous paper,[6] an analysis was made of the differences in equivalent sphere and cylinder vector[6] between the computer-suggested prescription and the clinician's prescription. Figs. 2–4 show curves with circle data points of the cumulative percentage of eyes or patients for the differences of sphere, cylinder power, and add, respectively. For "good agreement" the clinical committee allowed

maximum differences of 0.33 D, 0.45 D, and 0.58 D, although they were not aware of these values when they made their collective clinical judgments. For "agreement" the maximum values were 0.56 D, 0.68 D, and 0.87 D. Even though visual acuity and perhaps other considerations entered into the clinical judgment, these graphs indicate that dioptric differences were probably subconsciously the primary consideration.

On the same coordinates in Figs. 2 and 3 are plotted as triangles the data points for test-retest differences for the manual refraction method taken from Kratz and Flom.[10] At the left of the curve, where the differences are small, the computer appears to have better relative validity than the test-retest reliability of the manual refraction method. We suspect that the apparent superiority of the computer for these small differences may not be significant. The even slighter discrepancy favoring the test-retest differences of the manual method on the right side of the graph also may not be significant. It is perhaps explained by the 5% "unsatisfactory" responses (indicating disagreement) in this series, where the differences were larger than those shown on the abscissa. If the clear, large errors were set aside, even this difference would be minimal or absent. A clinician using the Refractor III system would be able to dis-

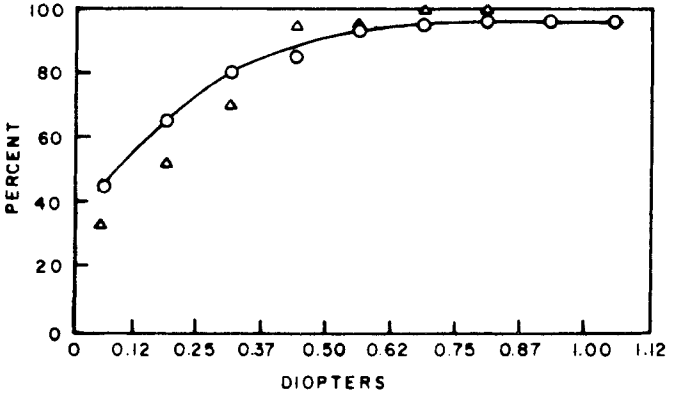

Fig. 2. Circles and curve fitted by eye represent the cumulative percentage (160 eyes) of the equivalent spherical dioptric difference between the computer-suggested prescription and the clinician's prescription. "Good agreement" showed a maximum difference of 0.33 D, "agreement" 0.56 D. Triangles are cumulative percentages of differences in a well-designed, masked procedure for manual test-retest subjective examination using a standard clinical refractor and procedures (from Kratz and Flom[10]).

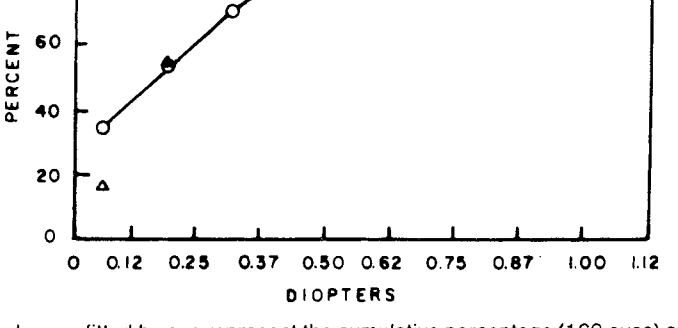

Fig. 3. Circles and curve fitted by eye represent the cumulative percentage (160 eyes) of the vector cylinder dioptric difference between the computer-suggested prescription and the clinician's prescription. "Good agreement" maximally showed 0.45 D difference, "agreement" 0.68 D. Triangles are data from Kratz and Flom.[10]

