The biVABA

BRAIN INJURY VISUAL ASSESSMENT BATTERY FOR ADULTS

TEST MANUAL

MARY WARREN PhD, OTR/L, SCLV, FAOTA

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PREFACE

My goal in designing the biVABA was to provide occupational therapists with a practical clinical tool to use to complete a quick, accurate, reliable and useful screening of the client’s visual processing following brain injury. The biVABA is not meant to be a diagnostic tool. Diagnosing an impairment in visual function and determining its etiology and pathology is the responsibility of ophthalmologists, optometrists, and neurologists. The purpose of the biVABA is to enable the therapist to screen for visual impairment so that appropriate referral can be made and to provide information to plan interventions to effectively address the limitations in daily occupations resulting from visual impairment. The biVABA should not be considered as a replacement for other diagnostic assessments and procedures. Instead, when properly used, the information obtained from the assessment should serve as a bridge to facilitate communication with other rehabilitation and vision specialists and a tool to develop successful interventions for the client.

Many of the assessments in the battery are instruments and procedures designed by experts from the fields of ophthalmology and optometry; others, I have designed based on the research literature and my clinical experience. I consider my primary contribution to the biVABA to be the information provided on how to interpret and use the data from the subtests to develop interventions to improve occupational performance. That information represents the culmination of thirty years of research, study, and clinical effort as an occupational therapist working with adults experiencing visual impairments following brain injury.

Four principles guided the design of this clinical tool. Those principles are:

1) That a client’s visual performance is not significant in terms of how it deviates from the established norm but how it interferes with functional ability.

2) That a client requires intervention only if the ability to use visual input has been altered in such a way that it prevents or interferes with performance of a necessary activity of daily living. Stated another way, limitations in occupation are the only issue of concern to the therapist.

3) That evaluation completed by therapists should be directed towards identifying the limitation in occupational performance and determining the client’s strengths and limitations in relationship to that impairment.

4) That treatment should be directed towards maximizing the client’s strengths and minimizing weakness to improve functional performance.

The visual functions addressed by the biVABA were chosen based on the frequency with which they are impaired following brain injury and their importance in ensuring that visual perceptual processing is accurately completed. Therapists will find few similarities between this assessment and those traditionally used to measure visual perceptual processing. For example, many of the tests use a task analysis approach and there is no mention of cut-off scores or much about scores in general. That is because the purpose of the biVABA is not to diagnose or label visual perceptual dysfunction but to identify how visual perceptual processing has changed secondary to the brain injury and how it affects the client’s ability to complete valued daily occupations. Comparisons between the client’s performance and that of other adults is of less concern than whether the client’s visual perceptual processing facilitates occupational performance or prevents it. Labels such as visual spatial neglect are interpreted differently by each profession and tend to inhibit understanding and discourse between professionals rather than facilitate it; they certainly do not contribute anything meaningful to intervention planning. It is better to describe how the impairment is affecting performance than to label it. Those familiar with my work have been exposed to and, hopefully, understand this perspective. Those unfamiliar with this approach to evaluation and treatment are strongly encouraged to read the first section of this manual to gain a greater understanding of the rationale behind this framework before moving onto the technical sections of the manual.

Mary Warren  July, 1998
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Understanding the limitations in occupational performance that accompany visual processing deficits cannot be achieved without first understanding how vision contributes to functional ability. Therefore, as an introduction to the assessments, the role of vision in adaptation and the effect of visual impairment occupational performance is discussed to provide a rationale for evaluation and intervention. The reader is urged to read this section and fully digest the information presented before concentrating on the mechanics of giving the subtests.

1.1 THE ROLE OF VISUAL PROCESSING IN OCCUPATIONAL PERFORMANCE

One of the primary functions of the central nervous system (CNS) is to analyze sensory input, integrate it's various forms, and respond to it. The goal of the integration of all sensory information including vision is adaptation to the environment. It is through the effort of adaptation that intellectual, physical, and emotional growth is achieved.

Vision plays a significant role in daily living. It is the primary sensory system used to acquire information about the environment, taking us farthest and fastest into our surroundings. No other sensory system can supply as much advanced warning as the visual system which is why we rely on vision to detect such life threatening events as fires, tornadoes and oncoming cars. Vision provides the information needed to make countless daily decisions, from where to sit in a crowded room to which piece of meat to buy, or which shirt to wear. It supplies information needed for successful social interactions as when we observe gestures and facial expressions to judge the mood of a person to whom we are about speak. Vision also dictates and guides motor actions, in that, seeing a quarter on the floor causes one to reach down to pick it up; a tennis ball approaching elicits a move of the racket to intercept it. Vision plays a critical role in postural control, warning of upcoming challenges to balance such as a curb, a step, or a banana peel on the floor. It functions so reliably as an advanced warning system, that it is rare to collide with an object or fall down during the course of a day.

The speed with which visual information is processed allows rapid assimilation of detailed information about the environment and quick decision making. That speed is critical to our ability to successfully adapt to complex and dynamic environments where multiple objects are in motion around us. We rely on fast, accurate visual input to complete such dynamic activities as driving in rush hour traffic, shopping in a crowded grocery store, or playing a game of basketball.

1.2 THE EFFECT OF VISUAL IMPAIRMENT ON OCCUPATIONAL PERFORMANCE

When visual impairment occurs, it alters the quality and quantity of visual input into the CNS and/or alters the way the CNS is able to utilize incoming information. Following brain injury, visual function can be compromised along several dimensions. Ocular impairment can occur, affecting the integrity and quality of the focusing of light on the retina, and reducing visual acuity. The pathways from the retina to the cortical areas of the CNS can be disrupted, causing visual field deficit (hemianopsia, quadrantanopsia). Cranial nerve lesion or disruption of central neural control in the brainstem can compromise oculomotor function. Cortical processing of visual information can be disrupted, impairing the ability to recognize objects. Exactly how visual function is compromised depends on the areas of the brain affected and the extent of the damage.
Regardless of the cause, the presence of a visual impairment results in a decrease in the ability of the CNS to use vision to assist in adaptation. Changes are observed in the skills vision supplies to adaptation. For example, speed of information processing is decreased which may prevent the person from responding safely in a dynamic environment. Changes in decision making are observed, with errors occurring because either the person does not obtain sufficient information to make the decision or receives faulty information. This may cause a once decisive person to become unable to make a decision. Changes also are observed in the person’s emotional response to the environment. Feelings of anxiety may occur along with diminished self-confidence and increased passiveness. The changes in these various areas may affect all aspects of daily living, from performance of the simplest selfcare task to the ability to resume driving and return to work.

1.3 THE CONCEPT OF A VISUAL PERCEPTUAL HIERARCHY

The ability to use vision to adapt to the environment depends on the ability of the brain to transform the raw materials supplied by the retina into cognitive concepts of space and form which are used to analyze situations and make decisions. The process by which this occurs is called visual perception. Visual perceptual processing relies on the interaction of seven levels of visual processing within a hierarchical framework. These levels, shown in Figure 1.1, consist of visual acuity, visual field, oculomotor control, visual attention, visual scanning, pattern recognition, and visual memory. Working together they enable visual cognition which allows one to mentally manipulate visual input and combine it with other sensory information to solve problems, formulate plans, and make decisions.

![Visual Perceptual Hierarchy](image)

FIGURE 1.1: The Visual Perceptual Hierarchy. Illustration courtesy of Josephine C. Moore OTR, PhD.

The foundation visual functions within the hierarchy are visual acuity, visual field and oculomotor control. Together these three functions ensure that accurate visual information is supplied to the CNS for perceptual processing. Visual acuity ensures the clarity of visual input. The CNS must have high quality, accurate visual input to complete object identification. A decrease in visual acuity prevents the CNS from accurately perceiving visual detail. Visual field integrity ensures the presence of vision, that is, that all of the visual input from the environment is represented. A visual field deficit causes the CNS to receive an incomplete picture of the environment. Oculomotor control ensures that visual information is acquired rapidly and accurately when the body is in motion or at rest, ensuring perceptual stability. Deficits in oculomotor control reduce the
speed, accuracy, and efficiency with which the brain takes in visual information. Because these skills ensure accuracy of visual input, any alteration in their function can have a profound effect on the engagement of higher level visual perceptual processing.

Brain injury or disease can disrupt visual processing at any of the processing levels in the hierarchy and, because of the unity of the hierarchy, a visual process cannot be disrupted at one level without an adverse effect on the operation of all of the processes within the structure. If a brain injury disturbs a lower level process, those above it also will be compromised. When this occurs, it may appear that the client has a deficit in a higher processing level when, actually, the deficit has occurred at a lower level in the hierarchy. For example, a client who is unable to complete an embedded figures test and appears to have a deficit in the visual cognitive process of figure-ground perception may, in fact, be experiencing inaccurate pattern recognition caused by an asymmetrical search pattern occurring as a result of visual inattention compounded by the presence of a visual field deficit. Treatment of the higher level process (figure-ground imperception) will not be successful unless the underlying deficits in visual attention and visual field first are addressed. This effect is similar to that observed in the motor system following brain injury. The observed motor deficit is that the client cannot use the hand to pick up an object. The underlying deficits are reduced muscle tone, sensation and weakness. Use of the hand for manipulation will not be possible until after the intervention addresses muscle tone, strength and sensation.

1.4 RATIONALE FOR THE APPROACH TO EVALUATION AND INTERVENTION

The concept of a visual perceptual hierarchy provides the rationale for the selection of the evaluations included in this battery. The assumption is made that many changes in visual perceptual function following brain injury occur from alteration of the lower level processes within the perceptual hierarchy including visual acuity, visual field, oculomotor control, and visual attention and scanning. Deficits in these processes prevent the CNS from accurately completing complex visual processing and using vision for adaptation. Identification of deficiencies in these processes followed by intervention will enable the CNS to process visual input more efficiently and, hopefully, enable adaptation. The word “hopefully” is inserted because, just as with motor impairments, the damage to the neural networks from the brain injury maybe so severe that restoration of normal visual processing is not possible.

Concentration on identifying deficiencies in primary visual functions is directly opposite the approach traditionally taken in evaluating visual perceptual function. The traditional approach focuses on interpretation of the client’s performance of complex visual processing (figure ground, visual closure etc.) with little regard to whether the client is receiving accurate visual input. It is an approach that has emphasized the distinctness of the various components of the visual system rather than the unity of the system. Adoption of the traditional approach has enabled therapists to label the perceptual deficit observed in the client but has done nothing to develop an understanding of the cause of the deficit or how to treat it. Because the purpose of evaluation is to guide the clinician in developing intervention strategies to improve the client’s functional performance, the assessments selected for this battery focus on the visual processes that enable application of perception to daily performance. These are the foundation functions of acuity, visual field integrity, oculomotor control, visual attention and scanning.

The goal of intervention never changes. It is always to improve the client’s level of performance in a needed activity of daily living (ADL). Limitations in ADLs should always be identified first with subsequent assessment completed to determine why the limitations are present. Deficiencies in visual processing are not significant unless they interfere with occupational performance. The maxim that guides the evaluation and intervention process is that visual impairment is present only if the client’s ability to use visual input has been altered in such a way that it prevents or interferes with performance of a necessary activity of daily living. Assessment is completed to identify the client’s strengths and limitations in visual processing so that weaknesses can be minimized and strengths enhanced to assist the client to achieve the functional goal.
Three intervention approaches are used; the first is a *remedial* approach where the emphasis is on changing the individual and improving his or her visual processing ability and the second, a *compensatory* approach that concentrates on changing the environment to facilitate visual processing. Which approach is selected depends on the strengths and limitations of the client as identified by the evaluation. A client with many strengths and mild impairment only may be able to remediate visual scanning, whereas the client with severe impairment may not have the capacity to improve visual processing but will benefit from modification of the environment. Education of the client and family as to the effect of visual impairment on the client’s performance is the third treatment approach and is always used in conjunction with the other two. Education is critical to success because it facilitates cognitive insight, a necessary prerequisite to the ability to adapt. Until one fully understands one’s limitations, it is not possible to adopt strategies to overcome them.

