JVIB

October 2004 • Volume 98 • Number 10

Low Vision Driving with Bioptics: An Overview

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Abstract: This article presents an overview of driving for adolescents and adults who meet their states' visual requirements for low vision driving using bioptic lenses. It also discusses the outcomes of two studies of bioptic driver education.

A driver's license is one of the most sought-after and guarded privileges that one obtains and preserves in one's lifetime, especially if one lives in a technologically advanced society where public transportation is not readily available. Teenagers eagerly anticipate the day when they will be able to drive (Peterson, 1992), and older adults fear that the time will come when they may need to give up their driver's licenses (Eisenhandler, 1990; Rosenblum & Corn, 2002). Not having an independent means of transportation limits where one can live and work (Corn & Sacks, 1994).

There are three populations for whom driving with low vision needs to be considered. They are working-age

adults who have congenital or adventitious low vision and who have never driven; children and adolescents, mainly those with congenital or early-onset visual impairments, who will become eligible to take their road tests and are developing the necessary visual knowledge and skills to obtain driver's licenses at the same age as their typically sighted peers; and older adults with age-related visual impairments, who have extensive driving experience and want to maintain their driver's licenses. According to the 2000 U.S. census, an estimated 2.4 million Americans (1.98%) had low vision (defined as lower than 20/40 best corrected vision in the better eye using the World Health Organization standards). By 2020, it is estimated that the number of Americans with low vision will increase by 70% to 4.1 million. Low vision affects 1 in 28 Americans older than age 40. The prevalence of visual disabilities will increase markedly during the next 20 years owing largely to the aging of the U.S. population (Eye Diseases Prevalence Research Group, 2004). This growing population of potential drivers with low vision highlights the need for rehabilitation personnel, driving instructors, motor vehicle licensing authorities, and consumers of services to address issues related to driving with low vision.

This article presents a historical overview of bioptic driving; introduces the components of bioptic driver education programs, including predriver skills, passenger-in-car awareness training, and behind-the-wheel instruction in the United States; and describes

how the bioptic device is used while driving. It is not intended to be a comprehensive curriculum for bioptic driver education and should not be used as such. Furthermore, the article addresses bioptic driving only; it is understood that some jurisdictions do not permit the use of bioptics for licensing drivers with low vision.

A bioptic telescopic lens system is a pair of prescription eyeglasses with a miniature telescope mounted above or below one's normal line of sight. While driving, the bioptic user glances into the telescopic portion of the device to obtain detailed information or enlarged images of objects or forms within his or her driving scene.

Historical perspective

The first vision standards for driving were proposed by some states in the mid-1920s (Appel, Brilliant, & Reich, 1990). As states began to adopt more-stringent vision standards (that is, 20/40 or better) in the 1960s (Korb, 1970), many persons with mild to moderate levels of visual impairment were unable to obtain or retain driver's licenses. Over time, visual acuity screening became part of the standard process for applying for driver's licenses in all states. The majority of states also use visual acuity as a requirement for renewing driver's licenses (Shipp, 1998). Higgins (1996) reviewed studies of accident rates and visual measures of the general driving population and stated that these studies "failed to provide the empirical

evidence that would justify any of the existing vision standards for driver licensure."

During the early 1930s, William Feinbloom, an optometrist and a pioneer in the field of low vision, invented optical devices for his patients with low vision (Collins, 1983). One of these optical devices was called a "bioptic telescopic lens system" (BTLS) or bioptic. Korb (1970, p. 620) described the bioptic as a "bi-visual lens system composed of two parts: (1) the usual lens correction and (2) a compact telescopic prescription unit incorporating the correction for the refractive error of the subject." One of the intended functions of the BTLS was to improve distance viewing for short-term spotting tasks while driving (for example, deciphering written or symbolic information on road signs or the colors of traffic lights). In addition, the BTLS enables people with low vision to pass the visual acuity screening test, where permitted, or to meet the visual acuity standard for restricted driver's licenses in states where the use of bioptics is legal.

The first driver with low vision was licensed with a bioptic in California in 1971 (Kelleher, 1984). Today, there is a growing body of literature on successful drivers with low vision (Bowers, Apfelbaum, & Peli, 2004; Goodrich, 1996; Szlyk et al., 2000). A conservative estimate, based on the senior author's communications with legal entities from various states that permit bioptic driving, is that approximately 4,000–

5,000 drivers throughout the United States use bioptics.

