O ne prerequisite for rehabilitation of any type is that appropriate diagnostic measures be undertaken first. Earlier in this volume (see Chapter 19), Seiller and Warren discussed issues concerning the screening, evaluation, and diagnosis of visual system dysfunction, including its high incidence following stroke, traumatic brain injury (TBI), and other forms of acquired brain injury (ABI). Nevertheless, even in spite of previous calls (1–8) for appropriate evaluation and diagnosis, in rehabilitation there is a huge service delivery problem in that evaluations of the visual system are minimized, deferred, or narrowly focused on eye health issues. All too often the patient with ABI has received an evaluation focused primarily on ocular and neurologic integrity and health. While these areas are of prime importance in the immediate posttrauma period, as the patient enters the rehabilitation arena, other functional aspects of the visual system become at least equally important. For example, cognitive rehabilitation can be seriously impeded if the patient is experiencing blurred or intermittent double vision that has not been diagnosed and managed.

It is important to understand the range of possibilities for intervention, to know how to implement a treatment plan, including which practitioners can be expected to play which roles, and to evaluate the outcome. It is often possible to bring about substantial improvement with basic “bread and butter” interventions, for example, a pair of +1 diopter lenses to give the accommodative-vergence system the boost it needs to provide binocular vision lost following ABI. Sometimes it is a matter of improving the fit of the lenses, especially bifocal or multifocal lenses. The high benefit-cost ratio of optometric intervention is yet another reason to pursue visual evaluation and rehabilitation.

There are times (e.g., when the patient is languishing in an ambiguous coma emergent state) when it is just as helpful to rule out visual problems as it is to identify them. Here again, the expertise of the rehabilitative optometrist is invaluable (9).

THE INVOLVED EYE CARE PROFESSIONS

Two professions, ophthalmology and optometry, are currently engaged in the ocular and visual care of the patient with ABI. Ophthalmology is a specialty of medicine, and is further divided into subspecialties: cataract, cornea, glaucoma, low vision, neuro-ophthalmology, pediatrics and strabismus, plastics and reconstructive, retina, and finally uveitis (10). In terms of the ABI patient, the neuro-ophthalmologist is most likely to be called on, particularly in the immediate posttrauma period. At this point, his or her expertise is essential in terms of patient management. At times, particularly in the case of accidents, the reconstructive or retinal ophthalmologist is needed. However, with the exception of the ophthalmologist specializing in low vision, in practice it is unusual for any of the other ophthalmologic specialists to play a significant role in rehabilitation. This is not meant to be a negative statement, for...
in general, ophthalmology is primarily a medical and surgical discipline. Indeed, the medical school graduate who is interested in rehabilitation is more likely to opt for a residency in psychiatry.

Optometry specializes in primary eye care (11). The profession’s scope of practice has been significantly extended with legislation authorizing the use of diagnostic and more recently, therapeutic pharmaceutical agents. For the present discussion, there has been and remains a distinct rehabilitative component in optometry. A prime example is optometric vision therapy, which has been defined as the art and science of developing visual abilities to achieve optimal visual performance and comfort (12).

This is an integral part of optometry in that courses relating to the anatomy and physiology of the components of the accommodative and binocular systems, along with didactic and clinical components relating to the noninvasive therapeutic interventions for these systems, are included in the curricula of all the optometric educational institutions. The same case exists for the basic science and clinical applications of visual perception and low vision. Optometric students not only must show competence in these areas in school, but also are tested in this regard by the National Board of Examiners in Optometry. The profession’s two major organizations, the American Optometric Association and the American Academy of Optometry, have particular subgroups representing the specialties of vision therapy and low vision.

In addition, three other organizations, the Optometric Extension Program Foundation, the College of Optometrists in Vision Development, and the Neuro-optometric Rehabilitation Organization, are devoted to continuing education and representation of these areas. Consequently, while the neuro-ophthalmologist is most likely the eye care professional to be involved with the ABI patient during the hospitalization period, the optometrist with interest and expertise in vision therapy or low vision has been and is increasingly called on by members of the rehabilitation team, such as the physiatrist, occupational therapist, physical therapist, and neuropsychologist (5,13–15).

