EXPERIENCE WITH CLOSED CIRCUIT TELEVISION IN THE BLIND REHABILITATION PROGRAM OF THE VETERANS ADMINISTRATION [ab]

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ABSTRACT

Veterans with low vision are using closed circuit television reading and writing systems. The program includes screening, examination, evaluation, comparison with optical aids, training, and subsequent followup at the veteran's home. Data are presented on reading speeds, duration time, minimum print size, magnification, working distances, and legibility of handwriting. Forty subjects are reported on with 28 being recommended for loan of a C.C.T.V. Initial test data from optical aids and C.C.T.V. are compared.

The Veterans Administration has been loaning closed circuit television reading and writing systems to eligible veterans who needed this assistance and who could benefit from using the devices. Since this is a relatively new device, the results of this experience should prove interesting to others. In evaluating the usefulness of the device, the performance was compared with C.C.T.V. and with optical aids recommended as optimum by an optometric low-vision specialist.

Weed (1) compared a C.C.T.V. yielding 10X magnification and viewed at 40 cm. with a loupe and an illuminated magnifier also providing 10X magnification. He reported enthusiasm for the C.C.T.V.

[a] Reprinted with permission from *American Journal of Optometry* and *Archives of American Academy of Optometry*, Vol. 50, No. 6, June 1973.

[b] Read before the Annual Meeting of the American Academy of Optometry, New York, N.Y., December 19, 1972.

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from a group of nine children tested. However, the five adults from private practice tested "felt that even though it appeared to help them read smaller type, in a few cases the apparatus was too large and expensive for home use."

All of Weed's subjects were tested with the same magnification, without consideration for individual differences in vision, etc. The device used does not appear to have reverse polarity capability, or an X - Y table. From the photographs accompanying the article we judged that it does not appear to provide either enough working space for writing nor the lower magnification, movable camera or table to make writing practical. His sample was small, economic factors appear to have had considerable weight, and no indication of amount of training is given.

Genensky et al. (2) reported on an informal testing of 120 partially sighted people with a C.C.T.V. system. They make the statement that, "Many of these people are unable to read printed or handwritten material or to write with a pen or pencil without the aid of a C.C.T.V. system." However, in describing their test procedures they point out that, "The only corrective lenses used in the procedure were those that the subject was wearing or happened to bring with him."

Their informal study was directed toward determining performance with C.C.T.V. and did not attempt to perform complete low vision examinations. Hence it is not known whether optical aids would have improved performance or how this performance would compare to performance with C.C.T.V.

Sloan (3) writes, "Whether expensive and nonportable closed circuit T.V. readers provide the best way to meet certain special needs of the partially sighted must be determined by comparison of such devices with other types of reading aids."

THE STUDY

In our study, ability to pay or willingness to pay for the device did not enter into consideration, since the VA paid the bill, whichever device was decided upon. All of our 40 subjects were male adults, ranging in age from 22 to 76 years with a mean age of 44. All were classified as legally blind. They ranged from 1 year of legal blindness to 38 years with a mean of 12.5 years. Their visual acuities ranged from 10/20 to 10/700 with a mean of 10/153.

While the veteran's desires were taken into account, he did not make the decision. No one received any aid he did not agree to use, but merely wanting a C.C.T.V. or optical aid was not sufficient to secure one. Eligible veterans were evaluated by the professional staff of the Western Blind Rehabilitation Center in Palo Alto, California,

to establish a need to manage the written word regularly or perform other specific near visual tasks. They then received a low-vision optometric examination with recommendations of the conventional low-vision aids to be tried and the lenses that should be used in conjunction with viewing C.C.T.V.

Viewing distances from the T.V. monitor ranged from 6 centimeters to 90 centimeters. All but two of our 40 subjects used viewing distances of 50 centimeters or less. Since most had significant refractive errors and two-thirds were presbyopes, it was felt that the C.C.T.V. would only receive a fair test if appropriate lenses were used in viewing. Each subject received guided practice and training using the recommended optical low-vision aids. Each subject received at least 15 hours of training and evaluation with the C.C.T.V.