While the goals of intervention are no different from those set for other disabilities, that is, safe and independent performance of daily living tasks, the methods used to achieve the goal are different, as are the group of professionals involved in the rehabilitation process. Instead of the physiatrist and physical therapist, it may be more appropriate to work with an ophthalmologist or optometrist and an orientation and mobility specialist. Descriptions of these professionals are given in Sections 6.1.2.5.1 and 6.1.2.5.3.
2 UNDERSTANDING SPECIFIC VISUAL IMPAIRMENTS FOLLOWING BRAIN INJURY AND THEIR EFFECT ON FUNCTIONAL PERFORMANCE

2.1 VISUAL ACUITY

2.1.1 Definition of Visual Acuity

Acuity is the ability to see small visual detail. The most common acuity measurement unit used in the United States is the Snellen fraction (20/20, 20/50 etc.). The numerator of the fraction is the distance (in feet) from which the client views the letter chart and the denominator is the distance at which a persons with normal vision can identify an optotype of a certain size. Thus, 20/20 means that standing at a distance of 20 feet the viewer can see a letter which a person with normal vision can see at 20 feet. 20/200 would indicate that a person standing at a distance of 20 feet can see a letter which a person with normal vision can identify at 200 feet. Visual acuity is measured using high contrast (black on white) test formats and often is referred to as high contrast acuity to distinguish it from contrast sensitivity function testing which measures low contrast acuity (see Section 2.2).

2.1.2 The Function of Visual Acuity in Adaptation

Acuity contributes to the central nervous system’s capability to recognize objects. The dictionary defines acuity as “keenness or sharpness” and, with regard to vision, acuity ensures that clear and precise visual information is provided to the CNS for processing. The higher the quality of the visual input, the more precise the image created by CNS processing; the more precise the image, the faster and more accurately the CNS is able to recognize the object and discriminate it from other features in the environment. Good acuity, therefore, enables speed and accuracy of information processing and decision making.

Two forms of recognition are used by the CNS in adaptation: the recognition of “where” and the recognition of “what.” The recognition of where something is in the environment is necessary to alert the CNS to the presence of objects and, as such, functions as a precursor to the recognition of “what.” To be aware that there are objects in the environment does not require as precise visual information as that needed to identify the object. The CNS only must be able to detect form, motion and gradations in shading to detect the location of an object. The peripheral retinal field is especially designed for this function and the CNS primarily relies on visual input from the peripheral visual field to complete “where” processing. In contrast, the ability to recognize what is being viewed requires extremely precise and detailed visual information. This information is supplied by the central (macular) retinal visual field.

Acuity occurs through a multi-step process which begins with the focusing of light onto the retina. Light rays enter the eye through the pupil and are focused on the retina by the anterior structures of the eye: the cornea, lens and optic media. The retina, acting like film in a camera, processes the light and records the picture which is relayed to the rest of the CNS by the optic nerve. Although the concept is simple, the process is complex involving many factors. These include the ability to precisely focus the light onto the retina, the ability to maintain sharpness of focus over a range of focal distances, the ability to obtain sufficient illumination of the retina, the ability of the retina to capture the image, and the ability of the optic nerve to transmit the image through the CNS for processing. Any compromise of the structures involved in this process will result in degradation of the image and reduced acuity.
2.1.3 Visual Acuity Deficits Associated With Brain Injury

Visual acuity deficits due to brain injuries primarily occur as a result of impairment in three areas of visual processing: 1) disruption of the ability to focus light onto the retina 2) inability of the retina to accurately process the image and 3) inability of the optic nerve to transmit the information to the rest of the CNS for processing. The impairments may be the direct result of the brain injury, or may occur incidental to the injury. It is not possible to describe all of the conditions which can result in reduced acuity following brain injury but the most common are described in the sections which follow.

2.1.3.1 Disruption of the Ability to Focus an Image on the Retina

Sharp focusing of the image on the retina largely depends on the transparency of the intervening structures between the outside of the eye and the retina and on the ability of these structures to achieve proper refraction of the light rays entering the eye. Light entering the eye passes through four transparent media: the cornea, aqueous humor, crystalline lens, and vitreous humor (see Figure 2.1). Any opacity or irregularity in these structures will prevent light from properly reaching the receptor cells in the retina. Conditions which can occur in conjunction with head trauma include corneal scarring, trauma induced cataract and vitreous hemorrhage. Corneal scarring may occur secondary to direct trauma to the eye during the assault to the head. The cornea is damaged and scars as it heals creating an irregular surface which refracts the light unevenly. The person experiences blurriness of vision similar to that created by astigmatism. Damage to the crystalline lens from trauma can result in the subsequent development of a cataract which clouds the lens and reduces acuity. Trauma to the eye can also result in bleeding into the vitreous humor. Since blood is an opaque medium, light cannot pass through it and the person experiences floaters, shadows and episodes of darkness as the blood passes in front of the retina. Of the three conditions, vitreous hemorrhage is the only one which is temporary and will resolve on its own without treatment.

![Schematic Illustration of Basic Structures](image)

FIGURE 2.1: Schematic Illustration of the Basic Structures of the Right Eyeball. *Illustration courtesy of Josephine C. Moore OTR, PhD.*
Another condition which affects the focusing ability of the eye and is associated with brainstem injury, either from head trauma or stroke, is impairment of accommodation. Accommodation is a neural process, regulated by the brainstem, which enables near vision by maintaining clear focus on objects as they come closer. As an object approaches the eye, the focal point of the image on the retina is pushed further back causing the image eventually to go out of focus. The CNS adjusts for this situation through the three step process of accommodation. As the object comes closer, the eyes converge to ensure that the light rays entering the eye stay parallel and in focus, the crystalline lens thickens to more strongly refract the light rays and shorten the focal distance, and the pupil constricts to reduce scattering of the light rays. These three steps enable objects to stay in focus in the near vision range (distances between 3 and 16 inches from the eyes).\[2,12\] A brainstem injury can affect the functioning of one or all of these components. The result is difficulty achieving and/or sustaining focus during near vision tasks. The most frequent complaint voiced by the client is difficulty maintaining focus during reading sometimes causing the print to blur and swirl on the page.

2.1.3.2 Disruption of the Ability of the Retina to Process the Image

Just as with the film in a camera, the retina must be adequately diffused with light to take a high quality picture. Too little or too much light will result in poor exposure of the film. The amount of light entering the eye is regulated by the pupillary light reflex which is controlled by the brainstem. The pupillary light reflex responds to changes in illumination by increasing or decreasing the aperture of the pupil to ensure proper exposure of the receptor cells in the retina.\[4\] Any condition which affects the responsiveness of this reflex will affect the client's tolerance to light and ability to rapidly adjust to changes in illumination. Clients, following brainstem injuries, may have difficulty regulating the speed and efficiency of the pupillary response causing them to be hypersensitive to light (photophobia), and/or slow to adapt to changes in illumination. Impairment of this reflex also interferes with the process of accommodation as discussed in the previous section. The receptor cells of the retina also can be damaged directly by injury or disease preventing them from responding to light. Diseases which affect retinal function, such as macular degeneration and diabetic retinopathy, are associated with age and significantly increase in incidence in the seventh and eighth decades of life.\[11\] It has been estimated that nearly one in four adults over eighty years of age has a visual impairment so significant that it prevents reading standard newsprint.\[11\] Macular degeneration, the most prevalent cause of vision loss in older adults, never progresses beyond the central visual field, so that the person never becomes blind.\[12\] However, damage in the central visual field can cause significant reduction of visual acuity. Because the incidence of stroke also increases with age and because diabetes is a risk factor for stroke, it is not uncommon for an older adult referred for treatment of a stroke also to have reduced visual acuity secondary to these eye diseases. Too often the vision loss resulting from the disease either is overlooked or misdiagnosed as an attentional or cognitive impairment associated with the CVA.

Less common is development of a central retinal artery occlusion (CRAO) which essentially is a “stroke” of vascular supply to the eye. CRAO often results in complete blindness in the eye, although some central visual field may be spared if enough collateral vascular supply is present.\[13\] An infarction also can occur in just one branch of the artery causing an altitudinal (horizontal) visual field defect. Vision loss is permanent when CRAO occurs. Direct trauma to the retina associated with a blow to the head also can result in vision loss by causing detachment of the retina.\[14\] The person may notice bright flashes or light progressing to shadow. This condition, if not immediately treated, will result in permanent visual impairment.

When the retina is damaged, it is like damaging the film in a camera, in that, a poor picture will result. Disruption of the picture depends on the area of the retina damaged. If the macular area is affected, the client will have difficulty seeing visual detail; color discrimination also will be affected as will contrast sensitivity function. The client will lose much of the “what” function of vision and the ability to identify objects but will retain the “where” function used for visual orientation to the environment. The reverse will be true if the peripheral retina is damaged; perception of visual detail will be retained but the ability to detect motion and low contrast form will be diminished.
2.1.3.3 Disruption of the Ability of the Optic Nerve to Send the Retinal Image

The most common cause of optic nerve damage associated with brain is injury to the optic nerve secondary to trauma. The injury may occur from a direct penetrating trauma to the nerve as may occur with a missile wound to the head from a gunshot, or another projectile. Indirect trauma also can damage the nerve such as occurs with an optic canal fracture associated with facial fracture or blunt forehead fractures. These are most common in children and young adults and usually result in unilateral injuries. Severe closed head injuries can cause stretching or tearing of the optic nerve during the sudden deceleration of the head resulting in significant and usually bilateral damage to the nerves. Bilateral nerve injury also can result from compression of the nerve secondary to intracranial swelling or hematoma. Immediate, sudden, and complete loss of vision due to optic nerve trauma often is unresponsive to treatment and results in severe visual impairment or blindness. A delayed onset of vision loss, where vision slowly dims over a period of hours or days is usually due to intracranial swelling and sometimes can be reversed with high doses of corticosteroids if treated in time.

Other commonly seen conditions which can result in optic nerve damage are glaucoma and multiple sclerosis. Glaucoma, an age related disease which damages the optic nerve, typically causes of loss of visual function in the peripheral visual field but can also affect the central visual field and eventually result in blindness if the disease process is not arrested. Glaucoma also may develop secondary to trauma to the eye. Multiple sclerosis can cause plaques to develop along the optic nerve resulting optic neuritis and reduced acuity and sensitivity to light.

2.1.4 Functional Deficits Caused By Reduced Visual Acuity

Reduced acuity can cause limitations in a significant number of daily living activities. The severity of the limitation depends on the extent of the acuity loss and whether there has been a loss of central acuity, peripheral acuity or both. Table 2.1 (next page) lists some of the limitations in daily occupations experienced by persons with reduced acuity.