THE INTERFACE WITH COMPREHENSIVE REHABILITATION

Some larger rehabilitation centers have ongoing relationships with rehabilitative optometrists, who are essentially integrated into the team. When for a variety of practical reasons this has not occurred, the physiatrist (as coordinator) and occupational therapist (OT) are most likely to become involved with issues associated with vision. The OT’s expertise in the practical, or as they would say functional, implications of interventions. The OT is the past master of activities of daily living (ADLs) and visual function is crucial to most ADLs. However, any member of the team should feel free to bring the issue to the attention of those who can do something and be prepared to support the treatment recommendations, even so simple as helping the patient to put on the correct pair of glasses. The neuropsychologist, speech-language pathologist, and vocational and educational therapists, who are likely to be working on reading and other near-point activities, should be well attuned to adjustments that have to be made for close vision.

Close working relationships have developed between OTs and eye care practitioners (1,4); however, at times the boundaries of professional responsibility are tested. What is the role of the OT? In some respects, these practitioners have been the real pioneers who have reached out to eye care practitioners and encouraged them to become more involved in rehabilitation. In hospital and residential rehabilitation settings with no in-house eye care professional, OTs have frequently had to forge links with outside eye care professionals. In order to rationalize referrals, they have had to conduct fairly extensive screening procedures, for example, using stereoscopic vision screeners. This information has helped them formulate the referral issue and evaluate the response. When OTs have been able to accompany the patient to the eye care consultation, they have been able to assist in the communication of history, symptoms, and other observations, as well as to bring back the findings and recommendations to the family and the rest of the treatment team. However, the independent spirit that has made it possible for these therapists to bring these services to their patients has at times led to misunderstanding and the appearance, if not the fact, of overstepping the boundaries of their professional expertise. It is important for the physiatrist or case manager to recognize that it is imperative to have a close working relationship with eye care professionals and to understand the limitations of OTs and other therapists. Important as the OT’s contribution is, it does not substitute for the active supervision of an eye care practitioner.

OPTOMETRIC REHABILITATION

A general rule for successful rehabilitation is that the caregiver fully discuss the diagnosed condition(s) with the patient and his or her family or significant others. Not only should the prognosis be addressed, but also, and perhaps even more important, is a thorough explanation of the behavioral and functional consequences of the condition(s). For example, in the patient with a left homonymous hemianopia (a loss of visual responsiveness on the left side of the field of view in each eye), one may anticipate frequent bumping into objects on the left, and ineffective scanning from the end of one line of text to the next. The individual may appear to “neglect” the left side, when in fact the problem should be identified as a product of the visual field cut. There should also be this type of communication with other members of the rehabilitation team, and other
health care professionals. For example, the OT or neuropsychologist who is using computer programs for their aspects of rehabilitation should be fully cognizant that reading glasses, prescribed for a 20-year-old accident victim whose accommodative function has been compromised by oculomotor nerve (cranial nerve III) damage, should be used only for near-point activity, and that the patient’s vision will be blurred when the glasses are used for distant vision.

**Ocular Health**

There is a relatively high incidence of blepharitis with or without an accompanying dry eye syndrome. Therapeutic measures for these conditions include patient education for lid hygiene, including lid scrubs and the use of ointment over-the-counter lubricants. Stroke patients often are diabetic or hypertensive and consequently are at risk for retinopathies and cataracts. These patients should be evaluated every 6 months, including with dilated fundus examination. The wearing of glasses with tinted lenses, as well as use of a hat with a visor, is a valuable intervention to reduce glare and soften bright environmental lighting conditions that are a common consequence of cataracts. Further, in the patient with new or worsening retinopathies, or cataracts that are compromising the patient’s lifestyle, ophthalmologic consultation is frequently in order.

**Refraction and the Prescribing of Glasses**

Determining the degree of myopia, hyperopia, and astigmatism can be accomplished by objective means (i.e., static retinoscopy or automated refracting devices). However, determining the precise lens prescription is usually somewhat more time-consuming; the objective measures are not always in concordance with the patient’s subjective experience. Some patients are unresponsive to lens changes over a relatively wide range, when based on Snellen chart criteria. It is productive to place lenses with the tentatively prescribed correction in a trial frame and engage the patient in real-life situations. Often, the increased clarity produced by the lenses will be appreciated when walking down a corridor, crossing the street, or looking for street signs.

