Department of Veterans Affairs

Journal of Rehabilitation Research and Development Vol. 37 No. 1, January/February 2000
Pages 101–108

CLINICAL REPORT

Measuring the effectiveness of bioptic telescopes for persons with central vision loss

Janet P. Szlyk, PhD; William Seiple, PhD; Denice J. Laderman, MS; Roger Kelsch, RKT; Joan Stelmack, OD; Timothy McMahon, OD

Department of Research and Development, Chicago VA Health Care System, West Side Division, Chicago, IL 60612; Department of Ophthalmology and Visual Sciences, UIC Eye Center, University of Illinois at Chicago College of Medicine, Chicago, IL 60612; Department of Ophthalmology, New York University, New York, NY 10036; Department of Physical Medicine and Rehabilitation, and the Blind Center, Hines VA Medical Center, Hines, IL 60141

Abstract—Purpose. 1) To evaluate a vision rehabilitation program aimed at training persons with central vision loss to use a bioptic telescope for improving life skills, including driving and 2) to compare the outcomes of subjects who are given bioptic telescopes and training, with subjects who are prescribed telescopic lenses without training. Methods. Twenty-five subjects ranging in age from 16 to 78 years were included in the study. Each subject was randomized to one of three groups: Group I received bioptic telescopes and training during the first approximately 3-month-long period of the approximately 6-month-long study; Group 2 received lenses and training during the second approximately 3-month-long period of the study; and Group 3 received the lenses for approximately 3 months without any training. An assessment battery consisting of clinical vision tests, functional tasks evaluated by an orientation and mobility specialist, driving skills evaluated by a kinesiotherapist specializing in driver's education, and psychophysical measures was administered to Groups 1 and 2 at baseline, and at approximately 3 and 6 months, and to Group 3 at baseline and at approximately 3 months. The tasks were categorized into 6 major functional categories: Recognition, Mobility, Peripheral Identification, Scanning, Tracking, and Visual Memory. Training consisted of 5 weeks of laboratory-based training focusing on skills within these 6 categories, and 8 weeks of on-road driving training. Results. There was significant improvement in all task categories with use of the telescopes. There was improvement in all task groups with training, though a significant difference between the trained and untrained groups existed only in the Recognition, Peripheral Identification, and Scanning Categories, but not in Mobility, Tracking, or Visual Memory. When the tasks involving driving-related skills were analyzed separately, training also had a significant effect. Conclusion. There was significant improvement in visual skills with the use of a bioptic telescope. This improvement was greater with training in the use of the lenses in a number of visual skills categories including driving-related skills.

Key words: *bioptic telescopes, central vision loss, driving, vision rehabilitation.*

INTRODUCTION

Bioptic telescopes have been used successfully for a variety of driving tasks, perhaps most effectively for spotting and identifying road signs and traffic signals (1). Korb published the first report on the use of bioptic telescopes for low-vision drivers (2). In that report, 128 subjects who used the telescopes had a significantly lower accident rate than did the general driving population over a 6-year period. Feinbloom published a large-scale report of 300 low vision drivers who had used bioptic telescopes for from 1 to 10 years (3). None of these individuals had suffered an accident

This material is based on work supported by the Department of Veterans Affairs, Veterans Health Administration, Rehabilitation Research and Development Service and the Foundation Fighting Blindness, Hunt Valley, MD.

This paper presented in part on May 13, 1998 at the Annual Meeting of the Association for Research in Vision and Ophthalmology, Fort Lauderdale, FL.

Address all correspondence and requests for reprints to: Janet Szlyk, PhD, Research Career Scientist, Chicago VA Health Care System, West Side Division, 820 South Damen Avenue, Chicago, IL 60612.

Table 1.
Patient characteristics.