2.2 CONTRAST SENSITIVITY FUNCTION

2.2.1 Definition of Contrast Sensitivity Function

Contrast sensitivity function (CSF) is the ability to reliably detect the borders of objects as they degrade in contrast from their backgrounds making it possible to distinguish and identify faint objects. CSF is sometimes referred to as low contrast acuity to distinguish it from high contrast acuity measured with black optotypes on white backgrounds (example: the standard eye chart). Like high contrast acuity, CSF provides a way of measuring the visual capability of the individual. Although the testing procedure used to measure CSF is similar to that used for high contrast acuity, CSF is considered to be a separate visual function and research has shown that it may be impaired in individuals even when their high contrast acuity is within normal limits.
**TABLE 2.1: Examples of Daily Occupations Affected by Reduced Visual Acuity and Contrast Sensitivity Function.**

<table>
<thead>
<tr>
<th>SELF CARE</th>
<th>MEAL PREPARATION</th>
<th>HOME MAINTENANCE</th>
<th>SHOPPING</th>
<th>MONEY MANAGEMENT</th>
<th>COMMUNITY ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• applying make-up</td>
<td>• setting appliance dials</td>
<td>• cleaning</td>
<td>• accessing transportation</td>
<td>• reading bills/financial statements</td>
<td>• accessing transportation</td>
</tr>
<tr>
<td>• applying toothpaste</td>
<td>• measuring ingredients</td>
<td>• setting dials on washing machine</td>
<td>• locating correct aisle/item</td>
<td>• completing a check or money order</td>
<td>• recognizing acquaintances</td>
</tr>
<tr>
<td>• completing nailcare</td>
<td>• timing food cooking</td>
<td>• yard maintenance</td>
<td>• reading prices</td>
<td>• maintaining financial ledger</td>
<td>• maintaining orientation in unfamiliar places</td>
</tr>
<tr>
<td>• selecting clothing</td>
<td>• determining when food is done</td>
<td>• car maintenance</td>
<td>• making change</td>
<td>• addressing/mailing bills</td>
<td>• locating public restrooms</td>
</tr>
<tr>
<td>• mending clothing</td>
<td>• cutting, chopping, slicing</td>
<td>• minor household repairs</td>
<td>• making grocery list</td>
<td>• identifying foods</td>
<td>• eating out in restaurants</td>
</tr>
<tr>
<td>• managing medications</td>
<td>• reading recipes, instructions</td>
<td>• telephone usage</td>
<td>• eating neatly</td>
<td>• identifying money</td>
<td>• negotiating curbs, steps etc.</td>
</tr>
<tr>
<td>• eating neatly</td>
<td>• identifying foods</td>
<td>• ironing</td>
<td>• spreading toppings on foods</td>
<td>• pouring liquids</td>
<td>• avoiding collisions</td>
</tr>
<tr>
<td>• seasoning foods</td>
<td>• operating microwave oven</td>
<td>• adjusting thermostat</td>
<td>• making change</td>
<td>• adjusting thermostat</td>
<td></td>
</tr>
<tr>
<td>• spreading toppings on foods</td>
<td></td>
<td></td>
<td>• accessing transportation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INFORMATIONAL READING</th>
<th>PLEASURE READING</th>
<th>LEISURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• newspaper</td>
<td>• newspaper</td>
<td>• sewing</td>
</tr>
<tr>
<td>• newspaper ads</td>
<td>• funnies</td>
<td>• quilting</td>
</tr>
<tr>
<td>• stock quotations</td>
<td>• magazines</td>
<td>• bingo</td>
</tr>
<tr>
<td>• TV guide</td>
<td>• books</td>
<td>• card games</td>
</tr>
<tr>
<td>• recipes</td>
<td>• daily meditations</td>
<td>• woodworking</td>
</tr>
<tr>
<td>• food labels</td>
<td></td>
<td>• needlework</td>
</tr>
<tr>
<td>• medication labels</td>
<td></td>
<td>• fishing</td>
</tr>
<tr>
<td>• menus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• telephone directory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• address book</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• incoming mail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• bank receipts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• bills/financial statements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• checkbook ledger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• watch or clock face</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• street signs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• aisle markers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• store signage</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.2.2 The Function of Contrast Sensitivity in Adaptation

Like high contrast acuity, CSF contributes to the central nervous system’s ability to detect and recognize objects. Because more of the visual environment is made up of forms with low contrast borders and features than with high contrast features, CSF may contribute more to one’s ability to perceive and visually adapt to the environment than high contrast acuity. Examples of low contrast features include curbs and curb cuts, steps, glass doors, water, and facial features. In addition, much of a person’s day may be spent in sub-optimal lighting conditions which reduces the contrast of objects in the environment.

2.2.3 Deficits in Contrast Sensitivity Function Associated With Brain Injury

Research has shown that person’s with cerebral lesions may exhibit deficits in contrast sensitivity function. Bulens, Meerwaldt, Van Der Wildt, & Keemink reported that 62% of their subjects with ischemic brain lesions affecting the posterior visual pathways demonstrated abnormal contrast sensitivity function despite normal Snellen measurements. The decrease in CSF observed with cerebral lesions is thought to be due to the destruction of neurons in the cortical areas receiving visual information along with a decreased sensitivity in the surviving neurons due to disruption of neuronal interaction. Reduced CSF also has been found in conjunction with visual field deficit, Alzheimer’s disease, age-related visual diseases such as macular degeneration, glaucoma and cataracts, and with aging itself. Reduced CSF sensitivity is associated with the ability to see in suboptimal lighting conditions and require enhanced illumination.

2.2.4 Functional Deficits Caused by Reduced Contrast Sensitivity Function

Reduced contrast sensitivity function causes difficulty identifying contours and shape in the environment and persons with CSF deficits often experience limitations in mobility. Persons with reduced CSF also have difficulty performing in suboptimal lighting conditions and require and significantly benefit from, enhanced illumination. Reduced CSF typically occurs in conjunction with other visual impairments (visual field deficit, macular scotoma, reduced high contrast acuity) and, in combination with these impairments, contributes to limitations in many different daily living activities. Table 2.1 lists some daily occupations involving low contrast features that may create challenges for clients with reduced CSF.

2.3 VISUAL FIELD

2.3.1 Definition of Visual Field Function

The visual field is the visual surround which can be seen when one looks straight ahead. It reflects the functioning of the receptor cells in the retina and is analogous to the dimensions of a picture imprinted on the film in a camera (with the retina representing the film). The normal visual field extends approximately 60 degrees superiority, 75 degrees inferiorly, 60 degrees to the nasal side and 100 degrees to the temporal side. Most of the visual field is binocular and is seen by both eyes. A small portion of the peripheral temporal field in each eye is monocular and can only be seen by one eye because vision in the other eye is occluded by the bridge of the nose. At the very center of the retinal visual field is the fovea, an area approximately 8
degrees in diameter containing only cones and used exclusively for capturing the visual details used to identify the features of objects. Surrounding the fovea is the macular area of the field also referred to as the central visual field. This area is approximately 20-30 degrees in diameter and contains a mixture of cones and rods and also is used for object identification. The rest of the visual field is the peripheral field which contains only rods and is used to detect general shapes and movement in the environment. On the border between the central and peripheral visual fields on the temporal side is the blind spot so called because the optic disc is located here and there are no rods or cones in this area. Figure 2.2 is a field diagram which illustrates the divisions and dimensions of the visual fields. (Note: field diagrams are drawn “as the client sees it” so that the field diagram on the right represents the client’s right eye and vice versa).

FIGURE 2.2: Field Diagram Illustrating the Divisions of the Visual Fields. Illustration courtesy of Josephine C. Moore OTR, PhD.

The visual field is often depicted as a “hill of vision” (see Figure 2.3) to describe its relationship to visual acuity. The peak or summit of the hill is the foveal area in the center of the visual field. This is the area of greatest acuity where the visual field is most sensitive to illumination and can perceive even small and dimly lit targets. As the field expands from the center, visual acuity decreases so that the peripheral visual field is capable only of perceiving larger and brighter targets. The downward sloping of the hill represents this progressive decrease in visual acuity. The goal of fixation is to place objects of interest on the foveal area of the visual field so that they can be seen in the greatest detail.
FIGURE 2.3: The “Hill of Vision” Depicting the Relationship Between Visual Acuity and Visual Field.
Illustration courtesy of Josephine C. Moore OTR, PhD.
2.3.2 The Function of the Visual Field in Adaptation

To successfully adapt to the environment, one must be able to keep track of all of the objects in the environment which potentially could provide assistance or harm. For example, to successfully drive a car to a destination without experiencing an accident, one must see the cars directly ahead as well as those moving on the side. One must also be able to see informational signs overhead and on the sides of the road and be able to see pedestrians, bicyclists, animals and other animate and inanimate objects which may come into the path of the vehicle. The visual field provides this panoramic picture.

The visual field is necessary, not only to get the “big picture”, but also to see the details of objects. In reading, for example, the visual field information encoded by the fovea enables the reader to clearly see approximately 19 characters (depending on the font size of the letters or numbers) with each fixation. The perceptual span created by field information is enough to allow the reader to quickly and accurately identify words and read with good speed and comprehension.

2.3.3 Deficits in Visual Field Associated With Brain Injury

Visual field deficit (VFD) is the most common visual impairment following CVA. It also is a frequent sequela to traumatic brain injury (TBI). The deficit is created by lesions which damage either the pathway transmitting visual field information from the retina to the cortical areas of the brain (the geniculocalcarine tracts) or damage to the cortical area receiving primary visual input from the retina (the occipital lobe). Figure 2.4 illustrates classical lesions and their associated visual field deficits. Because of the crossing of fibers at the optic chiasm, the geniculocalcarine tracts carry information from one half of the visual field in each eye. Geniculocalcarine tracts in the right hemisphere carry input from the left half of the visual field in each eye and those in the left hemisphere carry right visual field information from each eye. Because of this, lesions posterior to the optic chiasm always result in bilateral visual field deficits.

Occlusion of the middle or posterior cerebral arteries can damage these pathways as can intracerebral bleeds in TBI. The extent of the deficit is determined by where the damage occurs along the pathway. The geniculocalcarine tracts are divided into two loops: the temporal loop and the parietal loop (see Figure 2.5). The loops are named for the cortical areas traversed by the pathways. Information about the superior visual fields is carried through the temporal loop fibers. A lesion along the pathway in this loop causes a superior field quadrantanopsia (lesion G in Figure 2.4). Information about the inferior visual fields is carried through the parietal loop fibers; damage along this pathway results in an inferior field quadrant-anopsia (lesion H in Figure 2.4). If the lesion is large enough to damage the pathways of both loops, a hemianopsia would occur with involvement of both the inferior and superior visual fields in one half of each eye. Information from the macular (central) visual field is carried in the center of the geniculocalcarine tracts and peripheral field information is carried in the outer portion of the tract. If the lesion is deep, both the central and peripheral visual fields will be affected and the client will demonstrate the classic hemianopsia shown at site E in Figure 2.4. If the lesion is less severe, only the peripheral visual field may be affected leaving the very center of the visual field intact, a condition known as macular sparing (see site I in Figure 2.4). CVA, because it generally causes only unilateral damage, most often causes classic left or right hemianopsias or quadrantanopsias with or without macular sparing. Head trauma, which can cause diffuse and bilateral damage, has the potential to create deficits throughout the visual fields, causing loss of visual field in all four quadrants of both eyes and leaving the client with little usable vision.
FIGURE 2.4: Schematic Illustration of Lesion Sites Along the Optic Pathway Causing Visual Field Deficits. Illustration courtesy of Josephine C. Moore OTR, PhD.
2.3.4 Functional Deficits Caused by Visual Field Deficit

Although often considered mild in comparison to the dramatic loss of use of the limbs, the presence of VFD can have a significant impact on the client’s ability to complete daily living activities and safely adapt to the environment. Several behavioral changes may occur because of the loss of visual field which in turn challenge adaptation. The most significant of these changes occurs in the search pattern used by the client to compensate for the blind portion of the visual field. Instead of automatically adopting a wider scanning strategy and turning the head farther to see around the blind area, clients with VFD tend to narrow their scope of scanning, turning the head only slightly, if at all, and limiting visual search to areas immediately adjacent to the body.

This may seem like an odd strategy to adopt following vision loss, but it is in fact consistent with how the CNS processes visual information. Research has shown that the CNS responds to a loss of visual field by exercising perceptual completion. Perceptual completion is a perceptual process whereby the CNS fills in (or completes) absent visual information based on an expectation of the visual information to be found there. The perceptual outcome of this process is that the viewer perceives that he or she is seeing a complete visual scene despite the fact that part of the visual information is missing. Perceptual completion provides speed to information processing, allowing one to infer the whole from only partial visual input.