Over the years, a number of misconceptions and controversial issues have arisen concerning the licensure of drivers who use bioptics. These misconceptions include beliefs that those who use bioptics use the telescopic lenses continuously to see the roadway and that drivers with low vision cannot see beyond the hoods of their vehicles without bioptics. Fonda (1982) questioned whether speed smear (the effect of speed on the clarity of the peripheral field) would create dangerous peripheral-field restrictions for persons who use bioptics. Controversies have ranged from whether a person with low vision should be restricted to driving 45 miles per hour (Fonda, 1986) to whether people who are identified as “legally blind” should be permitted to take the road test leading to licensure (Fonda, 1989).

Jose and Butler (1975), Korb (1970), and Newman (1976) conducted the first studies of the driving performance of persons using bioptics, reviewing accident rates in Alabama, Massachusetts, and Florida, respectively. Data from these studies indicated that accident rates among drivers with low vision were higher than among those with typical vision, but supported the licensing of individuals who used bioptics. More-recent studies have also been supportive of allowing persons with low vision to pursue driver’s licenses using bioptics as accommodative devices (Bowers et al., 2004; Chapman, 1984a, 1984b;

Lippmann, Corn, & Lewis, 1988; Park, Unatin, & Hebert, 1993; Szlyk et al., 2000; Vogel, 1991).

Since the 1970s, new advances have been made in the design and development of bioptics, in concert with the development of specialized driver's education programs for people with low vision (Huss, 1988). In addition, the passage of federal statutes, such as Section 504 of the Rehabilitation Act of 1973 and Title II of the Americans with Disabilities Act of 1990, have raised questions about whether denying a driver's license solely on the basis of visual acuity is discriminatory. Policy statements on the licensing of drivers with low vision have been adopted by the American Optometric Association (1994) and the American Academy of Ophthalmology (2001); these statements endorse individualized assessments of people with low vision for obtaining driver licenses. Furthermore, the National Highway Traffic Safety Administration's (NHTSA) Office of Civil Rights (2001) indicated its continued commitment to ensuring the elimination of unlawful discrimination on the basis of race, color, national origin, and disability by any public entity, including departments of motor vehicles and driver's licensing programs. It has advised states that they must be more accommodating to the needs and concerns of consumers with low vision to prevent the loss of federal highway funds, awarded by NHTSA.

Peli and Peli (2002) found a wide range of levels of visual acuity that are required for restricted driver's

licenses among the 47 states that currently allow low vision driving privileges. For example, while 12 states allow individuals with 20/200 visual acuity to seek restricted driver's licenses, others require visual acuities up to 20/200. Peli and Peli also found that in some states, drivers with low vision may receive restricted licenses but are prohibited from using a bioptic as an accommodation.

Readiness and awareness skills

Pre- and postdriver readiness for bioptic driving differ according to the age groups mentioned earlier. Working-age adults with congenital or early onset low vision may not have attended closely to the actions or decisions made by drivers while riding as passengers in vehicles. They may not have been encouraged to develop visual skills or to use their distance vision efficiently. Unfortunately, many persons who now qualify for bioptic driving privileges are unprepared conceptually and skillwise to handle the rigors of driving. Huss (2000) and Spitzberg (1991) found that certain functional deficits are common among these predrivers: a short eye lead, or viewing distance ahead (leading to a greater likelihood of weaving in a lane), inconsistent or nonexistent head and eye scanning (which limits awareness of surroundings and landmarks), the lack of hazard-perception skills (such as the failure to recognize and react in time without an instructor's intervention), and the inability to make and act on decisions quickly and independently (in

response to visual information detected within dynamic environments).

On the basis of the outcomes of 69 predriving assessments of novice adult candidates for driving who were enrolled in a West Virginia study (Huss, 1988), five basic functional tasks and areas of related conceptual development were recommended in an effort to reduce the amount of formalized driver education needed by similar groups of novice drivers in the future. Box 1 lists the five prerequisite functional tasks and areas of related conceptual development.