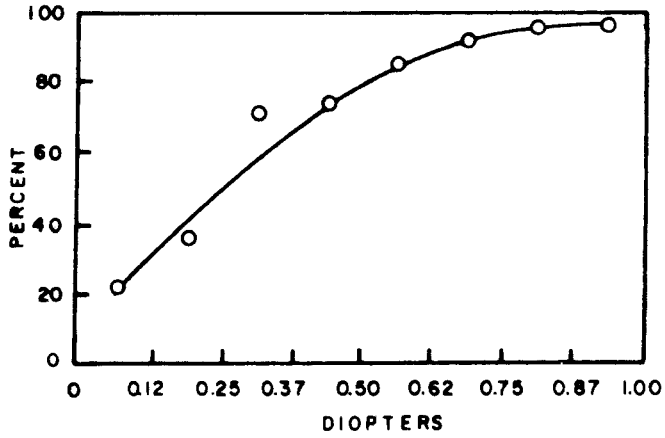

Fig. 4. Circles and curve fitted by eye represent the cumulative percentage (28 patients) of the difference in adds found by the computer and the clinician. "Good agreement" showed a maximum difference of 0.58 D, "agreement" 0.87 D.

TABLE 3. Mean refractive measures obtained with computer and manual subjective methods. Differences in means are also tabulated.

	Computer	Manual	Difference
Equivalent sphere	1.01	0.99	0.02
Cylinder vector			0.29
Add	2.16	2.04	0.12

cern and eliminate any large errors. No "clinical judgment" was used in the data or conclusions of these graphs. We conclude that the validity of the system is similar to that of the usual manual method of subjective refraction.

The differences in the three values of the computer versus manual results (Table 3) indicate any systematic error which could be masked by using absolute differences in Figs. 2–4. The small differences found allow the conclusion that there is little if any systematic error between the two methods.

DISCUSSION

In these tests of the Refractor III system described in our previous two communications[5,6] and in the present paper, the problems have been typical of those of any new system being put into practical operation. The past and current testing of the system could be even more refined but need not be since its purpose is to provide guidance for the improvement of the hardware, software, and flow charts for basic improvement in the system. However, as the system becomes more competent to perform its tasks, it should be used in its final mode of employment, not simply pitted against the manual method, but as a tool to aid the optometrist, to be used with the advantages of his experience and judgment. We believe that this should be the final test of the present design of the Refractor III system. Future tests should not compare the system per se with a human refractionist. They should match the total system *including* a computer-assisted refractionist against a different, manual refractionist. Under these circumstances it would be expected that fundamental errors will be minimized and most other errors might well be detected and rectified before they become manifest in a prescription. The method of comparison can be patient satisfaction, using matched patient samples from the clinic and the combined man-machine system. Such a double-blind or masked study could provide still another test for a computer-assisted eye-examination facility. However, extraneous factors such as appearance and fit of frames might make a definitive answer impossible without an impracticably large sample.

A relative-validity study similar to the test-retest procedures of Kratz and Flom[10] may be the most direct method of establishing the capability of the automated subjective eye-examination system.

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APPENDIX

Ratings

G = good agreement A = agreement
U = unsatisfactory / = ratings for distance/near

1.	June 6	1242	Age 32	Sex M	Rating G
Computer-suggested Rx				Clinician Rx	
RE	−1.62 = −0.50x1		20/15	−1.75 = −0.75x180	20/15
LE	−1.75 = −1.00x180		20/15	−1.75 = −1.00x180	20/15
2.	June 6	1124	Age 20	Sex M	Rating G
Computer-suggested Rx				Clinician Rx	
RE	−3.50 = −1.25x104		20/15	−3.50 = −1.25x105	20/15
LE	−2.50 = −0.75x62		20/15	−2.75 = −0.75x60	20/15
3.	June 6	1167	Age 25	Sex M	Rating G
Computer-suggested Rx				Clinician Rx	
RE	−0.75 = −1.50x90		20/15	−0.75 = −1.75x92	20/15
LE	−0.75 = −1.75x87		20/15	−0.75 = −1.50x85	20/15
4.	June 6	1222	Age 19	Sex M	Rating G
Computer-suggested Rx				Clinician Rx	
RE	−0.62 DS		20/20	−0.75 DS	20/15
LE	−1.00 = −0.25x76		20/20	−1.00 = −0.25x75	20/15
5.	June 6	1231	Age 19	Sex M	Rating G
Computer-suggested Rx				Clinician Rx	
RE	−1.75 = −0.25x153		20/25	−1.75 DS	20/20
LE	−2.00 DS		20/20	−1.50 DS	20/20
6.	June 13	9131	Age 57	Sex F	Rating G/G
Computer-suggested Rx				Clinician Rx	
RE	−2.75 = −0.25x179		20/15	−3.00 DS	20/15
LE	−1.62 DS		20/15	−2.25 DS	20/15
Add +2.25 DS				Add +2.25 DS	