Levine reported that, because of perceptual completion, persons experiencing visual field deficit are initially unaware that they have lost vision and only gradually become aware of the absence of vision through interaction with their environment. Until awareness occurs, the person acts on insufficient or false visual information and consequently makes errors, especially in activities where a complete visual field is necessary. For example, the person may collide with a doorframe or a chair while navigating the environment or may
not be able to find an object placed within the blind field.\(^{100}\)

Perceptual completion also prevents persons with VFD from having the benefit of a marker that would indicate a border between the seeing and non-seeing areas of the visual field. Instead they perceive a complete visual scene in which objects always seem to be appearing, disappearing and reappearing without warning on the affected side. Uncertainty regarding the accuracy of the visual input on one side may cause the individual to adopt a protective strategy which is more midline centered and tuned into the sound visual field.\(^{29,100}\)

This narrowed scope of scanning, however, creates problems in activities that require monitoring of the full visual field as is needed when driving a car or moving about in busy or cluttered environments.

In addition to a narrow scope of scanning, the speed of scanning is reduced towards the blind visual field. The client does not turn the head towards the blind field as quickly as towards the seeing field. The reason for the delay again is due to perceptual completion, which eliminates the presence of a marker that would indicate the true boundary between the fields. Unable to determine the actual border of the seeing field or where a target might be within the non-seeing field, the client naturally slows down when scanning towards the blind field. The reduction in scanning speed is a protective response, but it increases the difficulties the client experiences in moving and finding objects within the environment and also slows reading speed.

If the VFD has affected the macular portion of the visual field, and especially the fovea, the client may tend to miss and/or mis-identify visual details as all or part of objects fall into the blind area of the field. This can create challenges in locating objects in the environment during visual search and cause difficulties locating needed items for grooming, meal preparation and other activities. It can also have a profound affect on reading performance by narrowing the perceptual span from recognition of 19 characters to as few as 3 or 4 with each fixation.\(^{31,34}\) The client either may omit words in a line of text because he or she did not see them or misidentify words because the beginning or ending of the word was not seen. Many words in the English language are easily transformed into other words when the beginning or ending of the word is not seen. Examples include “shot” and “hot” and “automation” and “automatic”. Errors such as these can significantly slow reading speed and reduce accuracy. Accuracy in reading numbers poses a particular challenge to the client with VFD. Whereas the context of a sentence alerts the client to errors made in reading, numbers appear without precise context causing mistakes to go unnoticed. For example, a bill for $28.00 may be mis-read as $23.00 and the error missed until a notice of insufficient payment is received.

If the VFD has occurred on the same side as the dominant hand, the client may experience difficulty visually guiding the hand in fine motor activities. The most common functional change is a reduction of writing legibility. The client often cannot visually locate and maintain fixation on the tip of the writing instrument as the hand moves into the blind visual field, causing handwriting to drift up and down on the line. Writing over something which was just written and/or improperly positioning handwriting on a form also are also common mistakes. Quilting, hand sewing, pouring liquids and other fine motor activities are frequently impaired. The behavioral changes described; narrow scope of scanning, slow scanning towards the blind side, missing or misidentification of visual detail, and reduced visual monitoring of the hand, contribute to a variety of functional limitations. The primary functional skills affected include mobility, reading and writing, and the daily living activities dependent on these skills.

Clients with VFD often demonstrate changes in ambulation including a shortened, uncertain stride and a sense of decreased balance. They may adopt a strategy often observed in persons with profound vision loss, where they trail their fingers along a wall to give themselves tactile clues as to their position in space. They may also elect to follow another person as they walk to use the person as a guide. They complain of frequent collisions with objects, particularly in unfamiliar environments. The decrease in sensory input from the blind field also can cause disorientation when walking or especially when riding in a car. These difficulties are exacerbated in unfamiliar and crowded environments and may cause the client to avoid such environments.

A variety of ADLs can be affected by VFD including grooming, medication management, financial management, meal preparation, clothing selection and care, meal preparation, home management, telephone usage
and yardwork. Table 2.2 lists some of the most common limitations in occupations experienced with VFD. In general, the more dynamic the environment in which the occupation is completed and the wider the field of view required to complete the task, the greater the limitation. Therefore, only minor limitations generally are experienced in selfcare activities compared to significant limitations in shopping and driving.

TABLE 2.2: Examples of Daily Occupations Affected by Visual Field Deficit.

<table>
<thead>
<tr>
<th>SELF CARE</th>
<th>MEAL PREPARATION</th>
<th>HOUSEKEEPING</th>
</tr>
</thead>
<tbody>
<tr>
<td>• applying make-up</td>
<td>• locating items needed for meal prep in cabinets, &amp; on counters</td>
<td>• completely cleaning large surfaces (floors, counters etc.)</td>
</tr>
<tr>
<td>• shaving evenly</td>
<td>• locating items in refrigerator</td>
<td>• yard maintenance-mowing/trimming</td>
</tr>
<tr>
<td>• locating items for grooming</td>
<td>• cutting, chopping, slicing</td>
<td>• telephone usage</td>
</tr>
<tr>
<td>• selecting clothing</td>
<td>• reading recipes, instructions</td>
<td>• ironing</td>
</tr>
<tr>
<td>• eating neatly</td>
<td>• operating microwave oven</td>
<td></td>
</tr>
</tbody>
</table>

<table>
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<th>COMMUNITY ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• accessing transportation</td>
<td>• reading bills/financial statements</td>
<td>• accessing transportation</td>
</tr>
<tr>
<td>• locating correct aisle/item</td>
<td>• completing check or money order</td>
<td>• maintaining orientation in unfamiliar places</td>
</tr>
<tr>
<td>• reading prices</td>
<td>• maintaining financial ledger</td>
<td>• locating public restrooms/ exits</td>
</tr>
<tr>
<td>• maintaining orientation in stores</td>
<td>• addressing/mailing bills</td>
<td>• neatly eating out in restaurants</td>
</tr>
<tr>
<td>• avoiding collisions</td>
<td></td>
<td>• avoiding collisions</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INFORMATIONAL READING</th>
<th>PLEASURE READING</th>
<th>LEISURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• newspaper</td>
<td>• newspaper</td>
<td>• viewing television/movies</td>
</tr>
<tr>
<td>• newspaper ads</td>
<td>• funnies</td>
<td>• sewing/quilting</td>
</tr>
<tr>
<td>• stock quotations</td>
<td>• magazines</td>
<td>• board games</td>
</tr>
<tr>
<td>• TV guide</td>
<td>• books</td>
<td>• card games</td>
</tr>
<tr>
<td>• recipes</td>
<td></td>
<td>• woodworking</td>
</tr>
<tr>
<td>• menus</td>
<td></td>
<td>• fishing/hunting</td>
</tr>
<tr>
<td>• telephone directory</td>
<td></td>
<td>• tennis/volleyball/handball</td>
</tr>
<tr>
<td>• address book</td>
<td></td>
<td>• viewing sporting events</td>
</tr>
<tr>
<td>• incoming mail</td>
<td></td>
<td>• running/walking</td>
</tr>
<tr>
<td>• bank receipts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• bills/financial statements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• checkbook ledger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• watch or clock face</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• street signs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• aisle markers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• store signage</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These changes in adaptation can have a significant emotional impact on the client. For example, experiencing anxiety when moving in unfamiliar environments is a common side effect of VFD. Sometimes the anxiety can be so severe the client experiences an autonomic nervous system reaction, becoming nauseous and breaking out into a sweat. One individual with VFD described this sensation as "crowditis", saying that he became physically ill if he had to go into a department store or other crowded environment. This anxiety can become debilitating, leading to a withdrawal from community activities and social isolation.
2.4 OCULOMOTOR FUNCTION

2.4.1 Definition of Oculomotor Function

Oculomotor function is the ability to move the eyes together (conjugately) in a coordinated fashion. Conjugate vision ensures binocularity in which the two eyes are used in tandem to produce single vision.

2.4.2 The Function of Oculomotor Control in Adaptation

The purpose of oculomotor function is to achieve and maintain foveation of an object. Oculomotor function ensures that the object the person wishes to view is focused on the fovea of both retinas (to ensure a clear image) and that the focus is maintained as long as needed to permit the person to accomplish the desired goal. This is a daunting task since human beings are mobile creatures who interact within dynamic, moving environments. An image focused on the fovea is always in danger of slipping off as the head or object is moved. Foveation is achieved and maintained by eye movements which keep the target stabilized on the retina during fixation, gaze shift and head movement. Five oculomotor control systems interact to provide this control. These oculomotor systems (described in greater detail below) are the vestibular/ocular/cervical responses, the optokinetic system, the saccadic system, the smooth pursuit system, and the vergence system.

The vestibular/ocular/cervical responses hold images of the seen world steady on the fovea during transient movement of the head and body. Even when attempting to remain completely stationary persons will exhibit significant involuntary head movement from such varied sources as transmitted vibrations from the heartbeat or the support surface. Much larger head velocity is experienced with voluntary movement (walking, running, twisting etc.). Each movement of the head threatens the stability of the image on the retina. To counter this threat, the CNS combines the skills of the vestibular, cervical and ocular systems to produce compensatory eye movements which occur automatically in response to head movement and maintain a clear image on the retina. The vestibular ocular reflex (VOR) is the primary reflex used to stabilize gaze during transient head movement supplemented by the cervical ocular reflex (COR).

The optokinetic system augments the vestibular/cervical/ocular responses to maintain foveal stabilization during prolonged head movement. Head movement lasting longer than 30 seconds results in adaptation of the VOR preventing it from eliciting compensatory eye movements. Because the optokinetic reflex relies on a continuous (tonic) signal from the retina rather than a short term (phasic) signal from the labyrinth of the inner ear, it takes over the function of the VOR during sustained head movement.

The smooth pursuit system ensures that the target is maintained on the fovea during fixation and when the object is moving. If the eyes and the target both are stationary, the smooth pursuit system supplies continuous unconscious small eye movements which move back and forth over the boundaries of the target to ensure that the target image stays fresh on the retina and does not fade. If a target moves away and the viewer remains stationary, the target eventually will slip off of the retina and go out of focus. To prevent this, the smooth pursuit system initiates eye movement in the direction of the target's movement. The velocity of the eye movement increases until it matches the velocity of the target movement ensuring that the image stays focused on the fovea.

The saccadic system directs the fovea towards an object of interest. Saccadic eye movements have a short latency period (.2 seconds) and a rapid speed (averaging 600-700 degrees per second). They are designed to quickly redirect the line of sight to new objects and keep the CNS informed and updated on all objects.
within the field of view. They are under involuntary and voluntary CNS control.

The vergence system helps to maintain focus as objects move near to and away from the body. Convergence (moving the eyes inward in adduction) occurs in conjunction with pupillary constriction and thickening of the lens to produce accommodation ensuring that an object remains in focus as it is brought into near vision. During accommodation, convergence keeps the image of the object aligned on precise corresponding points on both retinas ensuring that only one image is seen as the object comes closer. When the object moves away from the body, divergence (moving the eyes outward in abduction to midline) occurs to ensure that only one image continues to be seen.10,38

All five oculomotor systems must work in conjunction with one another to produce binocular vision. The importance of binocular vision to function is that it ensures perception of a single image even though the CNS is receiving two separate visual images (one from each eye). The process of combining two visual images into one is called sensory fusion. For sensory fusion to occur, corresponding areas or points on the two retinas must be stimulated with the same image. If they are, and if the images match in size and clarity, the CNS is able to perceptually fuse the two images into one. If the eyes do not align with one another, a double image (diplopia) may occur.36,56

Eye movement rarely exceeds beyond 10 degrees from primary gaze. If a greater degree of eye movement is needed, head movement generally is substituted because it can be completed more efficiently and accurately.27 The field of vision which can be perceived when both the head and eyes move together is known as the practical field of vision. The ability to move the eyes through full range of motion, is not as critical to binocular function as the ability to move the eyes and head together through full neck range of motion.