Grp	Age	Sex	Diag	Eye	VA	LM	Power	VAB	LM
1	49	M	MD	OD	20/60	(0.48)	3x	20/20-1	(0.02)
1	77	M	MD	OS	20/200	(1.00)	4x	20/60	(0.48)
1	38	F	CD	OS	20/100	(0.70)	3x	20/40-2+2	(0.30)
1	30	F	S	OS	20/80	(0.60)	3x	20/25-1	(0.12)
1	41	M	CR	OS	20/125	(0.80)	3x	20/40+2	(0.26)
1	16	F	ROP	OD	20/100	(0.70)	3x	20/40+2	(0.26)
1	53	F	S	OD	20/50	(0.40)	3x	$20/25^{-1+3}$	(0.06)
1	76	M	MD	OD	20/160	(0.90)	4x	20/40-1	(0.32)
1	19	F	S	OS	20/125	(0.80)	3x	20/50+2	(0.36)
2	50	M	B	OS	20/100	(0.70)	3x	20/30	(0.18)
2	17	F	CR	OD	20/60	(0.48)	3x	20/30	(0.18)
2	52	M	CR	OU	20/160	(0.90)	4x	20/30	(0.18)
2	34	F	P	OD	20/100	(0.70)	3x	20/40-1+2	(0.28)
2	73	F	MD	OS	20/200	(1.00)	4x	20/40-1+2	(0.28)
2	76	F	MD	OS	20/200	(1.00)	4x	20/25	(0.10)
2	52	M	D	OD	20/70	(0.54)	3x	20/40-1	(0.32)
2	17	M	A	OS	20/50	(0.40)	3x	20/20+1	(-0.02)
3	45	F	MD	OS	20/50	(0.40)	3x	20/20-1	(0.02)
3	78	M	H	OS	20/60	(0.90)	4x	20/30	(0.18)
3	36	M	S	OD	20/200	(1.00)	4x	20/40-1	(0.32)
3	33	F	S	OD	20/125	(0.80)	3x	20/30	(0.18)
3	76	M	MD	OD	20/80	(0.60)	3x	20/30	(0.18)
3	48	M	S	OS	20/200	(1.00)	4x	20/40-1	(0.32)
3	33	M	ROP	OD	20/125	(0.80)	3x	20/30	(0.18)
3	47	F	S	OD	20/100	(0.70)	3x	20/40	(0.30)

Grp=group; Diag=diagnosis; VA=visual acuity; LM=Log MAR; VAB=visual acuity with bioptic telescope; A=albinism; B=Best disease; CD=cone dystrophy; CR=cone-rod dystrophy; D=diabetic retinopathy; H=macular hole; MD=macular degeneration; P=pattern dystrophy; ROP=retinopathy of prematurity; S=Stargardt disease.

causing bodily injury or severe property damage. Subjects' self-reports indicated that satisfactory adjustment to the telescopes occurred over 1 to 3 months, that safety records were good, and that they tended to restrict their driving to avoid unnecessary risks.

Despite these positive reports, the use of the bioptic lens for driving has been controversial. Lippmann, Corn, and Lewis compared a sample of 64 subjects who were licensed to drive in Texas with use of the bioptic telescopes with a random control group of drivers (4). The drivers using the bioptic lens were found to have 1.34 times more accidents than the controls. Similarly, a study by the California Department of Motor Vehicles found that a sample of 669 bioptic drivers had twice as many accidents when compared with a group of age-matched nonbioptic drivers (5).

Despite the controversy in the literature over the safety records of bioptic-dependent drivers, both sides agree that the telescope has some optical disadvantages. For example, a 3x wide-angle telescope used in Illinois and other states that allow bioptic driving, has an 11° central viewing field with a ring scotoma extending to about 17°. Most believe that any such deficiencies may be overcome by learning to use the bioptic system properly. For example, Jose and Ousley outline how the ring scotoma may be overcome by head movements (6). Additionally, the size of the magnified area may be inconsequential, since the driver only uses the bioptic for sporadic spotting, as recommended by the American Optometric Association (7).

Vogel notes that drivers using a bioptic telescope use their own peripheral vision for most driving situations just as fully as do normally sighted drivers and that the telescope is used only to spot signs and to scan distant road conditions for hazards (8). Kelleher, Mehr, and Hirsch reported that drivers with bioptics use their telescopes only 5 to 10 percent of the time (9). A survey of drivers in Illinois, reported by Taylor, found that the telescope wearer uses his or her optical device from 5 to 20 percent of the time (10).