It is essential to place the patient’s refractive status in the context of the overall condition. Again, assume there is damage to cranial nerve III; for individuals with myopia of approximately 2.00 diopters, removing the glasses for most near-point visual activities is indicated, whereas hyperopes of any degree should be instructed to wear the glasses for all visual tasks. Indeed, for many hyperopes with cranial nerve III damage, a separate reading prescription is indicated. Diabetic patients should be forewarned that their refractive conditions are subject to change, depending on the degree to which the diabetes fluctuates (16).

Over the past several decades, great strides have been made in the options available for the most appropriate ophthalmic lens type for the particular patient. For the ABI patient, this can be particularly important because of the frequent use of prisms to compensate for a binocular dysfunction or a visual field defect. Prisms can cause chromatic aberrations that are sometimes more noticeable to the patient than the benefit of more comfortable clear and single binocular vision or the ability to perceive more of the compromised visual field. High index lenses afford the benefits of being thinner and lighter along with physically protecting the eyes. Lens materials such as polycarbonate and CR-39 have optical characteristics that can be optimal for the patient’s refractive condition and for the incorporation of prism into the prescription. Further, antireflective coatings are a valuable option for the cataract or photophobic patient. Polycarbonate lenses are particularly effective in blocking harmful ultraviolet (UV) rays, which are etiologic factors in cataract formation and age-related macular degeneration.

**Vertigo**

As a result of head trauma or stroke, many patients have complaints of vertigo. Often, this is a result of a vestibular dysfunction. Substituting separate pairs of reading and distant glasses for bifocals helps some of these patients. Apparently, the head and eye movements involved in positioning the visual axes in the distant or near part of the multifocal lenses can often exacerbate the vestibular problem. Further, progressive addition bifocals are particularly disturbing to the dizzy patient; even many non-ABI patients need to adapt to the aberrations that are a consequence of the optical design of these “invisible” bifocal lenses. On the other hand, these progressive lenses can have particular advantages, including having only one pair of glasses to keep track of, being of variable strength for intermediate distances, and allowing for convenient adjustment to fluctuating needs.

**Photophobia and Related Visual Phenomena**

A not uncommon complaint of the ABI patient is an increased sensitivity to light, both outdoors and indoors. Further, some of these patients also remark on a perception of waviness or shimmering that is lessened in decreased lighting conditions. Lenses that absorb the shorter wavelengths of light (e.g., blue-tinted lenses) can relieve both the photophobia and the waviness or shimmering in a number of patients. While the type of tint may be determined by trial and error, recent research provided objective evidence to the patient’s subjective reports of decreased symptoms with light-filtering lenses. Jackowski et al (17), in a controlled experiment, demonstrated that the use of Corning Photochrome Filtering lenses (CPF 450) increased contrast sensitivity and improved reading rates in TBI patients who became photophobic after trauma.

**Optometric Vision Therapy (Visual Training)**

This type of intervention is used to rehabilitate dysfunctions of the dynamic systems of vision, including eye movements (fixation, pursuit, and saccade), the accom-
modative system, and the binocular system, ranging from constant strabismus, to intermittent strabismus, to the non-strabismic anomalies of binocular vision and visual perception (2, 18). There is also evidence that vision therapy is effective in controlling ABI-induced nystagmus (19).

Therapy to stabilize visual fixation ranges from using techniques that require sustained and accurate central fixation, such as filling in the circular portions of the letters “o,” “b,” and “d” contained on a newspaper page with a sharpened pencil, to using computer-based programs that require the patient to maintain fixation on a specific portion of the monitor screen, and respond by hitting the space bar or mouse when a predetermined number appears (20). The efficacy of such a regimen has been demonstrated by electronically based eye movement recordings (15) (Fig. 33-1).

Pursuit and saccadic eye movements are frequently impaired following ABI (21, 22). When the latency and accuracy of these eye movements are compromised, the results can be devastating. Thus, the not infrequent observations of some ABI patients that they see the car while crossing the street, but cannot follow it... “I lose where it is”... can often be attributed to delayed or inaccurate visual pursuit. Saccadic eye movements are a prerequisite not only for accurate and effortless reading, but also for accurately sampling a new visual environment. Ron (23, 24) conducted visual training with several TBI patients and gave objective evidence via infra-red eye movement recordings of enhanced pursuit and saccades. Further, he demonstrated that the improvements were beyond those attributed to the healing process.