2.4.3 Deficits in Oculomotor Function Associated With Brain Injury

The oculomotor systems controlling eye movements receive direction from several areas of the CNS including the parietal, occipital and prefrontal lobes, the cerebellum and the brainstem.2,37 However, all of these areas exert their influence through the same motor pathway: the nuclei of cranial nerves 3, 4, and 6 which innervate the extraocular muscles. Therefore, deficits in any of these CNS areas can result in a change in eye movements.

Damage to the oculomotor system generally occurs secondary to direct or indirect trauma, vascular compromise, or disease. In cases of trauma, the most common cause of damage is due the effect of shock waves transmitted through the brainstem and cerebrum following impact of the head. The shock waves may damage the cranial nerves as they course through the brainstem and pierce the dura to enter the cavernous sinus, or they may damage the motor nucleus of the nerves themselves within the brainstem.38 All three cranial nerves are susceptible to injury from this kind of trauma which results in paralysis of the extraocular muscles. The shock waves also may cause diffuse axonal damage compromising communication between the nuclear centers in the brainstem involved in coordinating visual responses resulting in generalized oculomotor dysfunction.2 Facial trauma can also result in injury to the oculomotor system. The three cranial nerves controlling the eye muscles are thinly myelinated and have long tenuous pathways from the brainstem to the orbit. Tearing, contusion or compression of the nerves may occur with facial trauma particularly to the cavernous sinus.3,14 An individual extraocular muscle also may be lacerated by a penetrating eye wound such as could occur from a glass shard from a broken window. A blow to the eye may cause an orbital blow out fracture where the thin skeletal structure of the eye socket is fractured. This type of injury may cause entrapment of the inferior rectus and oblique muscles restricting oculomotor motility. Enophthalmos, vertical diplopia and ptosis may result from the orbital fracture along with secondary complications from choroidal rupture, retinal hemorrhage and glaucoma.38
Vascular diseases including diabetes, hypertension, and atherosclerosis account for approximately 20% of oculomotor lesions. These diseases often cause discrete lesions of individual cranial nerves. Brainstem CVA secondary to occlusion of the basilar artery can cause significant motor, sensory and oculomotor impairment. One of the more common oculomotor impairments is internuclear ophthalmoplegia (INO) resulting from a lesion along the medial longitudinal fasciculus in the brainstem. INO results in an inability to voluntarily adduct the eye on the affected side during horizontal gaze accompanied by nystagmus with abduction of the other eye. However, adduction can be achieved with convergence of the eyes during accommodation. Multiple sclerosis is the primary cause of INO in younger populations and vascular lesion is the primary cause in older adults.3

Many neurological diseases also can cause oculomotor dysfunction. The more common diseases include Parkinson’s disease, Huntington’s chorea, multiple sclerosis, Alzheimer’s, Guillian Barre, diabetes and Myasthenia gravis.3 These diseases can impair both the initiation and control of eye movements in a variety of ways.

Damage to the pretectal nuclei in the brainstem can cause convergence insufficiency, a condition in which the person is unable to obtain and/or sustain convergence of the eyes.26 The impairment is caused by damage to pretectal nuclei in the brainstem and disrupts accommodation. As a result the person has difficulty obtaining or sustaining adequate focus during near vision tasks. Clients with this condition often complain of fatigue, eye pain or headache after a period of sustained viewing on near tasks such as reading. When reading the client may complain that the print starts to swirl and move on a page after several minutes. Convergence insufficiency is often overlooked in evaluation because cranial nerve function usually is intact. Instead, the client’s complaints instead are attributed to inattention, lack of effort, or alexia.

Visuo-vestibular dysfunction results in an inability to stabilize gaze during movement of the body and/or environment. Impairment can occur secondary to damage to peripheral vestibular structures (the labyrinth of the inner ear, cranial nerve 8) or the central vestibular pathways in the brainstem and cerebellum. Peripheral injuries can result from displacement of inner ear structures due to rapid acceleration and deceleration during the injury, or may occur secondary to skull fracture involving the temporal or petrous bones.40 Central injuries can occur with trauma to the brainstem or cerebellum. The chief complaint of the client with visuo-vestibular dysfunction is oscillopsia, the perception of constant swirling and movement of the peripheral environment. The illusion of movement occurs because of excessive slipping of visual images on the retina due to inadequate vestibular, cervical and ocular responses during head movement. Depressed VOR function generally is considered to be the primary cause of the disorder. Because visual stability is necessary for postural control, clients with oscillopsia and visuo-vestibular dysfunction often have impaired balance and postural control.39,41

2.4.4 Functional Deficits Caused by Impaired Oculomotor Function

The most common oculomotor impairment observed in clients following brain injury is acquired paralytic strabismus. Strabismus is defined as a visual impairment where one eye cannot focus with the other on an object because of imbalance of the eye muscles.27 Paralytic strabismus occurs when the muscle imbalance is due to paralysis of one or more of the extracocular muscles. The primary cause of the paralysis is injury to the cranial nerves from trauma, vascular occlusion, or disease.

Characteristics of paralytic strabismus include complaints of diplopia, restriction of eye movements and assumption of a deviant head position. Diplopia occurs as a result of the misalignment of the eyes as they focus on an object. Unless the eyes are aligned with one another so that equal corresponding retinal points are stimulated, the client will be unable to fuse the two images into one and may complain of a double image which splits vertically or laterally, or of ghosting images (such as appear with poor TV reception), or
state that images appear blurry. With paralytic strabismus, the diplopia increases in the direction of gaze of the paralytic muscle and decreases in gaze directions away from the action of the paralytic muscle (called incomitant strabismus). The increase in diplopia is due to the restriction of eye movement in directions supplied by the paralytic muscle. To minimize interference from the diplopia the adult client often assumes a head position which avoids the action of the paralyzed muscle. If a single image can’t be attained, the client may use a head position which allows the nose to occlude the second image or one which heightens the disparity between the images so that it is possible to identify the false image.

TABLE 2.3: Examples of Daily Occupations Affected by Oculomotor Dysfunction.

<table>
<thead>
<tr>
<th>SELF CARE</th>
<th>MEAL PREPARATION</th>
<th>HOUSEKEEPING</th>
</tr>
</thead>
<tbody>
<tr>
<td>• applying make-up</td>
<td>• reading recipes/instructions</td>
<td>• cleaning requiring large body movements</td>
</tr>
<tr>
<td>• applying toothpaste</td>
<td>• measuring ingredients</td>
<td>• ironing</td>
</tr>
<tr>
<td>• completing nailcare</td>
<td>• pouring liquids</td>
<td>• yard maintenance</td>
</tr>
<tr>
<td>• mending clothing</td>
<td>• cutting, chopping, slicing</td>
<td>• car maintenance</td>
</tr>
<tr>
<td>• filling cup/glass</td>
<td>• transferring foods</td>
<td>• minor household repairs</td>
</tr>
<tr>
<td>• spreading toppings on foods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• getting in and out of bathtub</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SHOPPING</th>
<th>MONEY MANAGEMENT</th>
<th>COMMUNITY ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• accessing transportation</td>
<td>• reading bills/financial statements</td>
<td>• accessing transportation</td>
</tr>
<tr>
<td>• locating items on shelf</td>
<td>• completing check or money order</td>
<td>• negotiating escalators/elevators</td>
</tr>
<tr>
<td>• reading prices</td>
<td>• maintaining financial ledger</td>
<td>• negotiating uneven surfaces</td>
</tr>
<tr>
<td>• handling groceries/items</td>
<td>• addressing/mailing bills</td>
<td>• negotiating curbs, steps, ramps, etc.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>READING</th>
<th>LEISURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading is affected by an inability to sustain focus. This can limit reading of:</td>
<td>• viewing television/movies</td>
</tr>
<tr>
<td>• newspapers</td>
<td>• viewing sporting events</td>
</tr>
<tr>
<td>• books</td>
<td>• sewing</td>
</tr>
<tr>
<td>• magazines</td>
<td>• painting</td>
</tr>
<tr>
<td>• recipes/instructions</td>
<td>• running/walking</td>
</tr>
<tr>
<td>• financial statements</td>
<td>• volleyball/tennis/handball.</td>
</tr>
<tr>
<td></td>
<td>• fishing/hunting</td>
</tr>
<tr>
<td></td>
<td>• woodworking</td>
</tr>
</tbody>
</table>

The presence of diplopia creates perceptual distortion which may significantly affect eye hand coordination, postural control, and binocular use of the eyes. The functional limitations experienced by the client depend on where the diplopia occurs within the focal range (i.e. near focal distance vs. far focal distance). Diplopia occurring within 20 inches of the face will disrupt reading, and activities requiring eye hand coordination such as pouring liquids, writing, and grooming. Diplopia occurring at a distance (as occurs with 6th cranial nerve lesions) will affect ambulation, driving, television viewing and playing sports such as golf and tennis. Sometimes the method used to eliminate the diplopia (such as using an eye patch to occlude one eye) creates additional functional limitations by significantly reducing visual field input on that side of the body. Generally, the functional limitations will always be more severe if the strabismic eye is also the dominant eye. Table 2.3 lists daily living activities which can be affected by oculomotor dysfunction.
Even oculomotor impairments which are not significant enough to produce diplopia, can impair functional performance. Research has shown that persons, following head trauma, demonstrate reduced quality and control of smooth pursuit eye movements, convergence and saccadic fixations and that these deficiencies can reduce the speed at which visual information is taken in during scanning and increase the effort required in visual search. This may contribute to the fatigue and limited concentration experienced by persons with brain injuries when reading and completing other tasks requiring sustained focus.

2.5 VISUAL ATTENTION

2.5.1 Definition of Visual Attention

Visual attention is the ability to closely and carefully observe objects to discern information about their features and their relationship to self and other objects in the environment. It requires being able to focus the CNS, ignoring irrelevant sensory input and random thought processes, and to sustain this focus over a period of several seconds to minutes. Visual attention also entails being able to shift visual focus from object to object in an organized and efficient manner to ensure that visual input is taken in in a meaningful way.

2.5.2 The Function of Visual Attention in Adaptation

Attention is a critical prerequisite to learning because if, and how, information is attended to determines the level of analysis and assimilation. Visual attention is particularly important in our culture because over the years, we have chosen vision to be our primary sensory system for gathering information about the environment and for making decisions. For example, we rely on print media, written instructions and labels, calendars, calculators, computers, thermostats and thermometers, scales, speedometers, traffic signs, paper money, telephones and telephone directories to provide us with needed information; we watch sports, movies, plays and television and we write, complete hand crafts, sew, and play cards.

Visual attention is divided between two areas of the visual field, the central (a.k.a. macular) field and the peripheral field. Information taken in through the central visual field is used to complete local perceptual processing also known as selective attention. The goal of focal processing is object identification, requiring that the incoming visual information is detailed and organized. In contrast, information incoming through the peripheral visual field is used to complete peripheral perceptual processing which relies on global visual input to supply an awareness of position in space and relationship to other objects. Peripheral processing enables orientation to space during movement. Both attentional processes are needed to move, interact with, and manipulate the environment and the CNS must simultaneously employ both, continuously dividing attention between the two areas of the visual field. To achieve this, the CNS has developed an extensive neural network for the control and modulation of visual attention involving all four lobes of both hemispheres, the cerebellum, and the brain stem.