The criteria for recommending that a C.C.T.V. be loaned to a veteran for use in his home were:

1. The veteran should be able to read print of 1M size or smaller with the C.C.T.V.

2. The veteran should attain a reading speed of 30 words per minute, or if he exceeds 30 w.p.m., read 50 percent faster with the C.C.T.V. than he can with the best near correction or other low vision aids. He should read with adequate comprehension as determined by the low-vision instructor.

3. The veteran should be able to read for 30 consecutive minutes with the C.C.T.V. If he can exceed this, he should be able to read 100 percent longer with the C.C.T.V. than he can with the best near correction or other low-vision aids.

4. The veteran should be able to address an envelope and write a letter. His writing should be legible.

5. The veteran should be able to operate the device independently for both reading and writing involving: a. Change of focus; b. Change of magnification; and, c. Change of polarity.

6. It has been established that there is a need to manage the written word regularly, or perform other specific near visual tasks. The need will be confirmed by the evaluations of the staff low-vision instructor, optometrist, and psychologist.

These criteria were viewed as guidelines rather than rigid requirements, and exceptions could be made for special reasons.

The training with the C.C.T.V. consisted of orientation to the instrument, with an explanation of the different parts and a demonstration of the controls and adjustments. Evaluation followed with a determination of the smallest print size in M units that the student could read with the T.V. and the magnification needed to read various common print sizes, and the working distance from the monitor. He was then tested to determine his reading speed and duration. During train-

ing, different reading materials and different writing tasks were used, and the student was instructed in ways of handling various sizes of books, magazines, dictionaries, etc. Practice was given in writing, including such practical tasks as writing checks and filling out credit applications. He also received instruction and practice in assembling the instrument, setting the controls, and trouble-shooting when things were not functioning properly. During training, he was periodically retested for reading speed and duration.

When a closed circuit T.V. was recommended, delivery was made personally, if the veteran lived in the immediate area of the Blind Rehabilitation Center. If not, delivery was handled by someone from the Prosthetics and Sensory Aids Service of the Veterans Administration who might not be as familiar with the instrument and its assembly as the instructor who had trained the veteran. However, the veteran was told that telephone consultation was available with the Center, and he was encouraged to use this service. Efforts were also made to contact the veteran by telephone to check on his progress and any problems he might be encountering. Followup visits to the veteran in his home after he had been using the device for an extended period have been made and will be made to others in the program.

Veterans selected viewing distance and magnification they preferred. They were encouraged to try various magnifications after becoming better acquainted with the instrument. The optical aids used in the study were those which the optometrist felt, in his best judgment, would represent a usable and useful aid for the veteran. Illumination, print size, useful field of view, ease of use, and working distance were all considered.

The group of veterans studied were all at the Western Blind Rehabilitation Center at least 1 week. Many spent 12 weeks there. Some had been admitted for the general comprehensive program of blind rehabilitation. It is routine at this center to investigate usable residual vision, and, whenever any form vision is found, to schedule an optometric low-vision examination.

A low-vision instructor performs visual field tests and color vision tests, and trains the veteran in use of optical aids and C.C.T.V. The instructor also conducted the performance tests of reading speed and duration.

Those low-vision veterans who expressed a desire to manage the written word or perform other near visual tasks were tested on the C.C.T.V. Another group of legally blind veterans had heard of the C.C.T.V. or might even have seen one demonstrated. They requested that the VA supply one and were sent to the Western Blind Rehabilitation Center to be evaluated in relationship to its usefulness for them

and their need before a decision was made whether to loan it to the veteran.

The primary purpose of the veteran's stay at the center is rehabilitation. While research is carried on, it must not interfere with the rehabilitation process. Some veterans performed poorly on the C.C.T.V. at their initial exposure or were not at all interested in using it further. It was therefore decided that both the veteran's and staff's time would be more usefully expended if he received other types of training during his stay at the center.

Consequently, some veterans with limited reading ability, or very poor vision, or who were very poorly motivated were eliminated early and not included in the study. Those included had at least 15 hours of work with the C.C.T.V. They also had an opportunity to use optical aids and perform writing and manipulative tasks without aids.