Table 2.
Group summary.

Variable	Group 1	Group 2	Group 3	F-value
Age	44.3	46.4	49.5	0.47, p=0.7
Sex	4/5	4/4	5/3	0.2, p=ns*
VF (SD)	4.8 (4.3)	4.5 (9.6)	2 (4.4)	0.29, p=0.7
LM VA (SD)	0.68 (0.18)	0.71 (0.18)	0.75 (0.26)	0.14, p=0.9
LM VAB (SD)	0.25 (0.16)	0.22 (0.11)	0.22 (0.15)	0.11, p=0.9
CS (SD)	1.2 (0.2)	1.2 (0.4)	1.3 (0.2)	0.13, p=0.9
CSB (SD)	1.2 (0.3)	1.1 (0.4)	1.4 (0.2)	0.79, p=0.5

Group 1=Immediate Training Subgroup; Group 2=Delayed Training Subgroup; Group 3=No Training Subgroup; age in years; sex as M/F; *=difference analyzed using a chi-square procedure, ns=no significance; VF=visual field, measured in degrees of central scotoma (III-4-e Goldmann target); (SD)=standard deviation; LM=Log Mar; VA=visual acuity; VAB=visual acuity with bioptic telescope; CS=contrast sensitivity. CSB=contrast sensitivity with bioptic telescope.

Although the criteria for drivers' licensing with bioptic telescopes varies by state, the norm (including Illinois) is to allow driving with the telescope if applicants can achieve 20/100 visual acuity through the carrier lens and at least 20/40 visual acuity with the telescopic aid. The driver must also demonstrate a binocular visual field of at least 140° or a monocular field of 105° and is restricted to driving only during daylight.

Regrettably, there are few bioptic drivers' training programs in those states that allow individuals to obtain restricted licenses using the telescopes. When they do exist, few include behind-the-wheel instruction (8). Eye care clinicians may prescribe a bioptic telescope appropriately, but training to use the bioptic often takes place in an office setting, where the subject learns to track objects while remaining stationary. The training may not generalize to the dynamic tasks involved in driving an automobile.

Kelleher (11), Jose and Butler (12), Huss (13), and, more recently, Vogel (8), have proposed training procedures for bioptic telescopes for driving. These programs all emphasize mastering a series of successful visual tasks involving scanning and tracking visual stimuli. Vogel provides an outline for a series of eight well-defined tasks, ranging from learning to spot stationary objects while the subject is stationary (skill #1, performed in the clinician's office) to using the telescope while driving (skill #8, performed in the vehicle). Although these protocols for drivers' training with bioptics exist, there have been no formal studies conducted to evaluate the effectiveness of the programs. The goal of the present study was to design and evaluate a rehabilitation training curriculum in the use of bioptic telescopes for persons with loss of central vision. The curriculum included training in stationary and dynamic tasks, as well as navigating the environment on foot and as a driver.

METHODS

Subjects

We recruited 25 subjects (13 men and 12 women) with central vision loss, ranging in age from 16 to 78 years. **Table 1** contains information about the subjects' characteristics including age, sex, diagnosis, eye with the telescope (the telescope was placed on the eye with better visual acuity), visual acuity in the better eye, magnifying power of the telescope, and visual acuity with the bioptic telescope. The three groups of subjects were statistically equivalent as determined by one-way ANOVA and chi-square procedures in age, sex, central scotoma size (as measured with the Goldmann perimeter using the III-4-e target), visual acuity (as measured with Lighthouse Charts), and letter contrast sensitivity, as measured with Pelli-Robson Charts (**Table 2**).

Study Design

A complex experimental paradigm was employed in order to determine the effect of the use of the telescopes on performance, the effect of training on performance, the sustained effects of training and lenses, and the test-retest reliability of measurements. Toward that purpose, three test groups were established.