Currently, five primary cortical areas have been identified as contributing to visual attention (more areas will no doubt be discovered as research continues). These areas are comprised of the visual cortical relay centers (the lateral geniculate nucleus and occipital pole); circuitry in the posterior areas of both the
temporal and parietal lobes, the frontal eye fields and dorsal lateral prefrontal cortex in the prefrontal lobe and the limbic circuitry (see Figure 2.6). The visual cortical relay centers receive raw input from the retina and refine it, enhancing some features and inhibiting others, to provide the CNS with the salient information needed to identify and interact with objects in space. This refined information then is simultaneously sent to the posterior temporal and posterior parietal areas for processing. Input processed through the temporal circuitry is used to identify and classify objects. This area therefore attends to information regarding the details of color, shape, size, and juxtaposition, utilizing the precise information supplied by the macular area of the retinal visual field obtained through the execution of selective attention. Input to the posterior parietal circuitry is processed for the visual spatial information needed to orient in space. This area of the CNS contains internal spatial and temporal maps of body and environmental space and time. These maps are maintained through the integration of peripheral visual input with somatosensory and vestibular input. Global attention to, and awareness of, the space surrounding the body and the body’s relationship to that space is the function of this circuitry.

![Diagram](image)

**FIGURE 2.6:** Schematic Illustration of Some of the Major Centers Involved in Modulating Visual Attention. *Illustration courtesy of Josephine C. Moore OTR, PhD.*

Following processing in the temporal and parietal circuitry, visual information is sent forward to the prefrontal areas of the brain. The prefrontal areas are responsible for making and executing decisions based on input received from all of the sensory systems combined with memory and past experience. The frontal eye fields within the prefrontal cortex execute voluntary eye movements in search of specific objects in the environment. This visual search is guided by the anticipation of where the desired object typically would be found in the environment. For example, a search for a fire extinguisher would be directed towards the walls of a room but not the ceiling or floors. The dorsal lateral prefrontal cortex (DLPC) assists in directing visual attention by maintaining a working memory of the location of objects in space. For example, when you park your car in the morning the memory of its location is maintained by the DLPC throughout the day so that you can find it again in the evening. Working memory also helps maintain attention on task because it keeps the image fresh in the mind’s eye.

The final area of the cortical network involved in visual attention is the *limbic circuitry*. This area of the CNS establishes short term and long term memory for objects viewed in the environment. It facilitates the development of visual memory by storing not just the image of the object but also the emotion attached to the image. Connecting emotion to visual images strengthens the ability to recall them from memory and to direct visual search.
Cortical attentional processing is preceded and supported by processing in the brainstem. The brainstem controls global attention through activation of the arousal sequence. This sequence is comprised of four stages: asleep, awake, alert and attending. Injury to the brainstem often diminishes the client's general level of alertness and therefore reduces visual attention. Medications which inhibit brainstem function may also affect visual attention.

### 2.5.3 Deficits in Visual Attention Associated With Brain Injury

Because of the extensive neural integration of visual attention, when brain injury occurs, visual attention is likely to be affected in some way. Injury to the primary cortical relay centers may cause features of objects to be missing or distorted. The client may not attend to certain objects or features in the environment because he or she did not receive sufficient information for recognition. Because these centers provide input to both the temporal and parietal areas, attention to global features of the environment as well as to the details of objects may be affected. Damage to the posterior temporal circuits may disrupt selective visual attention and object recognition. The client may not recognize certain objects and therefore not attend to these objects in the environment. Disruption of the posterior parietal circuitry may impair the internal sensory maps of the body and space which guide global attention to the environment. The client may no longer attend to environmental features and landmarks. Changes in topographical memory may result, with the client unable to discern where he or she has been or where he or she is going.

Injury to the prefrontal lobes may impair visual anticipation. Visual search may become random because the client is unable to anticipate where the information should be found and efficiently direct attention to that location. In some instances, visual search may cease altogether because the client has no idea where to look. Working memory may be affected impairing the ability to stay focused on task. Locating objects again after they have been laid down also may be impaired resulting in wasted time in randomly searching for needed objects.

Damage to the limbic circuitry may diminish the motivation to attend to objects by reducing their emotional relevance to the client. Attention is directed by the level of interest in an object, that is, the greater the emotional relevance of the object, the more focused the attention on it. For example, a piece of chocolate sitting on a plate in front of someone who loves it tends to rivet their attention to the chocolate. Without emotional relevance, objects are not worth searching for, or attending to, resulting in the appearance of indifference.

Any change in visual attention will be observed in the client as a change in the scanning pattern used for visual search. Visual scanning, comprised of eye movements, is a product of visual attention; it is the motor expression of the attentional process. Research has shown that visual search by adults is consistently completed in an organized, systematic and efficient pattern. The type of scanning pattern used depends on the demands of the task. In reading English, for example, a left-to-right and top-to-bottom linear strategy is used. In scanning an open array (such as a room), a circular, left-to-right strategy generally is employed, with the eyes following either a clockwise or counterclockwise pattern.

The type of change observed in the scanning pattern following brain injury is related to the area of the lobe and hemisphere where the damage occurred. Right hemisphere injuries appear to result in more deficiencies in visual search than left hemisphere lesions (although this may be due to the difficulty evaluating persons with aphasia). The most frequently observed change in scanning following right hemisphere lesions is a reluctance or inability to direct visual search towards the left half of the body and visual space. This creates an asymmetrical scanning pattern. Instead of initiating the scanning pattern on the left side of a visual array, where the majority of adults do, clients with right hemisphere injuries tend to initiate and limit scanning to the right side of the array. As a result, the client misses objects on the left side possibly losing some of the visual information needed to make a correct decision or complete an activity. The visual inattention associated with right hemisphere injuries is called hemi-inattention or, when it occurs in a severe form, spatial neglect.
This deviation from the normal scanning pattern occurs because of the difference in the way the hemispheres are programmed to direct attention.\textsuperscript{26} As illustrated in Figure 2.7, the left hemisphere directs attention towards the right half of the visual space surrounding the body. In contrast, the right hemisphere directs visual attention towards both the right and left halves of the body space. If a lesion occurs in the left hemisphere, visual attention and search towards the right side is diminished but some attentional capability is still provided by the right hemisphere. A similar lesion in the right hemisphere may completely eliminate attentional capability towards the left since there is no other area directing attention towards the left. This is why hemi-inattention and neglect are conditions only associated with right hemisphere injuries.

![Illustration of the Differences in the Direction of Visual Attention Between the Two Hemispheres](image-url)

**FIGURE 2.7:** Illustration of the Differences in the Direction of Visual Attention Between the Two Hemispheres. *Illustration courtesy of Josephine C. Moore OTR, PhD.*

A second change in visual scanning resulting from right hemisphere lesions, is the observation that the client lacks a general awareness of the environment and does not search the environment for visual information. An example of this, is the client who, when asked what time it is, responds that he doesn’t know even though he is facing a large clock on the wall. This lack of global attention to space may be the result of a difference in the way the hemispheres search for visual information. Research has shown that the left hemisphere, when directing visual search, employs an item by item search strategy which is very focal and detail oriented.\textsuperscript{2,35,54} In contrast, the right hemisphere employs a global attentional strategy which simultaneously assimilates several pieces of visual information creating a general awareness of the environment but not specific details.\textsuperscript{2,55,56,97} This global direction of attention provides the right hemisphere with an advantage in providing the visual information needed for orientation in space and enables this hemisphere, particularly the right parietal lobe to play a large role in topographical orientation.\textsuperscript{2,44,57} In contrast, the left hemisphere, particularly the temporal lobe, has an advantage in attending to visual detail enabling this hemisphere to play a
significant role in the detailed processing required for reading and writing. Working together, the hemispheres compliment one another and enable engagement of both focal and global visual attention to the environment.

Two other observations made regarding changes in visual search following right hemisphere lesions include a tendency to fixate first on the most peripheral visual stimuli occurring in the right visual field. Thus, if two visual stimuli simultaneously appear in the right visual field, the most peripheral stimuli will be attended to first. This may cause the client to engage in frequent head turning towards the right to attend to events occurring there in the periphery and create the impression that the client is distractible. The other observation is a reluctance to rescan for additional information once an area has been viewed, especially if the area is on the left side. This may cause the client to miss certain visual details when viewing complex visual arrays.

While four distinct changes in visual search have been observed with right hemisphere lesions, only one has been observed following left hemisphere lesions. Persons with left hemisphere injury often show a symmetrical decrease in scanning for detail when viewing a visual array. They broadly scan the visual array for information but do not examine specific aspects of the visual scene to gather additional information and so often cannot accurately interpret or identify the objects around them. This may be due to a disruption of the initiation of the selective item by item search strategy mediated by the left hemisphere. Left hemisphere injury does not result in hemi-inattention or neglect (suspect a right visual field deficit instead)

In general, persons with injuries to either hemisphere are slower in scanning and show more erratic fixation patterns compared to persons without brain injury. They also have greater difficulty engaging selective attention and executing an organized and efficient visual search strategy. Research has shown that when persons with brain injuries are asked to search complex visual arrays for specific targets, they have difficulty maintaining attention on the salient features of the target and mistakenly select targets with similar features. These errors may be due to a breakdown in the working memory supplied by the prefrontal areas. They also demonstrate an inability to superimpose an organized, efficient search structure on scanning an array with randomly displayed objects. For example, if asked to locate a certain individual seated among others on rows of benches (a structured visual array) the person would be able to accomplish the task. However, if asked to find the same individual standing in a jumbled crowd of persons (a random visual array), the person would display a random approach to scanning the array and likely miss the target.

### 2.5.4 Functional Deficits Caused by Visual Inattention

Disruption of visual attention creates asymmetry and gaps in the visual information gathered through scanning. The quality of the person's adaptation to the environment decreases because the CNS is not receiving complete visual information in an organized fashion, and therefore is unable to effectively use this information to make appropriate decisions. Reduction in visual attention will affect all aspects of the performance of activities of daily living. However, activities which require inspection and assimilation of visual detail and those completed in dynamic environments will be the most affected. Driving and reading are two diverse examples of tasks often significantly affected by inattention. Other daily living tasks are listed in Table 2.4.

Because visual attention is modulated through an extensive neural network, some capacity for visual attention generally is retained even in cases of severe brain trauma. On the other hand, changes in visual attention almost always occur with any brain injury even a mild injury. Whether or not the change in attention affects functional performance depends on the task to be completed. Different tasks require employment of different types and levels of attention. Tasks such as reading, can require enormous amounts of selective visual attention if one is reading a highly technical textbook, and less selective attention if one is reading an advertisement. Driving is a task which requires continuous global attention to monitor the speed and position
TABLE 2.4: Examples of Daily Occupations Affected By Visual Inattention or a Combination of Visual Field Deficit and Visual Inattention.