The performance data used are the initial testing taken after brief indoctrination and training in use of the C.C.T.V. and the optical aids. After further practice and training, there was generally improvement in reading speed and duration. However, the tests were performed sporadically after various amounts of training and were therefore difficult to compare and are not reported here. In measuring tolerance or duration, often the available time was limited. Consequently, no times over 1 hour are reported, since all veterans did not have the opportunity to work longer. It should be noted that some read over two hours with the C.C.T.V. without complaining or tiring.

The visual acuities reported were taken by special low-vision techniques. They were all measured using a cardboard chart at 3 meters or less, with best refractive correction and individualized optimum lighting conditions. Subjects were encouraged to use eccentric viewing when it was helpful and were given encouragement to use their vision and praise for doing so. The acuity used was for the better eye.

These acuities are not necessarily comparable to those taken under standard conditions by optometrists and ophthalmologists. For example, a veteran whose previous records showed an acuity of 1/200 was found by our technique to have 10/40. In other instances where ophthalmological records indicated 2/200, we found 10/60; instead of counts fingers at 1 foot, we found 10/100. There were many instances of striking dissimilarities. If the reported acuities appear better than one would expect from a group of legally blind adults, it must be remembered that our acuities were almost always the same or considerably better than those found by other doctors on the same people using "standard" testing techniques, and that many of our subjects had visual field defects.

THE DATA

In examining the data collected on the 40 subjects who participated in the study, they are divided into two groups. Group I comprises the 28 veterans who were recommended to receive C.C.T.V. systems after completion of their training and evaluation, and Group II comprises the 12 veterans who were not recommended for C.C.T.V.

The mean print size read unaided was 4.51M for the combined groups. The minimum was 0.50M and the maximum 28M. The print size read unaided was not significantly different for the two groups. The mean print size read with optical aids was 1.23M for the combined groups and was not significantly different for the two groups. The minimum we attempted measuring was 0.50M. Fifteen of our 40 subjects read 0.50M, or 0.75M. Only 6 of the 40 read 2M or poorer (Fig. 1).

Nearly all subjects chose more magnification on the T.V. than was recommended with optical aids. It is, therefore, not surprising to find that subjects in both the recommended and not recommended groups

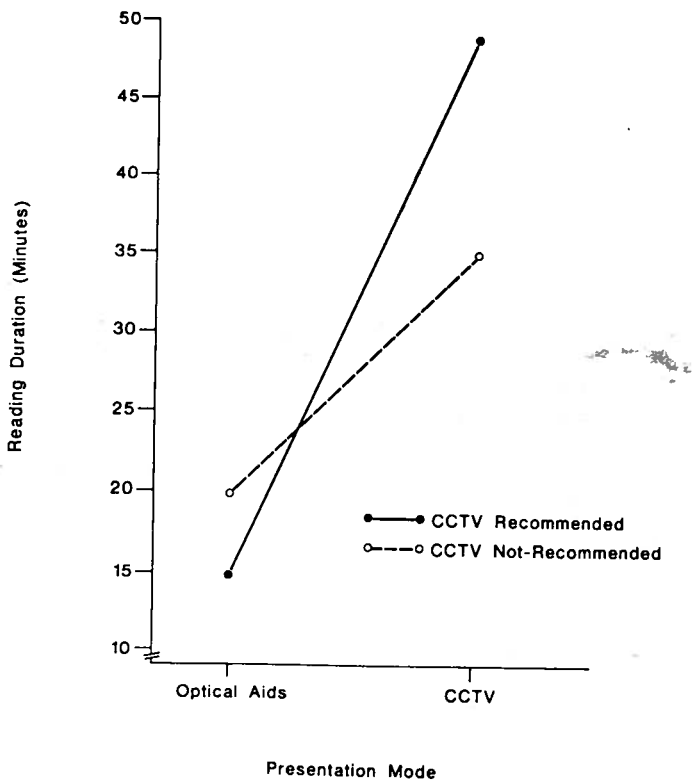

FIGURE 1.—Interactions. Duration with optical aids and C.C.T.V. for the two groups.