Therapies to rehabilitate saccadic and pursuit movements have long been an integral part of optometric vision therapy. In general, the goal is to equalize and maximize the performance of each eye as to latency, accuracy, and automaticity, in a purely visual fashion, that is, without active body, neck, or head movement. Then one proceeds to binocular techniques. Further, techniques to improve proprioceptive and kinesthetic awareness, or “feeling” of the extraocular muscles are used to enhance performance. Therapy proceeds from low to higher cognitive tasks as the individual gains increasing control over the saccade and pursuit movements. A popular technique for saccade therapy is the use of various electronically based devices that program random sequences of small light sources, which the patient is instructed to touch as each is lit. The speed and spatial complexity can be varied. Other advanced therapies for pursuits and saccades are available in computer programs that can be used for in-office and home procedures, some of which are listed in Table 33-1 (25). Others are described later in the section on interventions for visual field impairment.

Dysfunctions of the accommodative (focusing) mechanism are not uncommon in ABI patients (26). While the obvious immediate causes are trauma to cranial nerve III or the ciliary muscle, persistent accommodative dysfunctions (e.g., amplitude, flexibility, or sustenance) can be a consequence of anticholinergic or other medications that affect the parasympathetic nervous system. There is general agreement that the primary therapeutic measure is to prescribe the indicated convex lens power that enables the patient to attain clear near vision (8, 27). Incorporating techniques that enhance all aspects of the accommodative response, such as decreasing latency and increasing flexibility, are often effective. These techniques challenge the ability of the patient first to quickly clear targets at near, then at far, and so on. The next step is to sustain clarity of the near target for increasing periods of time, and then instantly to clear the far target, and sustain its clarity for increasing periods of time, and so on. This type of “accommodative rock” can be carried out in free space, or with the aid of lenses, or lens and prism combinations (28) (Fig. 33-2). During the therapy, the patient’s accommodative abilities should be closely monitored so that as improvement occurs, the convex lens prescription can be appropriately decreased in power.

Dysfunctions of the binocular system can be conceptualized on a continuum from constant strabismus, to intermittent strabismus, to nonstrabismic anomalies of...
binocular vision (Fig. 33-3). Patients with strabismus resulting from ABI most often do not make the adaptations that classically occur; there is little or no suppression-based amblyopia, or anomalous correspondence. Rather, even years after the accident or stroke, patients who are diplopic are told to either patch one eye or to "learn to live with it." One strategy has been to provide the patient with prism lenses that compensate for the eye turn, and then institute usual vision therapy to develop binocular vision (29). Basically, this is done by establishing single binocular vision with the eye in the primary position and the patient wearing the prism correction and then developing vergence binocular eye movements opposite to the direction of the turn (e.g., divergence in the case of esotropia, and convergence in exotropia). The primary method is to provide each eye with a discrete target that when combined with its counterpart, results in a meaningful visual percept. A number of devices have been developed for these purposes, so that it can be accomplished "in instrument" or in "free space" (Figs. 33-4 and 33-5). Targets that require various levels of binocular vision (i.e., superimposition, fusion, and stereopsis) are available. As the patient's ability in these tasks increases, it is usually possible to decrease the amount of prism in the patient's glasses. When it is believed that further progress cannot be made, active vision therapy is ceased, and the patient is monitored on a regular basis. In this manner, the patient is diplopic free without the use of a patch.

However, when further progress is possible, the same regimen is used for nonstrabismic anomalies of binocular vision.