<table>
<thead>
<tr>
<th>SELF CARE</th>
<th>MEAL PREPARATION</th>
<th>HOUSEKEEPING</th>
</tr>
</thead>
<tbody>
<tr>
<td>• applying make-up</td>
<td>• locating items needed for meal prep</td>
<td>• completely cleaning large surfaces (floors, counters etc.)</td>
</tr>
<tr>
<td>• shaving evenly</td>
<td>• locating items in refrigerator</td>
<td>• yard maintenance-mowing/trimming</td>
</tr>
<tr>
<td>• locating items for grooming</td>
<td>• cutting, chopping, slicing</td>
<td>• ironing</td>
</tr>
<tr>
<td>• managing medications</td>
<td>• reading recipes/instructions</td>
<td>• accurately dialing telephone</td>
</tr>
<tr>
<td>• selecting clothing</td>
<td>• operating microwave oven &amp; other appliances which require sequencing</td>
<td></td>
</tr>
<tr>
<td>• locating food items on plate and eating neatly</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SHOPPING</th>
<th>MONEY MANAGEMENT</th>
<th>COMMUNITY ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• accessing transportation</td>
<td>• reading bills/financial statements</td>
<td>• accessing transportation</td>
</tr>
<tr>
<td>• locating correct aisle/item</td>
<td>• completing check or money order</td>
<td>• maintaining orientation in unfamiliar places</td>
</tr>
<tr>
<td>• reading prices</td>
<td>• maintaining financial ledger</td>
<td>• locating public restrooms/ exits</td>
</tr>
<tr>
<td>• maintaining orientation in store</td>
<td>• addressing/mailing bills</td>
<td>• neatly eating in restaurants</td>
</tr>
<tr>
<td>• avoiding collisions</td>
<td></td>
<td>• negotiating curbs, steps etc.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INFORMATIONAL READING</th>
<th>PLEASURE READING</th>
<th>LEISURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• newspaper</td>
<td>• newspaper</td>
<td>• viewing television/movies</td>
</tr>
<tr>
<td>• newspaper ads</td>
<td>• funnies</td>
<td>• sewing/quilting</td>
</tr>
<tr>
<td>• stock quotations</td>
<td>• magazines</td>
<td>• board games</td>
</tr>
<tr>
<td>• TV guide</td>
<td>• books</td>
<td>• card games</td>
</tr>
<tr>
<td>• recipes</td>
<td></td>
<td>• woodwork ing</td>
</tr>
<tr>
<td>• menus</td>
<td></td>
<td>• fishing/hunting</td>
</tr>
<tr>
<td>• telephone directory</td>
<td></td>
<td>• tennis/volleyball/handball</td>
</tr>
<tr>
<td>• address book</td>
<td></td>
<td>• viewing sporting events</td>
</tr>
<tr>
<td>• incoming mail</td>
<td></td>
<td>• running/walking</td>
</tr>
<tr>
<td>• bank receipts</td>
<td></td>
<td>• gardening</td>
</tr>
<tr>
<td>• bills/financial statements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• checkbook ledger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• watch or clock face</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• street signs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• aisle markers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• store signage</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

of other vehicles and objects, and sporadic selective attention to landmarks, street signs and traffic lights.

Whether a deficiency in visual attention manifests itself following brain injury depends on the tasks the client is required to perform and the environment.
3 GENERAL TEST PROCEDURES

There are general instructions which apply to every subtest in the battery. Rather than repeat them in each section, the instructions are provided here. It is suggested that the reader become familiar with the contents of this section prior to reading the sections that describe the specific subtests.

3.1 WHEN SHOULD THE biVABA BE GIVEN

If possible, the biVABA should be given as soon as the client is referred for therapy services so that the earliest possible identification of visual impairment can be made. This is because the presence of visual impairment will influence client performance on both cognitive and motor assessments. The battery includes subtests which can be completed with minimal cooperation/interaction from the client and most of the subtests only take a few minutes to give so that the battery can be initiated in the acute stages of the client's recovery and completed as the client progresses through rehabilitation.

3.2 WHAT DIAGNOSES ARE APPROPRIATE FOR EVALUATION BY THE biVABA?

Because of the extensive integration of vision within the central nervous system (see Section 1), visual processing can be altered by any condition that affects the CNS and/or the anterior (ocular) structures of the eye. Therefore, a visual screening such as the biVABA should be completed on anyone experiencing brain injury from any cause including CVA, traumatic brain injury (including concussion), brain tumor, anoxia, degenerative neurological diseases including Alzheimers, encephalopathy, and multiple sclerosis. It should also be used to assess clients who have experienced trauma to the eye or have an age related eye disease such as macular degeneration or glaucoma or a disease which may affect the ocular system such as diabetes or poorly managed hypertension.

3.3 WITH WHAT AGE RANGE CAN THE biVABA BE USED?

The basic visual functions assessed by the biVABA (acuity, oculomotor function, visual field and contrast sensitivity function) are established in early childhood and the attentional functions measured by the battery appear to be established by the middle years of grade school. Therefore, technically, the biVABA could assess performance in children as young as 8 years of age. However, the level of language used in the instructions to the client and the level of pattern recognition (numbers and words) was designed for adults with at least a 5th grade level of education and the interpretation of the test performance is based on research completed on adults with brain injury. The biVABA can be used without modification for ages 14 years and older.
3.4 OPERATIONAL DEFINITIONS FOR ROOM ILLUMINATION

Illumination plays a significant role in the ability to see and therefore is an important factor in obtaining valid results whenever visual processing is evaluated. The amount of illumination required for each subtest is provided with the specific test instructions. The operational definitions for the levels of room illumination are as follows:

*Well lighted*: The room is fully illuminated through use of multiple lamps and/or overhead lighting.

*Moderate illumination*: The room has sufficient illumination for reading but is not brightly lit. The only source of illumination may be windows.

*Dim illumination*: The room is illuminated but not sufficiently to read or see small visual detail. The only source of illumination may be a single lamp or windows.

*Semi dark illumination*: The room is essentially dark, only low ambient lighting is provided for safety.

3.5 USE OF EYEGLASSES DURING TESTING

Many clients will have premorbid eye conditions, often from childhood, which have been corrected for with eyeglasses. These include such conditions as refractive errors including myopia (nearsightedness), hyperopia (farsightedness), and astigmatism, and phorias and other muscle imbalances. The evaluations in this test battery assume that the client is using his or her best corrected vision. Therefore, with few exceptions, the client always should be evaluated wearing his or her eyeglasses or contact lenses. If the client’s eyeglasses are missing or broken or it is not possible to adequately view the client’s response with the eyeglasses on, the examiner must compensate for the lack of correction by increasing the size, luminance and contrast of the target. Also, if the eyeglasses corrected a muscle imbalance, then without the glasses, some abnormalities in eye position and movements may be observed. If this occurs, because of the generally longstanding nature of these conditions, the client probably will not experience a functional limitation due to the deviant eye movement.

3.6 STANDARDIZATION OF TEST PROCEDURE

3.6.1 Order of Testing

Because of the hierarchical and integrated nature of visual perceptual processing (see Section 1.3) accurate interpretation of the client’s test performance only can be made if the integrity of the visual processing skills is identified in the order in which they contribute to perceptual processing. Therefore, the evaluation of the foundation skills (acuity, visual field and oculomotor function) must be completed before assessment of visual attention in order to accurately analyze how visual attention has changed. The foundation skills also have a hierarchy in that visual acuity must be established before accurate interpretation of visual field and oculomotor function can be made and the status of the client’s visual field must be known in order to accurately
interpret oculomotor function. Section 4 provides specific subtest instructions and also the order of testing. This order must be followed to obtain an accurate picture of the client's capabilities and limitations in visual perceptual processing. If needed, the assessment can be given in short segments over an extended period of time without changing the validity of the test results.

3.6.2 Modification of Test Procedures

The purpose of the biVABA is to assist the therapist to identify the client's strengths and limitations in visual processing and the resulting occupational limitations so that an effective intervention plan can be developed. It is not to diagnose brain injury or to label deficits. To be valuable as a tool to assist intervention planning, the therapist must be able to observe the client's approach to a task and his or her ability to modify unsuccessful strategies to complete the task. This only can be accomplished by using a task analysis approach and allowing flexibility in the test procedure wherein the client is able to position test materials as desired (within certain limitations) and the examiner is free to experiment with both physical and verbal cuing to assist the client in completing the task. Modifications in test procedure are allowed and encouraged as long as they do not alter the fundamental purpose of the subtest. Examples of permissible modifications are included with the specific subtest instructions in Section 4. Whenever a modification is made, it should be noted on the test form along with whether the client benefited from the modification. Verbal and physical cuing also is allowed and encouraged but should be documented when used.

3.7 COMPLETION OF CLINICAL OBSERVATIONS

Clinical observations are the cornerstone of a functional evaluation and the therapist’s most valuable evaluation tool. Completion of the Clinical Observations Indicating Visual Impairment form (a.k.a. the clinical observation form) is an important prerequisite to administration of the rest of the biVABA. The checklist can be completed by directly observing the client, by interviewing the client and/or family, and by comparing notes with other members of the rehab team.

The behaviors listed on the checklist represent many of those most commonly displayed by persons who have visual impairment. They are grouped according to the impairment in visual function most often associated with that behavior. There is some overlap because behaviors can be associated with more than one type of impairment. While observation of a single behavior on the list is not an absolute confirmation of impaired visual processing, observation of a pattern of behaviors combined with deficient performance on the subtests provides very strong verification for the presence of a deficit. In addition, the checklist helps to identify the functional limitations experienced by the client, providing justification for further evaluation of the client’s visual processing ability and treatment intervention.

3.8 EXPLAINING THE TEST TO THE CLIENT

Gaining insight into the nature of a disability empowers the person to adjust to it and hopefully overcome it. Because we want the client to understand what has happened to his or her vision and to develop the insight necessary for compensation, it is important that the client understand the visual process being evaluated by a subtest. Prior to evaluating a visual process such as visual attention, an explanation should be given on
why the process is important to the ability to use vision for adaptation, how it may have changed following brain injury, and how the subtests measure the visual process. Approached in this way evaluation also becomes an educational process.

All explanations should be kept short and simple and stated in laymen’s terms to facilitate understanding. Do not worry that describing a subtest to the client gives an unfair advantage in performing the test. If a significant disability exists the client will still make errors on the test despite this added information. For example, if you are given a test over French syntax and you’ve forgotten how to read French, an explanation of why it’s important to know French and how your knowledge of it may change with brain injury will not help you ace the test.

*Note: Explanations of the specific subtests are provided under the heading “instructions to the client” in Section 4.*

### 3.9 INTERPRETING TEST RESULTS TO THE CLIENT AND FAMILY

Just as important as understanding why a test is given, is the client’s understanding of how he or she performed on the test. Test results should be described in terms of how the client’s performance on the test may affect performance in daily occupations. For example, if the client displays an asymmetrical search pattern on the visual search subtests and misses all of the test targets on the left side because of it, it may be explained to him that the same search pattern is observed when he completes grooming in the morning and may explain why he can’t locate his toothbrush without help. As with the pretest explanation, interpretation of test results provides an opportunity to educate the client and family and increase their insight into the nature of the visual impairment.

The subtests included in this battery deliberately have been selected to provide simple, straightforward results that are easily interpreted. None of the subtests are difficult to perform if visual processing is intact and, more importantly, none are perceived by clients to be particularly difficult to complete. Therefore, when a client makes numerous mistakes on a subtest, he or she must confront the fact of the visual impairment. If, when shown the mistakes, the client wants to retake the subtest, he or she should be allowed to do so. If the client’s performance improves, it is a positive indication of the ability to learn from practice. If the client’s performance does not improve, it indicates limited learning capacity. Either piece of information is useful in establishing goals and time frames for intervention.