7. June 13	3018	Age 35	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE −0.75 = −0.25x22		20/20	−1.25 = −0.25x15	20/20
LE −2.75 = −0.25x176		20/20	−2.50 = −0.50x165	20/20

8. June 13	0693	Age 15	Sex F	Rating A
Computer-suggested Rx			Clinician Rx	
RE plano = −0.50x180		20/80	+0.50 = −1.00x165	20/20
LE plano = −1.00x180		20/50	+0.25 = −0.75x15	20/20

Remarks: Computer-suggested Rx is in basic agreement despite acuities. Patient is suspected of havi hyperopia. Patient exhibited fluctuating accommodation and acuity.

9. June 14	0225	Age 44	Sex M	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE +1.75 = −0.50x87		20/20	+1.50 = −0.50x92	20/20
LE +1.37 = −0.75x98		20/20	+1.25 = −0.50x98	20/20
Add +0.25 DS			Add +1.00 DS	

Remarks: Program to be modified so that recommended add will be eliminated unless +0.75 DS or more.

10. June 14	5224	Age 60	Sex F	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE +1.50 = −0.50x14		20/15	+1.75 = −0.50x30	20/20
LE +2.12 = −0.25x173		20/25	+2.00 = −0.75x170	20/20
Add +2.62 DS			Add + 2.25 DS	

11. June 14	3956	Age 18	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE +4.12 = −0.75x79		20/25	+3.75 = −0.50x65	20/20
LE +3.50 = −1.00x90		20/20	+3.50 = −0.75x90	20/15

12. June 14	3947	Age 18	Sex F	Rating G
Computer-suggested Rx			Clinician Rx	
RE −5.50 = −2.25x45		20/100	−6.00 = −2.50x55	20/60
LE plano		20/20	−0.25 = −0.75x60	20/15

Remarks: Patient has an amblyopic right eye.

13. June 14	6090	Age 20	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE −0.75 = −0.25x122		20/15	−1.00 DS	20/20
LE −0.87 DS		20/20	−1.00 DS	20/20

14. June 14	6543	Age 30	Sex F	Rating A
Computer-suggested Rx			Clinician Rx	
RE −0.12 = −1.50x175		20/25	−0.75 = −1.25x180	20/15
LE −0.75 = −0.75x26		20/25	−1.00 = −1.25x15	20/15

15. June 15	1226	Age 77	Sex F	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE +1.37 DS		20/20	+1.25 DS	20/20
LE +0.87 DS		20/25	+0.75 DS	20/20
Add +2.87 DS			Add +2.25 DS	

16. June 15	1226	Age 69	Sex M	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE +0.62 = −0.50x59		20/20	+1.00 = −1.00x65	20/20
LE +0.75 = −0.75x60		20/20	+0.75 = −0.75x65	20/20
Add +2.50 DS			Add +2.25 DS	

17. June 15	5330	Age 76	Sex M	Rating U/G
Computer-suggested Rx			Clinician Rx	
RE −2.00 = −1.25x91		20/40	−1.00 = −1.50x90	20/25
LE −1.50 DS		20/70	−1.25 = −1.50x90	20/25
Add +3.00 DS			Add +2.50 DS	

Remarks: Fundamental error-patient was extremely hesitant with responses.

18. June 15	3259	Age 28	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	

RE −3.25 DS		20/15	−3.00 DS	20/20
LE −3.00 = −0.50x19		20/15	−3.00 = −0.25x10	20/20

19. June 15	0470	Age 20	Sex M	Rating A
Computer-suggested Rx			Clinician Rx	
RE −0.50 = −2.50x94		20/15	−0.50 = −2.25x95	20/20
LE +0.12 = −1.75x72		20/30	−0.25 = −2.50x81	20/20

Remarks: Flow-chart problem subsequently corrected. Rx now chosen by best acuity which was not the situation at this time.