The *Training Group* received bioptic telescopes and training during either the first approximately 3-month-long period (Immediate Training Subgroup, Group 1) or the last approximately 3-month-long period of the study (Delayed Training Subgroup, Group 2). Those who received their telescopes and training during the second 3-month period were used as the Test-Retest Subgroup, Group 2. Those who received telescopes and training during the initial 3-month period were used to measure the sustained effects of training, Group 1.

The *Test-Retest Subgroup, Group 2,* received their telescopes and training during the second 3-month period. This group underwent baseline testing at the beginning of the study and then did not receive telescopes or training. Approximately 3 months later, they underwent baseline testing again. The two testing sessions were used for test-retest analysis.

The subjects in the *No-Training Group (Group 3),* after baseline testing, were given bioptic telescopes but without any training. This group was given an additional assessment battery after approximately 3 months to determine the effects of telescope use without training on the performance measures.

Assessment Battery

All subjects were given an assessment battery consisting of clinical vision tests, psychophysical and laboratory tests, orientation and mobility evaluations, and driving evaluations. The individual tasks within the assessment battery were coded independently by each author according to the primary visual skill involved in the task. In general, there was high agreement on these assignments. Only three of the items differed in their initial assignment. When the assignment of an item differed, the final placement was based upon a consensus. Some of the tasks represented more than one visual skills category; including Recognition (26 tasks), Mobility (19 tasks), Peripheral Identification (10 tasks), Scanning (36 tasks), Tracking (4 tasks), and Visual Memory (28 tasks).

Clinical Vision Assessment. The clinical vision assessment included the Recognition tasks of visual acuity using Lighthouse Acuity Charts, Pelli-Robson letter contrast sensitivity, and the Peripheral Identification task of Goldmann visual fields to the III-4-e target.

Psychophysical Assessment. We used two objective psychophysical tasks to measure Recognition and Peripheral Identification. In the Recognition task, we measured visual acuity thresholds for letter optotypes ranging in size from 20/50 to 20/700 at 61 percent contrast presented in the central visual field on a CRT monitor (Apple 13-inch). After measuring visual acuity using this technique, we measured Peripheral Identification of letter optotypes (of a size equivalent to one size larger than that measured as the threshold for central visual acuity) that randomly are presented at one of four corner locations on the CRT monitor. The visual angle for the four corner locations was 20°. The goal of the task was to detect the location of the letter and then identify it. With the telescope, the subject detects the letter using peripheral vision, then quickly scans into the telescope to identify it. Speed thresholds for this task were measured at each of the four corner locations.

Laboratory and Outdoor Functional Assessment. Recognition, Mobility, Peripheral Identification, Scanning, Tracking, and Visual Memory were tested using tasks ranging from desk top activities to those involving navigation of complex environments. The protocol used was similar to that used in a previous publication by the present authors in a study involving training with persons with peripheral vision loss due to retinitis pigmentosa (14). The protocol was modified to include a larger number of central visual field challenges. Examples of Recognition tasks would be to read signs within the grounds of the Chicago VA Health Care System/West Side Division and the University of Illinois. Mobility tasks included navigating urban sidewalks and common public areas. Peripheral Identification was measured by having the subject fixate upon a center target and then scan into the bioptic telescope and name the objects seen in the periphery of 35-mm slides that are presented for 1.5 seconds. An example of a Scanning task was to count the number of randomly placed white Styrofoam cups seen in our testing room within 15 seconds. An example of a Tracking task was to trace an irregular line with an unpredictable route connecting one number presented in an array on the left side of a projection screen to a corresponding number in an array presented on the right side of the screen. Visual Memory skills were assessed by having the subject fixate centrally at a target and recall the elements presented in the slide after a 1.5-second presentation duration.

A certified orientation and mobility specialist coded performance on the assessment tests using a scale of 1 (not able to perform), 2 (extreme difficulty), 3 (moderate difficulty), 4 (mild difficulty), or 5 (no difficulty) scale. On each task, either performance, speed, or both were coded.