TABLE 1.—*Summary Table. Results of Analysis of Variance for Various Dependent Measures Under Optical Aids and C.C.T.V. for the Two Groups*

	Presentation Mode			Groups (I)	(II)	
Dependent Measures	Opt. Aids	CCTV	F	Rec.	Not Rec.	F
Print Size (M)	1.23	.58	***	.89	.92	NS
Reading Speed (wpm)	40.19	58.22	*	47.58	50.83	NS
Reading Duration (Mins)	17.34	41.65	***	31.52	27.46	NS
Effective Magnification (X)	8.7	16.3	**	13.7	11.3	NS
Working Distance (cm.)	7.9	29.2	***	18.85	18.25	NS
Writing Legibility (%)	66	100	***	79	88	NS

*** $p<0.001$
** $p<0.01$
* $p<0.05$

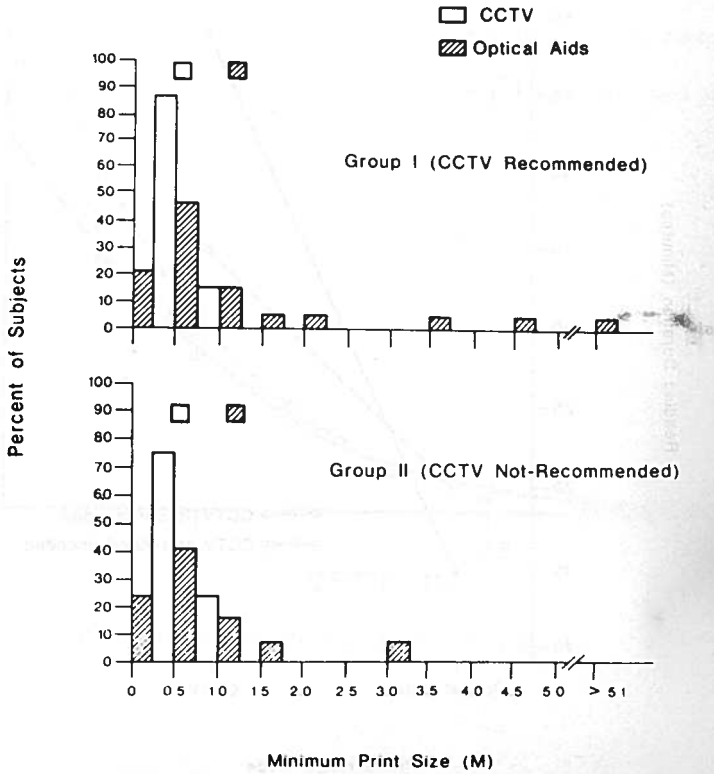

FIGURE 2.—Minimum print size read. (Small squares indicate the mean.)

were reading smaller size print with the T.V. than with an optical aid. With one outlier removed from Group I, the average size of print read with optical aids by those in Group I and Group II was an identical 1.23M. This was reduced to 0.55M using C.C.T.V. for Group I and 0.60M using C.C.T.V. for Group II. This slight difference between groups is not significant, but the reduction in print size read by both groups using C.C.T.V. is highly significant at the 0.001 level of confidence (Table 1 and Fig. 2).

On initial testing with optical aids and C.C.T.V., both groups showed an increase in average reading speeds with C.C.T.V. For the recommended group, this average speed increased from 37 words per minute to 58 words per minute; for the not recommended group, it increased from 43 words per minute to 58 words per minute. The differences between groups are not significant, but the reading rate is significantly faster with C.C.T.V. than with optical aids at the 0.05 level of confidence. (For this analysis 3 outliers in the optical reading rates, one in Group I, and 2 in Group II, were replaced with averages.) (Table 1 and Fig. 3.)