Table 33-1: Computer Resources for Optometric Rehabilitation

<table>
<thead>
<tr>
<th>Name</th>
<th>Author(s)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Orthoptics</td>
<td>J. Cooper</td>
<td>American Vision Therapy*</td>
</tr>
<tr>
<td>Block Breaker</td>
<td>Y. Emura</td>
<td><a href="http://www.emsoft.co.jp/block-e.htm">http://www.emsoft.co.jp/block-e.htm</a></td>
</tr>
<tr>
<td>Functional Visual Fields</td>
<td>R. Gianutsos</td>
<td>Life Science Associates⁴</td>
</tr>
<tr>
<td>BISECT—Line Bisection</td>
<td>R. Gianutsos</td>
<td>Life Science Associates⁴</td>
</tr>
<tr>
<td>OPTOMEX—Optometric Scanning</td>
<td>R. Gianutsos</td>
<td>Life Science Associates⁴</td>
</tr>
<tr>
<td>Visual Perception</td>
<td>S. Groffman</td>
<td>American Vision Therapy⁵</td>
</tr>
<tr>
<td>Gutenberg VS Memory Jig/S Morejong</td>
<td>G. Kerkhoff &amp; C. Marquardt</td>
<td>J Neurosci Methods 1995;63:75–84</td>
</tr>
<tr>
<td></td>
<td>S. Moraff</td>
<td><a href="http://www.moraffware.com">http://www.moraffware.com</a></td>
</tr>
<tr>
<td>Computer Aided Vision Therapy</td>
<td>S. Moraff</td>
<td><a href="http://www.moraffware.com">http://www.moraffware.com</a></td>
</tr>
<tr>
<td></td>
<td>G. Vogel</td>
<td>Bernell Corporation³</td>
</tr>
</tbody>
</table>

* American Vision Therapy, PO Box 197, Cicero, IN 46034. Tel: 800-348-4925.
³ Bernell Corporation, 750 Lincolnway East, PO Box 4637, South Bend, IN 46634-4637. Tel: 800-348-2225.

Figure 33-2. In the accommodative rock exercise, the patient holds "flipper" lenses that contain additional plus (magnification) lenses in one pair and additional minus lenses in the other. The task calls for attaining a clear image through one set of lenses and then flipping the lenses and using accommodation to attain a clear image as efficiently as possible. In the present illustration, an eye patch is worn and the exercise is monocular.

Figure 33-3. Continuum of dysfunctions of the binocular system. (Reproduced by permission from Suchoff IB, Petito GT. The efficacy of visual therapy: accommodative disorders and non-strabismic anomalies of binocular vision. J Am Optom Assoc 1986;57:119–125.)
This umbrella term classically encompasses the various vergence dysfunctions, for example, convergence and divergence insufficiency and excess, and vertical phorias for which the patient cannot compensate. However, an expanded classification has developed over the years (Table 33-2). Regimens and procedures to remediate these conditions have been fully described in the optometric literature (1,30–32). Further, once the patient has achieved sufficient binocular skills, exercises can be based on the stereograms available in popular books and computer programs (e.g., see Web page at http://www.vision3d.com). It is usually not difficult to motivate patients to use these attractive materials. The basis of these therapies is to maximally develop the quality, range, and sustenance of comfortable clear and single binocular vision by sequentially increasing the complexity of the cognitive and sensory-motor demands.

While the synkinesis between accommodation and convergence is certainly a consideration in strabismic therapy, it takes on a key role in the rehabilitation of the nonstrabismic anomalies of binocular vision. Hence, the ultimate goal of therapy is to normalize this relationship, that is, to develop an appropriate or expected accommodative convergence to accommodation (AC/A) ratio. This is accomplished by developing a freedom between the two functions. In this instance, the patient is given techniques where, for example, convergence must be inhibited, in the interest of single vision, while accommodation is stimulated, or where accommodation is inhibited while convergence is stimulated. These techniques require the use of lenses or prisms that vary the accommodative and vergence demands, respectively.

In one of the best controlled efficacy studies, applying the single case experimental design, Kerkhoff and Stogerer (33,34) trained fusional convergence using three orthoptic devices (fusion trainer, prisms, and cheiroscope). Eleven of 12 ABI patients showed 1) no gains in baseline, 2) gains during treatment, and 3) maintenance of gains during a 10-month follow-up period. They also experienced gains in near-point acuity, stereopsis, and reading, together with a reduction in subjective symptoms associated with fusional deficiency (e.g., eyestrain and headache).