Driving Skills Assessment. Driving skills were measured using a driving simulator test that has been described and validated in previous publications by the present authors (14–16) and real-world driving on a road course at the Hines VA Medical Center, which has also been described in detail in a previous publication by the present authors (14). Recognition on the driving simulator was assessed, for example, by measuring the braking response times to stop signs and traffic signals on the course, and by measuring mean speed across the simulator course.

Recognition on the road course was assessed by noting whether the subject maintained proper speeds and following distances. Examples of Mobility tasks included numbers of simulator accidents, braking deceleration ratios to traffic control signals on the driving simulator, and navigation of complex traffic situations on the road course. Examples of Peripheral Identification tasks included numbers of lane boundary crossings during simulator driving. For the road course, Peripheral Identification was assessed using lane position and the subject's ability to locate landmarks and signs, and mirror use. Examples of Scanning tasks included horizontal and vertical eye movements during simulator driving and the frequency and effectiveness of spotting through the lenses while driving the road course. Visual Memory skills were assessed on the road course by having the subject recall critical information while driving (e.g., reporting the current speed limit or street signs).

All training and testing protocols were reviewed and accepted by our Institutional Review Boards and comply with the Association in Research and Vision in Ophthalmology standards for conducting research involving humans.

Training Curriculum

Orientation and Mobility Training (O&M). This 0&M training was accomplished in five weekly sessions with each week focusing on specific areas of visual function. The training curriculum utilized was modified from the protocol for training in the use of bioptic amorphic lenses described in a previous paper by Szlyk et al. (14). Each session lasted approximately 3 hours. A main emphasis in the training was on the use of the lens as a spotting device; that is, to spend the majority of time in the carrier lens with brief and frequent systematic glances into the bioptic lenses. Subjects were also trained to navigate complex environments on indoor and outdoor courses within the medical center and university grounds. These trained areas included locating objects, tracking stimuli, scanning skills, and enhancing visual memory. The training elements in these courses included such tasks as locating addresses and items on shelves, and locating and identifying signs placed at random locations across the visual field.

Driving Training. Following the 0&M training, subjects began a driver training curriculum consisting of eight weekly sessions on a road course within the grounds of the Hines VAMC. Again, it was emphasized that while driving, the bioptic lenses were to be used only for brief spotting to gain information. For training, the instructor gave the subject tasks to accomplish while driving, such as locating addresses and informational signs. Training focused on specific skills related to the use of the lens system for driving. These areas included reading dashboard displays, maintaining proper vehicle position within driving lanes, selecting appropriate gap distances when entering traffic, locating relevant peripheral traffic control signs, improving visual memory skills, utilizing mirrors, and navigating complex traffic situations as a passenger.

RESULTS

Data Analysis

Variances obtained from the Test-Retest Subgroup (Group 2) were used to establish just noticeable difference threshold criteria for each of the assessment instruments used. For each assessment task for each individual in the Test-Retest Subgroup, we computed the change in score from the initial baseline testing to the repeat baseline testing, after approximately 3 months. We then averaged these change scores for each task. This average was used as a criterion for each task. For all subjects for each task, the change from baseline was coded as "improved" (coded as a "1") if it exceeded the criterion change. If the individual score did not exceed this criterion, it was coded as "no change" (coded as a "0"). All presentation and analyses were based on the recoded data. For each subject, the percentage of tasks within a visual skills category showing improvement was calculated. Then the average improvement across subjects within a visual skill category was calculated.

Test-Retest Reliability (Group 2)

The subjects from this group were simply enrolled in the study during the first 3 months, they did not receive lenses or training. By evaluating their change from test to retest in the absence of intervention, we were able to determine any changes in performance due to time or testing alone. These subjects took this test two times, separated by 3 months. The values for the individual test items served as the criterion to judge improvement due to the interventions. The mean change across all tasks averaged 11.9 percent.