A highly significant difference at the 0.001 level of confidence in

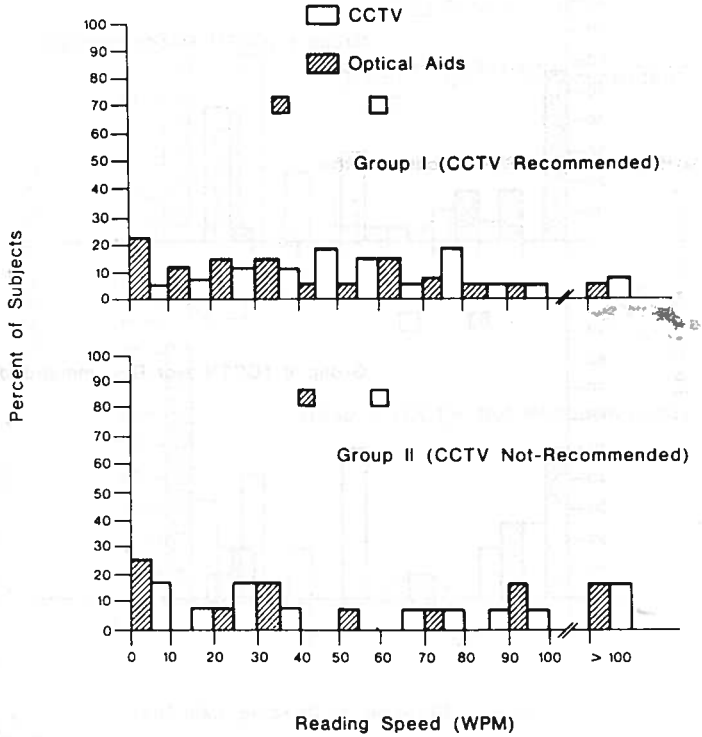

FIGURE 3.—Reading speeds. (Small squares indicate the mean.)

duration of reading with the C.C.T.V. as against optical aids was found for both groups. However, the increase was significantly greater at the 0.05 level of confidence for the recommended group (Fig. 1).

Subjects in the recommended group have a duration of 14.8 minutes, on the average, when reading with optical aids. With C.C.T.V. their duration increased to an average of 48.3 minutes. The not recommended group's duration with C.C.T.V was 35 minutes as compared to 19.9 minutes with optical aids. The gain in duration for Group I averages 33.5 minutes, while the gain for Group II is only 15.1 minutes (Table 1 and Fig. 4). Thus, solely on the basis of initial measures of endurance, those in the recommended group appear to gain much more than those in the not recommended group from closed circuit television. Since increases in speed and duration were part of the criteria for selecting those to be recommended for C.C.T.V., these are not unexpected findings.

Since need was one criterion for receiving a C.C.T.V., it is not sur-

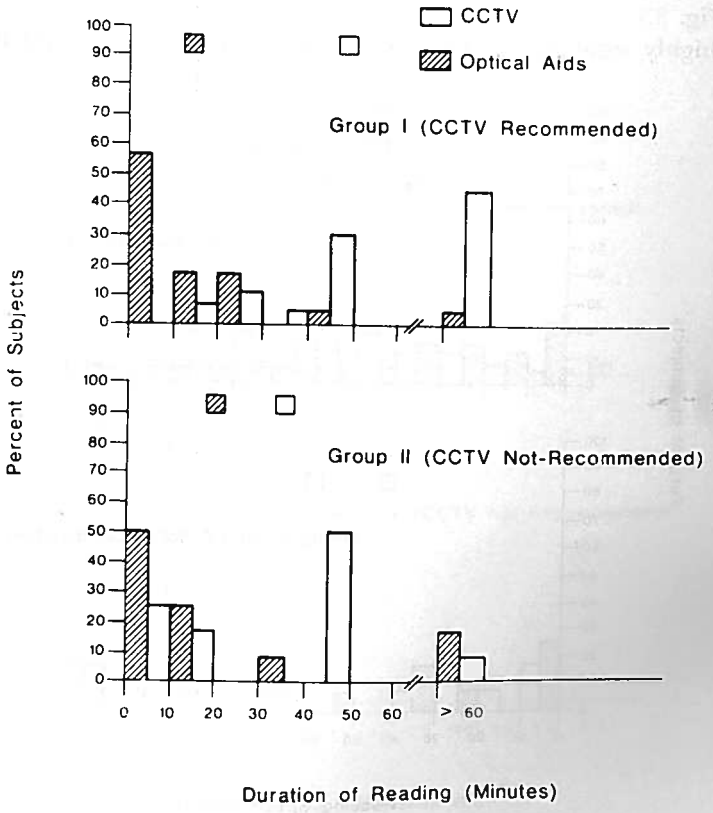

FIGURE 4.—Duration of reading. (Small squares indicate the mean.)

prising to find that the eight veterans with no specific use for the device did not receive it, or that those wanting it primarily for school were represented by 17 in Group I as against 1 in Group II. Those with vocational uses were divided with 7 in Group I and 1 in Group II. Those expressing a recreational need were small in number but divided proportionately between the two groups with 4 in Group I and 2 in Group II.