Young children and adolescents with low vision may be receiving instruction for developing their visual skills for learning in classrooms, for participating in leisure activities, and for beginning independent mobility and wayfinding tasks. They may be learning to respond to visual images quickly and to use handheld optical devices for distance viewing of chalkboards, theatrical productions, and sporting events (Corn et al., 2003). Through orientation and mobility (O&M) instruction, they will learn such skills as understanding how cars travel; how to read maps; and how roadway landmarks, such as road signs, pavement markings, and traffic lights, provide information to pedestrians and drivers for safer street crossings and safe passage through intersections. On the basis of O&M assessments, these skills should be taught to all students with low vision, whether or not they will become drivers.

Older adults with low vision who want to retain their driver's licenses already have a good working knowledge of road signs, traffic lights, pavement markings, the behavior of other drivers, and the basics of operating motor vehicles. They need to concentrate on interpreting imperfect visual images and reacting to visual stimuli at different speeds. In addition to short-term bioptic training, they may need to deal with other attributes of aging that all elderly people experience, such as slowed reflexes or restricted physical movements. Additional clinical and on-road assessments may be required to determine or predict if these individuals can relearn to drive safely.

For elderly drivers with certain types of adult-onset visual impairments who have not driven for a long time, remedial passenger-in-car and behind-the-wheel instruction are strongly recommended. Some areas that need to be emphasized are anticipatory driving skills (sighting a distance down the road, scanning widely beyond the limits of one's path of travel versus fixating on an object or form, and maintaining at least a three- to four-second following distance from the vehicle ahead to maintain the big picture of the dynamic driving environment and an escape route if a collision is possible); critical object or condition awareness exercises (objects or conditions that can be predicted to cause drivers to alter their speed or lane position); and deciphering the details, color, or movement of distantly positioned objects or forms via vertical spotting

activities using a BTLS. Other important areas include the proper use of car mirrors and checks for blind spots when turning, changing lanes, or passing or during general driving; relearning state road laws and the meaning of road signs (by their shape, color, and symbol versus the printed message); and strengthening hazard-perception skills (recognizing when other drivers are not likely to see one because of fixed hazards that hide the presence of others; because they are distracted and change lanes unsafely or are confused; or because they execute driving maneuvers incorrectly, such as unsafe passing).

Low vision driver training programs

Once a person with low vision reaches the chronological age to drive, has predriver skills, meets the visual requirements for a driver's license in his or her state, and is determined to be an appropriate candidate for a BTLS, he or she can then enroll in a formalized program of bioptic driver education. A list of contact persons for 21 states that offer or are considering the implementation of formalized bioptic driver education programs may be obtained from the first author. The states in which private and public formalized programs of bioptic driver education are available or under consideration are listed in Box 2.

Formalized bioptic driver education may be obtained through local educational agencies, special schools,

state commissions for the blind (as in Kentucky), and rehabilitation centers (as in Ohio). Some programs for adults may offer training up to the point of behind-the-wheel instruction and then refer the students to private rehabilitation driving instructors or independent driving schools. In these circumstances, referrals may be made to driving schools that are interested in and have expertise in preparing drivers to use a BTLS. In some states, however, formal bioptic driver education is either not required or not available. However, the reader is encouraged to consider the comprehensive nature of bioptic driver education programs as providing either a legal advantage (if a department of motor vehicle's administrative appeals hearing is needed to validate the driving credentials of a person with low vision) or the best opportunity for individuals with low vision to obtain driver's licenses and to become safe drivers.

Children and adolescents who are in school programs may receive instruction in visual efficiency provided by teachers of students with visual impairments and O&M instructors. Many school programs have adopted the expanded core curriculum for students with visual impairments (Hatlen, 1996). The expanded core curriculum provides an avenue through which visual efficiency skills may be taught; these skills will be useful to a student whether he or she becomes a driver or an independent pedestrian and user of public transportation. In addition to placing predriving visual skills in Individualized Education Programs under the

expanded core curriculum area of visual efficiency, several other areas may also be appropriate for predriving instruction, such as independent living, O&M, assistive technology, and career education. Access to the general education curriculum is a tenet of the Individuals with Disabilities Education Act of 1990 that directs special education practices. When typically sighted students attend standard driver's education classes, students with low vision may also request adaptive driver's education, a curriculum for gaining access to transportation, or both. Access to transportation has been linked to employability for adults with visual impairments (Blankenship, 2000; Corn & Sacks, 1994; Kirchner, Johnson, & Harkins, 1997; Moore & Wolffe, 1997).