The Effects of Lenses and Training (Training Group)

Figure 1 shows the average percentage of tasks improved for each of the visual skill categories for the Immediate Training Subgroup (Group 1). The group showed substantial improvements from baseline assessment to the assessment day following training. There were improvements in all visual skill categories beyond the test-retest reliabilities for these tasks. Similarly, the Delayed Training Subgroup (Group 2, from the second to the third

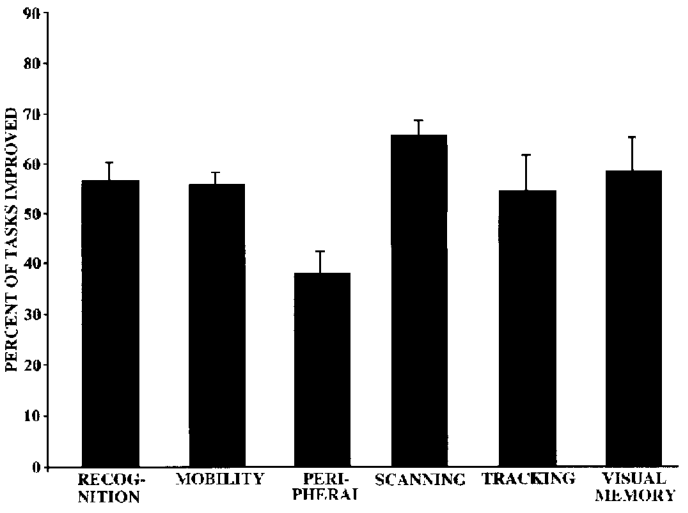

Figure 1.
A histogram of the percent of tasks improved for the Immediate Training Subgroup beyond the test-retest criteria across all the visual skills categories. The group showed substantial improvements from baseline to the assessment day following training. The standard errors are also plotted.

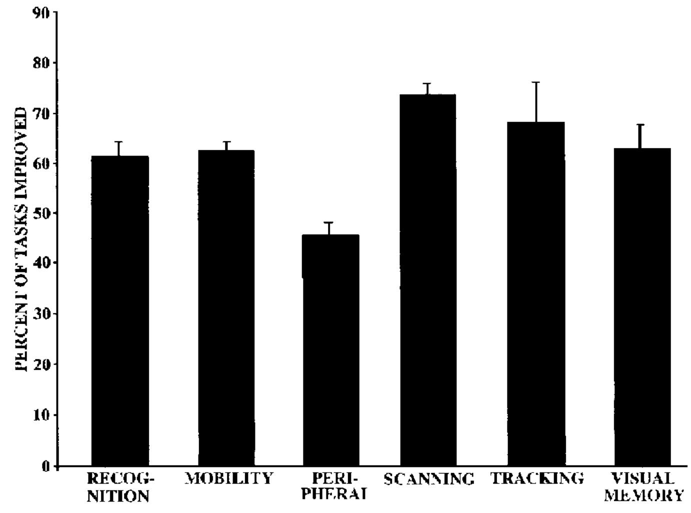

Figure 2.
A histogram of the percent of tasks improved for the Delayed Training Subgroup beyond the test-retest criteria across all the visual skills categories. This group also showed substantial improvements from baseline to the assessment day following training. The standard errors are also plotted.

assessment day) also showed substantial improvements in all visual skill categories following training (**Figure 2**). There were no statistically significant differences between the Training Subgroup and the Delayed Training Subgroup in the distribution of the percentage of tasks improved (chi-square (5) = 0.32, p = ns). Though the data are plotted in the figures as percentages, to allow for comparison among categories with unequal *n*, all statistics were performed on the absolute values. Both groups showed that the highest average percentage of tasks improved within the Scanning category, and the lowest as being within the Peripheral Identification category.

The correlations among vision measures and the percentage improvement for each of the visual skill categories are presented in **Table 3**. Interestingly, those with better vision (better visual acuity, higher contrast sensitivity) showed a higher percentage of tasks improved within the Peripheral Identification and the Visual Memory categories. Similarly, those with smaller central scotomas showed a higher percentage of tasks improved within the Peripheral Identification Category. There was a significant correlation between improvement within the Recognition and the Visual Memory categories (**Table 3**).