Effective magnification used (relative to a 40 cm. viewing distance), is significantly greater at the 0.01 level of confidence for the C.C.T.V. as compared to optical aids for both groups. (Two outliers were removed from Group I for C.C.T.V.) The amount of magnification used with optical aids was prescribed by the optometrist, while the amount of magnification with C.C.T.V. was selected by the subject. Since it is possible to obtain greater magnifications with C.C.T.V. without some of the attendant disadvantages of this amount of mag-

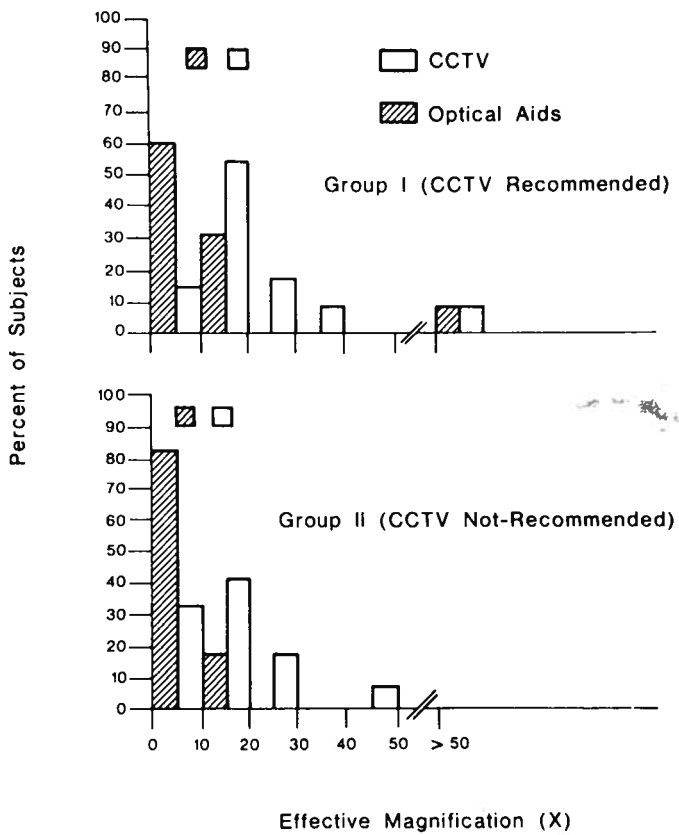

FIGURE 5.—Effective magnification relative to 40 cm. (Small squares indicate the mean.)

nification using optical aids, their choice of a higher amount of magnification is understandable. The effective magnification with optical aids varied from 1.2X to 20X (2 subjects could not read with optical aids and were shown on the graph as greater than 50X) with a mean of 8.7X which was not significantly different for the two groups. The effective magnification with C.C.T.V. varied from 2.5X to 118X with a mean of 16.3X which is not significantly different for the two groups (Table 1 and Fig. 5).

Despite the increased magnification with C.C.T.V. compared to optical aids, the working distance for both groups increased from an average of 7.9 cm. for optical aids to 29.2 cm. for C.C.T.V. This difference is significant at the 0.001 level of confidence (Table 1 and Fig. 6). There was no significant difference between the two groups on working distance. This increased working distance has many obvious advantages. Probably the most important of these is that small changes in working distance have considerably less effect on the accommodative effort required. At a working distance of 7.9 cm. a variation of 1 cm. in this distance changes the focus by 1.61 D. At 29.2 cm. working distance the same 1 cm. variation in the distance causes a negligible 0.11 D change in focus.