20. June 16	4171	Age 18	Sex F	Rating A
Computer-suggested Rx			Clinician RX	
RE plano		20/25	+0.50 DS	20/15
LE plano		20/25	+0.50 = −0.25x90	20/20

21. June 20	0641	Age 13	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE −2.25 = −1.25x177		20/15	−2.25 = −1.50x180	20/15
LE −1.37 DS		20/15	−1.75 = −0.50x175	20/15

Remarks: Good agreement. On retest by a clinician the patient preferred less concave power in the left eye. Acuity in left eye supports suggested Rx.

22. June 20	7221	Age 24	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE −1.00 = −0.75x1		20/20	−1.25 = −1.00x2	20/15
LE −2.12 DS		20/15	−2.00 DS	20/15

23. June 20	8009	Age 55	Sex M	Rating G/A
Computer-suggested Rx			Clinician Rx	
RE +1.50 DS		20/15	+1.25 DS	20/20
LE +1.50 DS		20/15	+1.25 DS	20/20
Add +3.00 DS			Add +2.25 DS	

24. June 20	9697	Age 19	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE +0.37 = −0.50x86		20/15	+1.00 = −1.00x90	20/20
LE plano		20/20	+0.50 = −0.50x110	20/20

25. June 20	5126	Age 22	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE −2.72 = −0.25x94		20/15	−2.75 = −0.50x90	20/20
LE −2.75 = −0.25x66		20/15	−2.75 = −0.50x70	20/20

26. June 21	2179	Age 15	Sex M	Rating A
Computer-suggested Rx			Clinician Rx	
RE −4.12 DS		20/25	−4.25 = −0.25x175	20/20
LE −4.12 DS		20/40	−4.50 = −0.50x170	20/20

Remarks: Agreement. (Software error-suggested Rx did not prescribe best acuity.)

27. June 21	4500	Age 21	Sex F	Rating G
Computer-suggested Rx			Clinician Rx	
RE plano = −0.50x84		20/20	Plano = −0.50x84	20/20
LE +0.12 = −0.50x80		20/20	Plano = −0.75x85	20/20

28. June 22	3475	Age 32	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE −0.75 = −0.50x165		20/15	−0.75 = −0.75x170	20/20
LE −0.75 = −0.50x14		20/15	−0.50 = −0.50x5	20/20

29. June 22	7693	Age 16	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE +2.87 DS		20/200	+2.75 = −0.50x15	20/50
LE Plano		20/20	Plano	20/20

Remarks: Good agreement. Patient has amblyopia.

30. June 23	4194	Age 52	Sex M	Rating G/G
Computer-suggested Rx			Clinician Rx	

RE −3.50 = −1.00x86		20/15	−3.25 = −1.25x95	20/20
LE −3.37 = −0.25x129		20/20	−3.00 = −1.00x155	20/20
Add +2.62 DS			Add + 2.25 DS	
31. June 27	0095	Age 59	Sex F	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE +0.75 DS		20/15	+1.00 = −0.50x120	20/20
LE +0.50 DS		20/15	+1.00 DS	20/20
Add +2.37 DS			Add +2.25 DS	
32. June 27	6286	Age 54	Sex M	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE −0.75 = −1.50x93		20/20	−1.25 = −1.25x90	20/15
LE −1.75 = −0.50x94		20/20	−1.50 = −0.75x110	20/15
Add +2.25 DS			Add +2.00 DS	
33. June 27	7709	Age 16	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE −1.12 = −0.25x180		20/15	−1.00 = −0.25x170	20/15
LE −1.50 DS		20/15	−1.25 = −0.50x15	20/15
34. June 27	5628	Age 40	Sex F	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE −2.62 = −0.50x66		20/20	−2.75 = −0.50x65	20/20
LE −2.37 = −0.50x84		20/20	−2.75 = −0.75x85	20/20
Add +1.37 DS			Add +1.00 DS	
35. June 28	1570	Age 13	Sex M	Rating U
Computer-suggested Rx			Clinician Rx	
RE −2.87 = −1.50x168		20/30	−3.00 = −4.75x5	20/20
LE −1.75 = −4.00x180		20/60	−2.75 = −4.00x173	20/25
Remarks: Unsatisfactory.				
36. June 28	6295	Age 53	Sex M	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE +1.25 = −0.50x90		20/20	+1.50 = −0.50x90	20/20
LE +1.12 DS		20/20	+0.50 = −0.25x90	20/20
Add +2.37 DS			Add +2.00 DS	
37. June 28	8565	Age 35	Sex F	Rating U
Computer-suggested Rx			Clinician Rx	
RE None			−2.75 = −0.50x140	20/20
LE None			−3.75 = −0.50x60	20/20
Remarks: Hardware failure, axis chatter.				
38. June 29	5682	Age 15	Sex F	Rating G
Computer-suggested Rx			Clinician Rx	
RE +1.00 = −0.25x158		20/15	+1.00 DS	20/15
LE +0.37 DS		20/15	+0.50 DS	20/15
39. June 29	0981	Age 15	Sex F	Rating G
Computer-suggested Rx			Clinician Rx	
RE −0.87 DS		20/20	−1.00 = −0.50x170	20/20
LE −0.62 DS		20/20	−0.50 = −0.25x15	20/20
40. July 5	7795	Age 19	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE +0.25 = −0.25x57		20/15	+0.25 = −0.25x55	20/20
LE +0.25 = −1.25x88		20/15	+0.50 = −1.75x90	20/20
41. July 5	2921	Age 66	Sex M	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE +1.12 = −1.00x105		20/20	+0.75 = −0.75x114	20/15
LE +0.50 = −1.00x81		20/20	+0.50 = −1.00x92	20/15
Add + 2.12 DS			Add +2.25 DS	