Sustained Effects of Training and Lenses

We measured the sustained effects of training with the lenses for the Immediate Training Subgroup (Group 1) only. **Figure 3** shows the percentages of tasks improved from the baseline evaluation to the 6-month point. The change in performance from the 3-month point to the 6-month point was neither clinically nor statistically significant (chi-square(5) = 2.49, p = ns).

The Effects of Lenses and No Training (No-Training Group, Group 3)

Figure 4 shows the combined average percentage

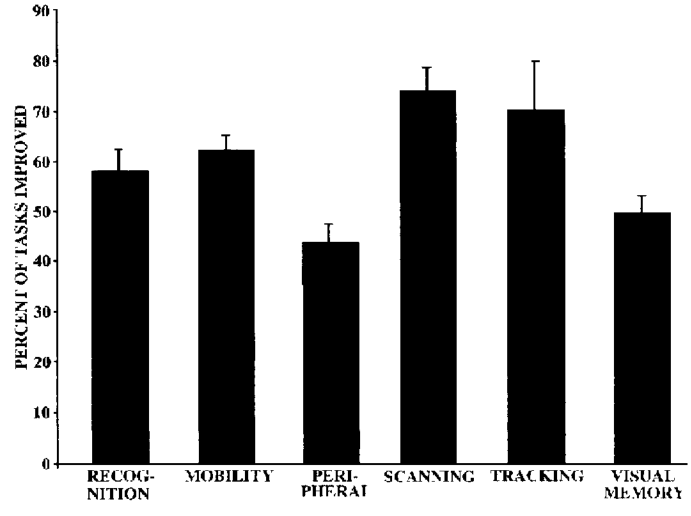

Figure 3.
A histogram of the percent of tasks improved from the baseline evaluation to the third testing period (at 6 months from baseline) for the Immediate Training Subgroup across all of the visual skills categories. The effects were sustained across all of the visual skills categories following 3 months of no training for the group. The standard errors are also plotted.

Table 3.
Correlations among the visions measures and improvements in visual skill categories.

	VF	*VA*	*VAB*	*CS*	*CSB*	*RCG*	*MOB*	*PER*	*SCN*	*TRK*	*MEM*
VF	*X*	*0.38*	*0.21*	*-0.04*	*-0.101*	*-0.46*	*-0.05*	*-0.54**	*-0.08*	*0.22*	*-0.16*
VA		*X*	*0.47**	*-0.19*	*-0.59**	*0.12*	*0.29*	*-0.50**	*0.16*	*0.43*	*-0.60**
VAB			*X*	*-0.48**	*-0.48**	*-0.24*	*0.31*	*-0.57**	*-0.17*	*0.02*	*-0.08*
CS				*X*	*-0.79**	*0.43*	*-0.32*	*0.43*	*0.08*	*0.22*	*0.60**
CSB					*X*	*0.25*	*-0.39*	*0.57**	*-0.24*	*0.04*	*0.49**
RCG						*X*	*-0.06*	*0.42*	*0.27*	*0.11*	*0.53**
MOB							*X*	*-0.04*	*0.60*	*-0.02*	*-0.22*
PER								*X*	*0.17*	*0.10*	*0.06*
SCN									*X*	*0.09*	*0.03*
TRK										*X*	*0.11*
MEM											X

VF=visual field, measured in degrees of central scotoma (III-4-e Goldmann target); VA=visual acuity, VAB=visual acuity with bioptic telescope; CS=contrast sensitivity; CSB=contrast sensitivity with bioptic telescope; RCG=recognition; MOB=mobility; PER=peripheral; SCN=scanning; TRK=tracking; MEM=visual memory; *=p<0.05.

improvement for the two training subgroups (Groups 1 and 2) compared with the improvement for the No-Training Group that received lenses but no training. The trained groups showed significantly greater improvement compared with the untrained group for the Recognition ($t(20) = 2.07$, $p = 0.05$), Peripheral Identification ($t(20) = 2.60$, $p = 0.02$), and Scanning ($t(20) = 2.41$, $p = 0.03$) categories, but not for the Mobility ($t(20) = 2.00$, $p = 0.06$), Tracking ($t(20) = 1.5$, $p = 0.15$) or Visual Memory ($t(20) = 1.9$, $p = 0.07$) categories. However, when the tasks evaluating specifically driving-related skills were analyzed separately, there was a significant difference between the trained and untrained groups ($t(20) = 2.45$, $p = 0.02$). The percentage of driving-related tasks showing improvement for each group was as follows: Immediate Training Subgroup, 62; Delayed Training Subgroup, 66; and the No-Training Group, 55. These findings demonstrate a combined effect of improvement with telescopic use and training.