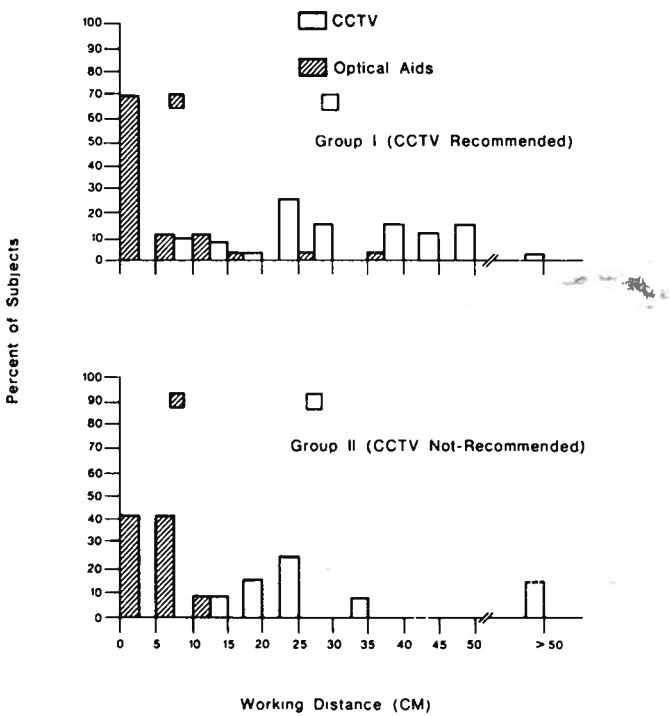

FIGURE 6.—Working distance. (Small squares indicate the mean.)

The two monitor sizes available were 9 and 17 in. screens. The preponderant choice of both groups was in favor of the larger screen size by a ratio of 34 to 6.

There was a 3 to 1 preference for reversed contrast on the C.C.T.V. with the ratios being identical for Groups I and II. Reverse contrast is a feature unavailable with optical aids.

Another very significant difference at the 0.001 level of confidence that showed up between optical aids and C.C.T.V. was ability to write legibly. With optical aids, only 25 of our 40 subjects could write legibly while with the C.C.T.V. all 40 could do so (Table 1 and Fig. 7). This feature of the C.C.T.V. as more than a reading aid is one of its principal advantages over optical aids and other types of projection magnifiers.

It was not possible to draw any meaningful conclusions from the medical diagnoses since with 40 subjects we had 29 different diagnoses, or combinations. We attempted grouping these into five functional defects: refractive media impairment, R. central visual field impairment, L. central visual field impairment, peripheral visual field impairment, and brain dysfunction. There were no significant differences between groups on this basis at the 0.05 level of confidence.

The two groups did not significantly differ in visual acuities with the mean for Group I being 10/170 and Group II 10/113. For the

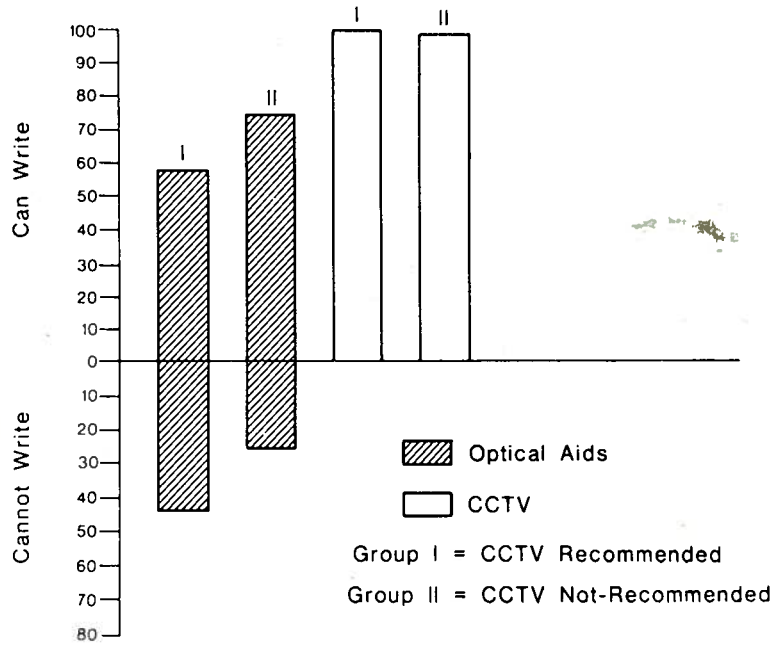

FIGURE 7.—Ability to write legibly.

combined groups acuities varied from 10/20 to 10/700 with a mean of 10/153.