Formalized bioptic driver education often includes classroom, passenger-in-car, and behind-the-wheel instruction before students may consider applying for driver's licenses. While such formalized programs vary in length, content, and mode of delivery, most involve collaborative efforts of staff from a variety of different disciplines.

Box 3 presents a list of some driving tasks that challenge even the best drivers with low vision. These tasks can be incorporated into routes of travel undertaken as part of the behind-the-wheel instruction of prospective bioptic drivers that is provided by driving instructors. Some of these tasks entail the proper and appropriate use of the BTLS.

When a prospective driver demonstrates competence behind the wheel, a referral is made by the driver education instructor who determined his or her competence to the motor vehicle authority, where a road test is conducted. Each state has responsibility for determining whether an individual should receive a driver's license. Hence, rehabilitation professionals may prepare an individual for the road test but do not make the final judgment about whether a driver qualifies to be licensed. In some states, the road test is more rigorous than that given to typically sighted candidates; in others, the test is the same as that taken by the general public. In some states, a medical advisory board reviews all applications for bioptic driver's licenses. In some states, all drivers with low vision are given restrictions on their licenses (for example, they may drive only in daylight); in other states, restrictions are placed on drivers at the discretion of the examiners. Regardless of state-imposed restrictions, Corn, Lippmann, and Lewis (1990) found that many drivers who use bioptics restrict their driving to those times when they consider themselves safe.

Use of the bioptic

When driving, a bioptic user uses his or her standard optical correction for most of the driving task. To perform tasks for which the telescopic portion of a bioptic is used, the driver either lowers his or her head

to look through the telescopic portion of the device, positioned centrally and above the line of sight (Bailey, 1979) or lowers his or her eyes to look through the telescope, positioned in the inferior central position (Spitzberg, 1991). The trained user is able to complete vertical spotting tasks in one second or less per fixation (Freeman, 1984). Because of its physical location, the telescopic portion of the device does not obstruct 95%–97% of normal nonmagnified viewing, undertaken while the driver is looking through the larger carrier lens while driving. With the device, the driver is able to increase his or her margin of safety to avoid critical objects or forms that are present within, alongside of, or approaching his or her intended path of travel (Jose & Ousley, 1984). The margin of safety is defined as the time or equivalent distance that is needed to process and predict critical objects or conditions and to decide whether to react to them (Doron, 1985).

There are various types and brands of bioptics. From differences in light-gathering properties to differences in the power and degree of visual field through the telescopic portion and from devices that accommodate sun wear to devices that have different weights, the clinical low vision specialist and the consumer must determine which device is the most useful.

A BTLS is not a cure-all for being a safe driver with low vision (Huss, 2001). Although it provides added information and increases the margin of safety by allowing a driver to make quicker decisions about

redirection or adjustments in the speed of a vehicle, alone, it will not enable a person to handle all the dynamics and complex visual decisions that must be made while driving.

In lieu of driving slower and closer to critical objects or conditions before reacting, bioptics enable a user to obtain detailed information about the distant, dynamic driving scene (such as spotting and deciphering the words *slow* versus *stop* on a portable stop sign held by a construction worker, the hand signals of a police officer directing traffic at an accident scene, the correct color of an approaching traffic light, or confirming a landmark on a designated route of travel). Bioptics are never used for searching or as primary driving lenses. There are also times when bioptics should not be used, even when the driver wants to have additional information, such as when maneuvering on a curved section of roadway, when other drivers invade the space cushion around one's vehicle, when fast-moving traffic is present, or when weather conditions prevent the effective use of the device.

The bioptic may be likened to having an additional mirror in the car; the bioptic user learns when to use and not to use it, just as a typically sighted driver decides when to use or not to use a rearview or side mirror. The frequency of use of the telescopic portion of the bioptic is dependent on the user's ever-changing driving environment, his or her familiarity with the environment, weather conditions, and the dynamics of

the driving environment. An individual's functional visual acuities, under variable lighting and environmental conditions, also need to be considered with and without the use of a BTLS (Geruschat & Smith, 1997).