CONCLUSION

In this study, we have identified the visual skills categories showing the greatest improvements with training. Following training in the use of bioptic telescopes, there was improvement in all the visual skills categories beyond a test-retest reliability measure obtained for each task. Interestingly, the improvement in all of the visual skills categories was maintained for at least 3 months following training. The trained groups showed statistically significantly greater improvement compared with the subjects who have been prescribed bioptic telescopes without training for the visual skills involved in Recognition, Peripheral Identification, and Scanning. However, the untrained group did show improvement in all of the visual skills categories, as well. In the areas of Mobility, Tracking, and Visual Memory, this untrained group improved at a level that was equivalent to those groups that received both lenses and training. When the driving-related skills were independently assessed, the trained groups showed significantly greater improvement compared with the untrained group. In general, training would be recommended for effective use of the bioptic lenses, and for optimal enhancement of visual skills, especially for use in driving.

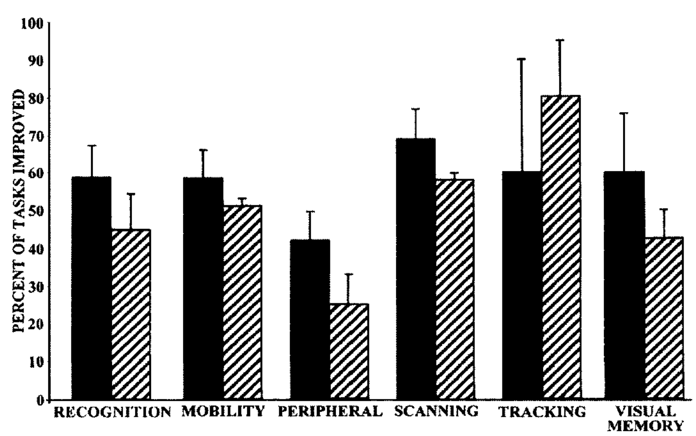

Figure 4.
A histogram comparing the percent of tasks improved across all of the visual skills categories for the trained (Series 1) and untrained groups (Series 2). The standard errors are also plotted.

In a questionnaire that was administered at the end of the program, 82 percent of the subjects reported that they were "very satisfied to extremely satisfied" with the bioptic lenses, and the remaining 18 percent reported that they were satisfied with the lenses. Additionally, 82 percent reported that they planned to apply for a restricted license to drive with the bioptic telescopes. Besides driving, the subjects reported that the lenses were most useful for navigating their environments on foot, seeing far objects in a classroom, grocery shopping, seeing movies at the theater, reading signs, and seeing the faces of people. All the subjects reported that the lenses had improved their quality of life.

In summary, we have developed and evaluated a training program for the use of bioptic telescopes and found that training resulted in improvement in all of the areas assessed by the program. However, subjects for whom the lenses were simply prescribed, but who were given no training, also showed improvement in visual skills. Training resulted in significantly greater improvement in 50 percent of the visual skills categories, while in the other 50 percent, improvement in the trained group was equivalent to the improvement in the untrained group.

Future research should be dedicated to identifying the long-term advantages of training. For example, are persons who are trained less likely to be involved in future automobile accidents compared with untrained persons? All subjects in the untrained group were offered training following the study. Out of the eight subjects in the untrained group, three subjects enrolled in rehabilitation training and completed the program. The remaining subjects in the untrained group felt that they could effectively use the telescope without training. The present data demonstrate that training significantly enhances the effectiveness of bioptic telescopes as a visual aid for life skills.

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Submitted for publication June 15, 1999. Accepted July 29,1999.