42. July 6	2264	Age 60	Sex M	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE −0.50 DS		20/15	−0.50 DS	20/15
LE −1.12 = −0.75x94		20/15	−1.25 = −1.00x97	20/15
Add +1.75 DS			Add +2.25 DS	
43. July 19	1986	Age 40	Sex F	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE +0.12 DS		20/20	−0.25 DS	20/20
LE −0.12 DS		20/20	−0.25 DS	20/20
Add +0.12 DS			Add +0.50 DS	

Remarks: Good agreement for distance Rx. Total reading lens on right eye the same for both methods.

44. July 19	9826	Age 21	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE plano = −0.25x128		20/20	−0.25 DS	20/20
LE −0.75 = −0.25x62		20/30	−0.75 = −0.75x68	20/20
45. July 19	8703	Age 27	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE −5.12 = −1.75x1		20/15	−4.75 = −1.25x180	20/20
LE −6.12 = −0.50x117		20/20	−5.50 = −1.00x100	20/20
46. July 20	4787	Age 33	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE −5.75 = −0.87x4		20/20	−5.75 = −1.00x180	20/20
LE −6.00 = −0.75x175		20/20	−6.00 = −0.75x175	20/20
47. July 20	6873	Age 23	Sex F	Rating G
Computer-suggested Rx			Clinician Rx	
RE −1.62 DS		20/15	−1.50 = −0.50x90	20/15
LE −1.25 = −0.25x88		20/20	−1.25 = −0.50x75	20/15
48. July 20	0408	Age 69	Sex M	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE +1.75 = −1.50x81		20/20	+1.50 = −2.00x83	20/15
LE +1.12 = −1.75x98		20/20	+0.50 = −1.50x100	20/15
Add +2.12 DS			Add +2.50 DS	
49. July 20	9635	Age 36	Sex M	Rating A
Computer-suggested Rx			Clinician Rx	
RE −2.62 DS		20/20	−1.25 = −0.50x4	20/15
LE −2.50 = −0.25x29		20/20	−1.50 = −0.50x53	20/15
50. July 20	2744	Age 32	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE −2.37 = −0.50x105		20/15	−2.75 = −0.50x110	20/15
LE −2.75 = −0.75x83		20/15	−2.75 = −0.75x87	20/15
51. July 21	3896	Age 32	Sex F	Rating G
Computer-suggested Rx			Clinician Rx	
RE +0.37 DS		20/20	+0.25 = −0.25x175	20/15
LE +0.37 DS		20/20	+0.50 DS	20/15
52. July 21	0923	Age 66	Sex M	Rating A/G
Computer-suggested Rx			Clinician Rx	
RE +2.50 DS		20/25	+3.25 DS	20/20
LE +2.87 = −0.25x145		20/20	+3.00 DS	20/20
Add +2.50 DS			Add +2.25 DS	

Remarks: Agreement. Software error-last long message was not played.