Outcomes of driving with bioptics

A review of the literature revealed two studies that presented outcomes that are directly related to persons who have participated in formalized programs of bioptic driver education (Huss, 2000; Szlyk et al., 2000). In the first study, Huss found that there were 18 accidents over a 10-year period in which trained drivers who used bioptics were involved. However, only 8 of those accidents were the fault of the drivers with low vision. Bioptic drivers with visual acuity ranging from 20/80 to 20/200 inclusive were found to have half the number of at-fault accidents as those with visual acuities of 20/50 to 20/70. In the second study, Szlyk et al. found that persons with low vision who were given bioptics and training showed a statistically significantly greater improvement compared with those who had been prescribed bioptics without training for visual skills involving recognition, peripheral identification, and scanning types of tasks. When driving-related skills were independently assessed, the trained group showed significantly greater improvement than did the untrained group.

Other considerations

One may surmise from this article that people with low vision who have the potential to become drivers want to do so. However, Huss (2000) found that a portion of those who qualify by meeting visual standards do not wish to pursue instruction for driving. In his 1995 study, only 64% of those who qualified came for an initial evaluation, and only 44% of those who completed the initial evaluation returned to participate in driver training.

We can only draw on our personal conversations with qualifiers who chose not to drive, those who obtained bioptic driver's licenses, and those who stopped driving many years after they obtained driver's licenses because of acquired visual dysfunction. In an effort to provide a "balanced" view of bioptic driving, we offer some reasons why individuals who qualify may choose not to seek or retain driver's licenses:

- They believe that they truly do not have sufficient vision to drive a car.
- They meets a state's requirements but have additional visual needs that are not considered in the state's regulations.
- They have not acquired the visual skills needed for driving.
- They worry about being considered "imposters"

after many years of being seen as severely visually impaired.

- They are concerned about losing governmental financial supports if they obtain driver's licenses.
- They worry that failing the driving test will be a personal failure and confirmation that they are severely disabled or blind.
- They are younger than age 18, and their parents have apprehensions about their driving for reasons of vision and/or maturity.
- They may have established routines for obtaining transportation and do not find driving desirable or necessary.
- They obtained their driver's licenses but found that driving with low vision was exhausting, anxiety producing, and/or too visually demanding.
- They found the costs—of evaluations, bioptics, and appropriate instruction—to be too high.
- They live in a city where public transportation is readily accessible.
- They believe that people with low vision should not drive.

Discussion

Can a person who is deemed "legally blind" by federal

law drive a car safely? At a time when there are great shortages of rehabilitation personnel, should professionals' time be spent arranging for individuals with low vision to learn to drive? With the advances in optics and vision rehabilitation techniques, should those with the potential to become bioptic drivers be given the opportunity to receive rehabilitative driver's education? These are just a few of the many questions posed when the topic of bioptic driving is raised in consumer and professional meetings.

This article provided a brief history of bioptic driving and a brief description of the components of bioptic driver's education. There are many aspects of driving with low vision that an article of this length cannot address, including the psychosocial aspects, the choice of a vehicle, insurance premiums, and laws governing the transfer of driver's licenses from state to state.

We offer the following recommendations for special educators and rehabilitation personnel who work with people with low vision who are visual learners and qualify for bioptic driving:

- Share information about whether your state has regulations that allow people with low vision to seek driver's licenses. If your state does not have such regulations, inform your students or clients of states in which they may qualify.

- Obtain information about the procedures in your state for obtaining a driver's license and assist

those who may qualify to go through the steps to obtain their driver's licenses.

- Ensure that children and adolescents with low vision receive instruction in visual efficiency and O&M that may lead to their safe functioning as pedestrians and that may be applied to predriver and driver training.
- Work to establish comprehensive bioptic driver education programs in your state if none exist.
- Work to establish legal allowances for bioptic drivers in your state if none exist.
- Establish continuing education programs for professionals who want to learn more about preparing individuals for driving with bioptics.
- Provide instructional programs for gaining access to transportation for those who will not become bioptic drivers and for bioptic drivers who are licensed with restrictions using, for example, the Finding Wheels Curriculum (Corn & Rosenblum, 2000).

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