DISCUSSION

In comparing optical aids and C.C.T.V. it is well to remember that other factors besides magnification were operating as positive influences for the C.C.T.V. We recognize the following factors with some evidence in our statistics or from our observations and knowledge of how partially sighted people see:

1. Motivation to obtain a C.C.T.V.

Some of our subjects came to the center to get one of these devices from the VA. They worked hard to prove that they could use it and needed it. There were also a few who came to get a C.C.T.V., but were happy to receive a less cumbersome optical aid when they discovered that they functioned well with it.

2. Writing and other hand-eye tasks.

The figures clearly show that writing with a C.C.T.V. was very successfully managed by our subjects. It is possible that more of our subjects could have written better with optical aids if we had prescribed a weaker or different aid for this purpose in a greater number of cases. We need to look at our procedures and recommendations to be sure we are not slighting the need to write legibly in our prescriptions.

3. Contrast reversal.

The three to one preference for reversal indicates that this is a substantial benefit. It is unrelated to magnification. Since our subjects were all adults, it might be expected that they would be somewhat biased towards the usual black on white reading matter since they were accustomed to it all their lives. If this bias was operating, it was overwhelmed by the benefits obtained from reversal of contrast. We could postulate many reasons for this acceptance of reversed contrast, but our study does not conclusively prove them. There is a small trend for those having refractive media impairment to prefer reverse contrast. A larger sample with a greater number of subjects having only one impairment might be able to show a significant correlation.

4. Contrast enhancement.

One of the principal reasons for the failure of most previous projection magnifiers was the deleterious effect of decreased contrast. C.C.T.V. has the possibilities of increasing contrast when everything is functioning correctly.

5. Increased depth of focus.

All of those who have worked with optical aids for magnification have been faced with the problems of critical focus for shortened working distances. Projection magnification offers a solution to this problem. Since slight changes in working distance will not cause the retinal

image to become extremely blurred, it no longer is necessary to maintain a rigid distance from eye to book while scanning a page. The use of stand magnifiers to maintain this distance is not without its problems in illumination, moving the stand, maintaining the page flat against the stand, and preventing other hand-eye coordinated tasks.

6. Reduction of aberrations and distortions.

It is practical to obtain greater amounts of magnification without degrading the image through aberrations and distortions than is possible using the available optical aids.

7. Postural tension is reduced.

The shortened working distances and the necessity to arrange illumination in a restricted area cause awkward postural problems when many optical aids are used. This is particularly true for tasks such as writing. C.C.T.V. permits sitting up in a very normal and relaxed manner while using it.

8. Reduction of necessity for saccadic movements.

We have noted that many patients who have very narrow fields or large scotomas near their fixation point will read a word and then lose the following word in trying to perform a saccadic movement. In using the C.C.T.V. they can continuously fixate the same area of the screen as the X - Y platform causes the words to appear sequentially on the same area.

9. Binocularity with larger amounts of magnification.

Some partially sighted people perform better binocularly, but if large amounts of magnification are required, the amount of convergence required for binocular vision with optical aids effectively prevents single binocular vision. With projection magnifiers, including C.C.T.V., this problem is readily overcome.

Another observation that was made was in relation to lenses for viewing the T.V. monitor. Since large amounts of magnification are possible with C.C.T.V., many subjects could use the device without lenses to help focus their eyes for the viewing distance. However, when lenses were used, they were able to use less magnification and reported a better looking image, as might have been expected.

Presbyopic subjects rarely had suitable lenses for this purpose already. Bifocals are not advisable for viewing a screen directly in front of them, and the working distance might be very different from anything they have used recently.

Duration of reading or tolerance time was most significantly increased for all our subjects. This is a measurement seldom made in low-vision clinics, but one that showed the greatest improvement with C.C.T.V. and the change in duration time differentiated our two groups. It is extremely important to the student or anyone who wishes to read extensively. We can hypothesize that most of the nine factors favoring

C.C.T.V. listed above contribute to this increased duration time. Further study is warranted to identify the factors for each person so that we can systematically work towards improving duration for low-vision people whatever type of aid is used.

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