53. July 21	9581	Age 35	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE −0.37 = −2.00x98		20/20	−0.25 = −2.00x100	20/15
LE +0.75 = −1.25x94		20/15	+0.25 = −1.50x90	20/15

54. July 25	5842	Age 21	Sex F	Rating G
Computer-suggested Rx			Clinician Rx	
RE +0.12 DS		20/15	Plano	20/20
LE −0.12 DS		20/15	Plano	20/20

55. July 25	2804	Age 23	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE −6.12 = −1.00x168		20/20	−5.75 = −1.00x174	20/20
LE −6.37 = −0.50x146		20/20	−6.25 = −0.75x174	20/20

Remarks: Good agreement. Left axis has an approximate difference of 30 degrees but it did not affect acuity. It was probably caused by delay from a hardware error, axis chatter, which has been eliminated.

56. July 25	4170	Age 12	Sex F	Rating G
Computer-suggested Rx			Clinician Rx	
RE −1.12 DS		20/15	−1.00 DS	20/15
LE −0.87 DS		20/15	−0.75 DS	20/15

57. July 25	6653	Age 19	Sex F	Rating G
Computer-suggested Rx			Clinician Rx	
RE +0.87 DS		20/20	+0.75 DS	20/20
LE +0.87 DS		20/20	+0.75 DS	20/20

58. July 26	9679	Age 46	Sex F	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE −0.75 = −0.25x175		20/20	−1.00 DS	20/20
LE −0.12 DS		20/20	Plano	20/20
Add +1.37 DS			Add +1.00 DS	

59. July 26	0799	Age 42	Sex F	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE +0.50 = −0.25x9		20/15	+0.75 = −0.50x15	20/20
LE +0.75 = −0.25x88		20/15	+0.50 = −0.50x135	20/20
Add +0.87 DS			Add +1.25 DS	

60. July 26	1748	Age 58	Sex M	Rating G/A
Computer-suggested Rx			Clinician Rx	
RE +0.62 DS		20/15	+0.25 = −0.50x90	20/20
LE +0.37 DS		20/15	Plano	20/20
Add +1.00 DS			Add +2.25 DS	

Remarks: Near add has a difference of 1.25 D.

61. July 27	0848	Age 53	Sex F	Rating A/G
Computer-suggested Rx			Clinician Rx	
RE plano		20/20	+0.75 = −0.25x10	20/20
LE +1.00 = −0.25x180		20/25	+0.75 DS	20/20
Add +2.62 DS			Add +2.00 DS	

Remarks: Axis chatter may have affected the results through delay on successive discriminations.

62. July 27	2855	Age 49	Sex M	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE −0.50 = −0.75x96		20/25	−0.50 = −1.00x95	20/15
LE −1.12 = −0.50x69		20/25	−0.75 = −1.00x70	20/20
Add +1.87 DS			Add +1.75 DS	

63. July 28	2261	Age 20	Sex F	Rating G
Computer-suggested Rx			Clinician Rx	
RE −3.00 = −0.25x139		20/15	−3.25 = −0.50x150	20/15
LE −4.87 DS		20/15	−4.75 DS	20/15

64. July 28	2921	Age 61	Sex F	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE +1.62 = −0.50x52		20/20	+1.25 = −0.25x60	20/15
LE +0.62 DS		20/20	+0.50 DS	20/15
Add +2.62 DS			Add +2.00 DS	

65. July 28	1746	Age 41	Sex M	Rating G/G
Computer-suggested Rx			Clinician Rx	

RE −1.00 = −0.25x96		20/20	−1.00 DS	20/20
LE −1.00 = −0.25x70		20/15	−0.50 = −0.25x95	20/20
Add +1.12 DS			Add +1.00 DS	

66. August 1	9266	Age 18	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE −2.12 = −1.25x80		20/20	−2.25 = −1.00x85	20/15
LE −2.75 DS		20/20	−2.75 = −0.50x81	20/15

67. August 1	0329	Age 18	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE +0.25 = −0.25x79		20/20	Plano = −0.50x90	20/15
LE +0.25 = −0.25x53		20/15	Plano = −0.25x60	20/15

68. August 1	8421	Age 24	Sex F	Rating G
Computer-suggested Rx			Clinician Rx	
RE +0.37 DS		20/20	Plano = −0.25x130	20/20
LE −0.50 = −0.25x86		20/15	−0.50 = −0.25x85	20/15

69. August 1	3333	Age 37	Sex F	Rating G
Computer-suggested Rx			Clinician Rx	
RE +1.62 = −0.25x146		20/20	+2.00 = −0.50x165	20/20
LE +1.75 DS		20/40	+2.50 DS	20/30

Remarks: Patient has amblyopia.