In general, there is increasing utilization of vision therapy for ABI patients. Morton (35), an ophthalmologist, proposed that this therapy uses repetition to retrain neural pathways that have been damaged, or to develop alternative pathways, and presented several case studies. Freed and Hellerstein (36) presented a more scientific demonstration of the efficacy of this type of optometric intervention. An experimental group of 18 patients with mild brain injury received a regimen of optometric rehabilitation, while 32 matched control subjects did not. At 12 to 18

Table 33-2: An Expanded Classification of Vergence Dysfunctions

<table>
<thead>
<tr>
<th>Category</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fusional vergence dysfunction (skills case)</td>
<td>Convergence insufficiency</td>
</tr>
<tr>
<td></td>
<td>Pseudoconvergence insufficiency</td>
</tr>
<tr>
<td></td>
<td>Convergence excess</td>
</tr>
<tr>
<td></td>
<td>Divergence excess</td>
</tr>
<tr>
<td></td>
<td>Divergence insufficiency</td>
</tr>
<tr>
<td></td>
<td>Basic exophoria</td>
</tr>
<tr>
<td></td>
<td>Basic esophoria</td>
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</table>
months after therapy, the experimental group showed a significant decrease in pattern visually evoked cortical potential (VECP) abnormalities, as opposed to the control group.

**Rehabilitation of Visual Field Impairments**

Following brain injury, visual field impairment is fairly common, yet it is often undiagnosed or underdiagnosed. These problems are usually characterized by a lateralized differential pattern of response to visual stimuli. The loss may be relative or absolute, and the problem may involve the central (perifoveal) or the peripheral fields, or both.

Formal optometric diagnostic procedures, detailed elsewhere (5), include perimetry for the peripheral fields and testing using the Amsler grid for the central fields. Unfortunately, these assessment procedures present cognitive demands, which can limit their use with the ABI patient. Specifically, the individual must sustain a focus of attention on a fixation point, while reporting on perceived events elsewhere in the field of view. In the case of threshold perimetry, in which the minimum light intensity seen at each point is mapped, these decisions may involve fine discriminations and rapid judgments. To help meet this diagnostic challenge, Gianutsos and Suchoff (5) recommend a modified two-person confrontation procedure and computerized functional visual field tests with norms (37).

**Functional Visual Field Procedures**

The functional visual field procedures, listed in Table 33-3, require responses to visual stimuli throughout a computer screen. In most instances, there is no fixation requirement and the speed of response to stimuli in different locations is measured. The functional visual field procedures have proved to be simple enough for most ABI patients to do and there are norms for both young and old adults (37). The procedures for the peripheral fields address responsiveness to the near periphery (about 30 degrees) and range from attentionally simple [e.g., Reaction Time Measure of Visual Field (REACT)] to complex [e.g., Search for the Odd Shape (SOSH) and Search for Shapes (SEARCH)], illustrated in Figure 33-6.

### Table 33-3: Functional Visual Field Assessment Procedures

<table>
<thead>
<tr>
<th>Peripheral (to 20 Degrees)</th>
<th>Perifoveal (Central 4 Degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>REACT: Reaction Time Measure of Visual Field</td>
<td>INSPECT: Shape Inspection</td>
</tr>
<tr>
<td>SDSST: Single and Double Simultaneous Stimulation</td>
<td>FASTREAD: Tachistoscopic Reading</td>
</tr>
<tr>
<td>SOSH: Search for the Odd Shape</td>
<td>ERROR DETECT: Error Detection in Texts</td>
</tr>
<tr>
<td>SEARCH: Visual Search</td>
<td></td>
</tr>
</tbody>
</table>

*Source: Life Science Associates, 1 Fenimore Road, Bayport, NY 11705. Tel: 516-472-2111. Web site: lifesciassoc@pipeline.com.*
presented more slowly. The nature and pattern of errors are analyzed. For example, POLICE may be changed to “POLICY,” a right substitution, or to “LICE” a left truncation. Following brain injury, substitutional errors are more common than truncations and probably reflect macular sparing. Error Detection in Texts (Fig. 33-9) calls for proofreading of continuous text and affords a sensitive index of perifoveal hemi-imperception. Although errors are distributed equally on the left and right sides of the page, more often than not, the critical factor is whether the error occurs at the beginning or end of the word.

Optical Interventions for Visual Field Loss

Until fairly recently, rehabilitative interventions for visual hemifield impairment were limited to counseling and compensatory training. Fortunately, optical interventions are now being refined to complement, if not correct the problem. Optical interventions for visual field loss, reviewed by Cohen and Waiss (40), involve the use of displacing prisms or spectacle-mounted mirrors. Ground-in yoked prisms in the range of 6 to 12 diopters appear to be most useful. The base of each prism is placed in the same lateral direction in relation to the patient. In other words, the displacement is in the same direction in each eye. A pair of spectacles designed for a stroke survivor with an upper-right-quadrant field loss is illustrated in Figure 33-10. A different set of glasses with greater prismatic power than would be used for distance may be necessary for near-point work. The fit of the spectacle is important. Here we would especially recommend spring-loaded frames as they remain more consistently in place. Small oval lenses have less optical distortion and are lighter. Often the best response to these lenses is subjective, although the patient should be prepared not to expect a cure. Further, since the optical interventions do not fully correct the loss, it is essential to complement this intervention with awareness counseling, practice with feedback, and training in compensatory scanning.