70. August 1	2702	Age 19	Sex F	Rating G
Computer-suggested Rx			Clinician Rx	
RE +0.37 DS		20/15	Plano	20/15
LE +0.62 DS		20/15	+0.25 DS	20/15

71. August 1	5607	Age 20	Sex F	Rating G
Computer-suggested Rx			Clinician Rx	
RE −3.62 DS		20/25	−3.50 DS	20/20
LE −3.37 DS		20/25	−3.00 DS	20/20

72. August 2	1402	Age 20	Sex M	Rating G
Computer-suggested Rx			Clinician Rx	
RE −4.87 = −0.50x135		20/20	−4.75 = −0.25x140	20/15
LE −5.25 = −0.25x69		20/20	−5.50 = −0.25x60	20/15

73. August 2	4262	Age 47	Sex M	Rating U/A
Computer-suggested Rx			Clinician Rx	
Re −2.62 DS		20/25	−0.25 = −0.75x170	20/20
LE plano		20/30	Plano = −0.75x15	20/20
Add +1.87 DS			Add +1.50 DS	

Remarks: Patient complained that during the test his monocular diplopia made discriminations difficult. Unusual problems such as this one are not suitable for automated testing in its current state of development.

74. August 2	1405	Age 58	Sex M	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE +1.50 = −1.25x79		20/25	+2.00 = −1.50x90	20/15
LE +0.75 = −0.75x84		20/20	+1.00 = −1.00x85	20/15
Add +1.87 DS			Add +1.50 DS	

75. August 2	2086	Age 33	Sex F	Rating G
Computer-suggested Rx			Clinician Rx	
RE −0.12 = −1.25x172		20/20	−0.50 = −1.25x2	20/15
LE plano = −1.75x5		20/15	+0.25 = −1.75x8	20/15

76. August 3	7225	Age 49	Sex F	Rating G/G
Computer-suggested Rx			Clinician Rx	
RE −0.12 = −0.25x179		20/30	Plano = −0.25x160	20/20
LE −0.50 = −0.25x9		20/40	−0.50 DS	20/20
Add +2.50 DS			Add +2.25 DS	

77. August 3	1361	Age 26	Sex M	Rating G

Computer-suggested Rx			Clinician Rx	
RE −5.37 DS		20/15	−5.25DS	20/15
LE −5.50 = −0.25x175		20/15	−5.25 = −0.25x175	20/15

78. August 3	5562	Age 61	Sex F	Rating G/A
Computer-suggested Rx			Clinician Rx	
RE +0.87 = −0.50x93		20/20	+0.75 = −0.75x105	20/20
LE +1.37 = −1.00x112		20/20	+0.75 = −0.75x90	20/20
Add +3.00 DS			Add +2.00 DS	

Remarks: Patient had difficulty with hearing and following instructions.

79. August 3	0202	Age 16	Sex F	Rating G
Computer-suggested Rx			Clinician Rx	
RE −3.25 DS		20/20	−3.00 = −0.25x115	20/15
LE −3.00 = −0.25x49		20/20	−3.25 DS	20/15

80. August 17	7885	Age 48	Sex F	Rating A/G
Computer-suggested Rx			Clinician Rx	
RE −0.62 DS		20/20	+0.25 DS	20/20
LE plano		20/25	+0.25 DS	20/20
Add +1.87 DS			Add +1.50 DS	

Remarks: This patient had difficulty differentiating between 0.25 D changes, especially in the right eye.

JOHNSON TO RETURN TO ARMY AFTER SERVING AT PACIFIC

Dr. David E. Johnson, who has been assistant dean of the Pacific University College of Optometry for the past 2 years, is leaving Pacific in July to return to active duty with the U.S. Army. He has been recalled to be chief of optometry at Walter Reed Army Medical Center in Washington, D. C. He will have the rank of lieutenant colonel. Previously he served 21 years with the Army.

While at Pacific, Dr. Johnson was active in public health planning, was on the legislative committee of the Oregon Public Health Association, and was chairman of the public health committee of the Oregon Optometric Association.