Counseling

Typically, visual hemifield impairments caused by central nervous system injury are exacerbated by a loss of awareness. It is important to understand that this lack of awareness is inherent to some forms of sensory loss, as when the person with a hearing loss thinks others are not speaking clearly. Gianutsos (41) parallels this phenomenon with the unawareness all of us have for the rather substantial (the size of a fist at arm’s length) visual field loss corresponding to our physiologic blind spot. She contrasts this with the heightened response to glare, which triggers immediate attempts to avoid or control. While this unawareness of neurologically produced visual field losses is sometimes profound, more often it is expressed as an underappreciation of the magnitude of the problem. Accordingly, there is much misinterpretation of the patient’s behavior, and safety is compromised (42). It is therefore essential that rehabilitative interventions address the awareness issue. While a true subjective awareness of the lost vision often does not develop, as it would for a cataract or a retinal defect, it is possible for the patient to develop an intellectualized awareness of the problem. In other words, they can learn that if they cannot locate something, then it must be in the area covered by the visual field defect. Therefore, treatment must be directed toward increasing awareness of the visual field problem to the extent that it cannot be treated optically and by developing compensatory eye movements.

Practice with Feedback

Exercises that offer feedback organized by the location of the stimuli are useful for building both skill and awareness. Examples include cancellation (43,44), Error Detection in Texts, and common word-search and hidden-figure puzzles. These, especially error detection, tend to focus on central field impairments. Practice materials for error detection (38) can be created from texts downloaded from sources such as Project Gutenberg (see Web site http://www.promo.net/pg/), including famous speeches, short stories, and even whole books. These can be reformatted and edited with a word processor, as illustrated in Figure 33-9. Advanced computer spelling checkers, which highlight incorrectly spelled words, are particularly convenient for the creation of these materials, as one can see the errors and their distribution on the page.

Computerized tasks can have special value by offering immediate feedback to promote the development of...
persons with limited motoric control, a trackball) to control the cursor on the screen. Developing the eye-hand coordination necessary for controlling the cursor in this fashion may be a special challenge for patients with visual field problems. Frequently it is a good idea to begin with a simple solitaire game on the computer—an insight that computer software manufacturers have long recognized, since solitaire is supplied with just about every computer that has a graphic user interface!

A dynamic scanning task, widely available under many names is Breakout. This task is like playing tennis off a backboard, except that the board is an array of bricks, which are removed by hitting them with the ball. The lateral movement of the paddle is typically under mouse (trackball) or joystick control. We use a “freeware” version (shown in Fig. 33-11) called BlockBreaker (see Web site http://www.emsoft.co.jp/block-e.htm) because it is very plain, has parameters affording a wide range of difficulty, and supplies meaningful scores.

A favorite among these computer exercises (or games) is Mahjongg, which goes under different names, such as Taipei, Shanghai, and Morejongg. This shape-matching exercise is visually appealing and presents constraints that challenge logic and sequencing. Morejongg (see Web site http://www.moraffware.com) is a multimedia
version of this exercise that offers rich visual and auditory inducements to engage in the exercise (Fig. 33-12). Further, it yields scores (time and number of pieces remaining) that can be tabulated. The clinician enters this information on a spreadsheet that computes a rate of matching and a graph (Fig. 33-13) that reveals an overall trend, which can be very motivating for the patient (and the insurance company!).

Jigsaws Galore (see Web site http://www.dgray.com/jigalo.htm) is a program that preserves most of the features of the classic noncomputerized game and adds some useful ones. For instance, it keeps track of the time and number of pieces put together, information that can also be converted to a solution rate index and graphed. As illustrated in Figure 33-14, one can make jigsaws out of virtually any picture, including family photographs and scenes varying in complexity. Furthermore, the number, size, and orientation of pieces can be specified so that the difficulty can be controlled over a broad range. Like Mahjongg, the fun index for this exercise is high and patients engage in it eagerly on their home computers.

The value of the computer is that it is dynamic, it keeps track of performance automatically, and it is appealing. While the computer is not for everyone, it is a tool that can be invaluable. There is, however, no risk that the computer will replace therapists. While the computer may extend what is possible for therapists to do, the therapist is crucial in identifying appropriate tasks and parameters, introducing them and helping the patient to appreciate why the task is useful, advising on what methods should be used to improve performance, and counseling regarding the implications of the results.

Efficacy studies substantiating these techniques for promoting visual field awareness and compensation have been published by Kerkhoff and his colleagues (46,47), Scherzer (48), and researchers at the Rusk Institute in New York (43,45,49). Encouraging as these studies are, it is well to appreciate that visual field impairment remains one of the more challenging problems for optometric rehabilitation. The problem may persist and the individual lulled into thinking that the problem has been overcome. It is often useful to offer “booster doses”
Figure 33-10. Spectacles (upper panel) with a yoked (bases up and right) prism used to assist an individual with an upper-right-quadrant (lower panel). The prisms displace the image down and to the left. In these reading glasses, the strength of the prism is greater than for distance viewing. Note that the visual fields shown are for the central 4 degrees and clearly show only a degree of macular sparing.

Figure 33-11. BLOCKBREAKER display. The bar at the bottom is the paddle that is controlled by rolling the trackball (or mouse) to the left and right. As the ball hits the bricks, they are removed. The ball bounces off the walls and the observer must engage in rapid visual pursuit, much as in the game of paddle tennis. The score is the number of bricks removed.

Figure 33-12. Mahjongg starting display from the program Shanghai: Dragon’s Eye (Activision, Inc.). Visually, this stack of 144 attractively colored tiles is viewed slightly from the left. In computerized Mahjongg, the object is to match identical tiles, with the constraint that a piece cannot be covered by another piece and it must have a left or right edge exposed. Here the center (also the top of the stack) tile (eight balls) could be matched with one in the second row on the right, but not with the one in the third row from the bottom. As the exercise progresses, the computer reports the number of shapes remaining and elapsed time. From this, solution rate is the ratio of shapes matched per unit time.

Figure 33-13. Progress on computerized Mahjongg of a patient after right-hemisphere cerebrovascular accident who has dense left homonymous hemianopia. For the most part, there was one session per week, although later on there were two sessions on 1 day. To minimize acuity issues, sessions 1 to 85 were conducted with tiles containing a large letter (designed like a child’s alphabet block). The dip at session 86 reflects the beginning of the more visually complex tiles shown in Fig. 33-12. The overall trend shows distinct progress; however, there was much session-to-session variation.
of tasks with feedback to counter this tendency. Periodically, the individual with persistent visual spatial hemi-perception needs to be reminded of the limits of compensation.

CONCLUSIONS

Importance of Comprehensive Evaluation

All too often following brain injury, visual problems remain undiagnosed. Diagnosis is a prerequisite for systematic rehabilitation to occur. Early, appropriate, and comprehensive evaluation is essential because of the primacy of vision in information processing and many visual problems do not reveal themselves subjectively.

Rehabilitative Optometry

Rehabilitative optometrists are the key service providers for such comprehensive diagnosis and functionally oriented treatment planning. They work most closely with OTs, physiatrists, neuropsychologists, and physical therapists, and are becoming an integral part of the treatment team. Consultation with ophthalmologists is appropriate when there is a need for ocular surgery or for the treatment of complicated ocular pathologies.

Visual Rehabilitative Interventions

Interventions include the treatment of ocular disease, prescription of lenses and prism, vision therapy, patient and family education and counseling, and environmental modifications. Computerized visual tasks have particular value as a therapy tool. Often conventional interventions (e.g., properly fit spectacles with correction) are overlooked or incorrectly applied following ABI. These all too common failures in the implementation of standard eye care occur, perhaps, because of the need for special clinical skill with this population.

Efficacy

Efficacy studies offer support for these approaches. The most difficult conditions to treat include visual field loss coupled with hemi-inattention, significant nystagmus, and optic nerve atrophy. In most instances, however, results range from at least helpful to, in some patients, a complete functional solution.

REFERENCES