### 3.10 CONSULTING WITH OPHTHALMOLOGISTS AND OPTOMETRISTS

Ophthalmologists and optometrists are the primary eye care specialists involved in the medical management of visual impairment. They diagnose the condition causing the impairment, determine etiology and prognosis for recovery, and may provide treatment primarily in the form of optical, pharmaceutical, or surgical intervention. Early consultation with one or both of these specialists is strongly encouraged as there are many correctable vision impairments which occur following brain injury which, if allowed to go untreated will compromise the benefits gained from rehabilitation. The client, for example, may develop a compensatory strategy as a result of a visual impairment that interferes with his or her ability to complete some daily activities and presents a confusing picture to the rehabilitation team. An example would be when a client with bilateral 4th cranial nerve palsy assumes a head down position when viewing objects to prevent double vision. It may appear as though the client has poor neck control rather than a visual impairment and use of this strategy also may interfere with the client’s ambulation and dressing.
If the visual impairment can be correctly and promptly diagnosed and appropriate therapeutic intervention prescribed, the client’s rehabilitation course will be improved. However obtaining prompt consultation often is a formidable task, made even more difficult by the persistent circulation within the rehab field of the belief that the client’s vision can not be tested for at least three months following a brain injury because it will change. The origin of this misstatement is unknown, however it stubbornly surfaces in rehab clinics with a tenacity rivaling that of any of the great urban myths. Most of the significant visual impairments that occur secondary to brain injury such as optic nerve atrophy, retinal detachment, or visual field deficit are as debilitating on the 90th day following onset as they were on the first day. What most likely has changed in three months is not the severity of the visual impairment but the client’s cognitive and attentional ability to accurately follow directions and participate in the visual assessment and his or her physical ability to transfer to the exam chair in the doctor’s office. In other words, by waiting, the probability of obtaining a complete and accurate assessment increases. If one is thinking only in terms of the cost of an eye exam, it pays to wait. However, if one is concerned about the client’s ability to constructively participate in and benefit from rehabilitation, then early identification of visual impairment is critical. Many ophthalmologists and optometrists advocate for early consultation beginning with a brief “bedside” exam in the acute rehabilitation setting to rule out any vision threatening conditions such as globe perforation, orbital fracture, optic nerve or retinal injury and progressing to a more comprehensive exam in the doctor’s office as the client’s cognitive and physical function improves.\textsuperscript{63} The initial bedside exam probably will be completed by an ophthalmologist since he or she is more likely to have hospital privileges; the more comprehensive exam could be completed by either ophthalmology or optometry. It probably will take several years before this model is adopted, and ophthalmologists and optometrists are included on the rehab team. In the meantime, therapists are strongly encouraged to actively seek consultation with ophthalmologists and optometrists whenever possible and work towards developing close professional collaboration. Establishing clear lines of communication with these professionals is important in developing a working relationship. When seeking consultation, it is recommended that the therapist avoid suggesting a possible diagnosis for the client’s visual condition and instead describe the visual behaviors being observed and their effect on ADL performance. This not only eliminates the embarrassment of misdiagnosing a condition, but establishes why the visual exam is needed and guides the doctor in completing the appropriate visual testing. It also educates the doctor about the field of rehabilitation and may help in development of a reciprocal referral relationship. Appendix D provides an example of a cover letter and form jointly developed by an occupational therapist and a neuro-ophthalmologist to use when seeking an ophthalmology or optometry consultation.
4 SPECIFIC TEST PROCEDURES

Please refer to the test forms when reading this section.

4.1 MEASUREMENT OF VISUAL ACUITY

Acuity testing generally is divided into two measurements: distance acuity, measured at 20 feet or 6 meters, and near or reading acuity measured placing a card at the reading distance of 16 inches or 40 centimeters. Until the 4th decade the two acuities usually are the same as one has good accommodative ability. After the age of 40, accommodative ability starts to decline and one may need additional magnification to clearly view objects at near distances. Because brain injury can affect accommodative ability, it is important to measure both near and distant acuity in the client. As described in Section 2.1.3.1, pupillary function can have significant impact on acuity especially at near distances, therefore, pupillary function is assessed prior to measuring acuity. Eye dominance also impacts acuity in the sense that the client will attempt to use the dominant eye to view objects and direct reading even if that eye has poorer acuity than the non-dominant eye (see Section 4.1.3). Because of this, the OU acuity (measured using both eyes together) generally matches the acuity of the dominant eye as does the reading acuity (which is measured using the eyes together).

General Instructions to the Client for the Acuity Subtests:

“I am going to give you several short tests which measure how well you can see objects at a distance and up close. Brain injury can sometime cause changes in acuity making it difficult to read and see things at a distance. Because how your pupils respond to light can affect how well you see things, I am going to check the responsiveness of your pupils to light before I check acuity.”

4.1.1 Considerations When Measuring Acuity

4.1.1.1 Room Illumination

Acuity shares a direct, linear relationship with illumination; that is, as illumination decreases, so does acuity (no one can read a letter chart in the dark). Accurate measurement of acuity requires that testing be completed in a well lighted room with full and even illumination of the chart. Eliminate any sources of glare which may affect the client’s performance.

4.1.1.2 Viewing Distance

Because acuity is depicted as a fraction of distance over letter size, the measurement is not accurate unless the viewing distance is accurate. The test cards have been equipped with a cord to ensure that accurate viewing distance is maintained.
4.1.3 Client Response

Clients with brain injury may have deficits in cognition, language and perception that interfere with the ability to provide an accurate and timely response in a testing situation. Extra time may be required for the client to locate the optotype (number) on the chart, process the image, and respond. Slowness in responding, therefore, does not necessarily indicate that the client lacks the acuity to identify the optotype. To determine when the client has reached his or her maximum acuity, a comparison is made between the speed at which the client identified the optotypes on the previous (larger) line and the speed at which the current line is read. If the client quickly identifies optotypes on the preceding line and then suddenly slows down and has difficulty reading a line, that is a strong indication that the client has reached his or her maximum acuity. If the client struggles with identification of optotypes on each line but is accurate, the test should proceed until a line is reached on which the client can no longer identify the majority of the optotypes.

4.1.2 Test Instructions: Pupillary Responses

The responsiveness of the pupil to light is assessed prior to measuring acuity because pupil size and reactivity affect focusing of the image on the retina. Inability to adequately constrict the pupil will interfere with the process of accommodation and impair near acuity. Slowness or inability to alter pupil size in response to changes in illumination may cause sensitivity to light or slowness in transitioning between light and dark environments, reducing acuity in these situations. Three observations are completed to assess the integrity of pupillary function: pupil size, responsiveness to light, and responsiveness to accommodation.

4.1.2.1 Appearance: Pupil Size and Symmetry

Test Materials:

Basic Visual Function Assessment test form
distant target (large enough to be seen easily at 6 feet without eyeglasses)

Environment:

Moderate illumination; the light source should not be shining directly into the client’s eyes.

Procedure:

1) The client is seated comfortably with the eyes open and eyeglasses off, if worn.
2) Observe the pupils of both eyes as the client fixates on a distant target.
3) Note the size of the pupils, referring to the pupil gauge chart on the test form.
4) Record deviations in pupil size and symmetry in the space indicated on the test form.

Instructions to the Client:

“I am going to look at the pupils of your eyes to see if they match in size. Please look straight ahead and keep your eyes fixed on the ___________as I check your eyes.”
4.1.2.2 Responsiveness of the Pupils to Light Stimulation

The pupils should respond to direct light stimulation of the eye with both direct (ipsilateral) and consensual (contralateral) constriction. That is, the pupil of the eye receiving stimulation should quickly constrict and the non-stimulated pupil also should constrict equally at the same time. Impaired responsiveness of the pupils to light stimulation may be an indication of a localized disease process such as iritis, an optic nerve disorder, brainstem dysfunction, retinal disease or cranial nerve impairment.\(^3\)

**Test Materials:**

- Basic Visual Function Assessment test form
- penlight
- distant target (large enough to be seen easily at 6 plus feet without eyeglasses)

**Environment:**

- Semi dark illumination

**Procedure:**

1) The client is seated comfortably with the eyes open and eyeglasses off, if worn.

2) Observe the pupils of both eyes as the client fixates on a distant target held at eye level.

3) Holding the penlight directly in front of the eye approximately 3-4 inches from the pupil, shine the penlight directly into the right eye for 2 seconds and observe the response of both pupils to the light stimulation.

4) Lower the penlight and move it to the left eye. Shine the penlight directly into the eye for 2 seconds. Observe the response of both pupils to the light stimulation.

5) The normal response to this test is for the eye receiving direct stimulation to quickly constrict and maintain constriction throughout stimulation. The fellow eye should remain equally constricted in a consensual response. Both eyes should show the same rate, amount and maintenance of constriction regardless of which eye is receiving direct stimulation. (*Note: The normal pupillary response is printed in italics on the test form*).

6) Record the client’s performance on the test form.

**Instructions to the Client:**

“I am going to check how well your pupils respond to light by shining this penlight into each of your eyes for a couple seconds. I am looking to see if your pupils will constrict (get smaller) when I shine the light into your eye. I will test your right eye first and then your left eye. During the test please look straight ahead and keep your eyes fixed on the _______ as I shine the light in to your eye.”
4.1.2.3 Responsiveness of the Pupils to Accommodation

Bilateral pupillary constriction accompanies convergence of the eyes when an object is brought into near focus.

*Test Materials:*

Basic Visual Function Assessment test form
- distant target (large enough to be seen easily at 6 plus feet without eyeglasses)
- near target (large enough to be seen at 16 inches without eyeglasses)

*Environment:*

Well-lighted room; ensure that the light source is not shining directly into the client's eyes.

*Procedure:*

1) The client is seated comfortably with eyeglasses *off*, if worn.

2) Instruct the client to focus on the distant target; observe pupil size.

3) Then instruct the client to focus on the near target; observe pupil size. The pupils should constrict as the client changes focus from the distant target to the near target. *(Note: if the pupils are already partially constricted it may be difficult to observe them change-in this case observe the ease at which the client transitions between the two distances-impaired accommodative response will result in a slowed performance).*

4) Record the client's performance on the test form.

*Instructions to the Client:*

“I am going to check to see how well you are able to switch from looking at the (point to distant target) which is far away to looking at this *(show near target)*. Please look from one target to the other when I tell you to do so.”

4.1.3 Test Instructions: Eye Dominance

Just as there is a dominant hand for manipulation, there is a dominant eye for fixation. The dominant eye establishes fixation on an object and directs successive shifts in fixation as various objects are viewed. The non-dominant eye follows the lead of the dominant eye and assists. A preference has been shown for right eye dominance. However, preference for the right eye does not match the predominance found in handedness and many persons show cross eye/hand dominance where they are right handed and left eye dominant or vice versa. Some persons also establish dominance in one eye for distance and the other eye for near vision. Eye dominance is as important to visual processing as hand dominance is to motor function and is as resistant to change once established. For example, a person automatically will attempt to use the dominant eye to direct fixation in reading even if that eye has poorer acuity and will resist occlusion of the dominant eye to eliminate diplopia even if that eye has poorer oculomotor control. Eye dominance is so firmly established in most people that the eye literally must be occluded to prevent its use before the non-dominant eye will direct fixation. Because of its strong influence on visual function, eye dominance is measured prior to assessment of acuity.
Test Materials:

Basic Visual Function Assessment test form
card with 8mm hole
flower design card (from the design copy test)

Environment:

Well lighted room; the light source should be directed from behind the client onto the chart; ensure that the light source is not shining directly into the client’s eyes.

Procedure:

1) The client is seated comfortably, with eyeglasses on, if worn.
2) Place the card with the 8mm hole on the table in front of the client.
3) Hold the card with the flower directly in front of the client so that the card can be easily viewed by the client (approximately 16 inches from the client’s face).
4) Instruct the client to pick up the card with the 8mm hole and to look through the hole with one eye to view the flower (encourage the client to do this automatically without thinking about which eye to use).
5) Record on the test form which eye the client used to look through the hole to view the flower.

Instructions to the Client:

“I am going to check on how well you can see the flower on this card (indicate design copy card with flower on it) through the hole in this card (indicate card with 8mm hole) Please pick up the card with the hole in it and hold it up to your eye to view the flower.” (Note: an explanation as to why this test is given should not be provided until after the test is completed to avoid biasing the client’s response).

4.1.3.1 Alternative Methods for Determining Eye Dominance

1) Hand the client a cardboard tube (such as the that from the center of a roll of paper towels) or a rolled up piece of paper and instruct the client to use the tube to view a specific target (for example, a clock on the wall). The target should be 4-6 feet away and clearly visible. The eye the client uses to view the object is the dominant eye.

2) If the client is unable to communicate or follow directions, question family members or friends as to whether they remember which eye the client may have used to view through a camera, a gun scope, a magnifier, a telescope, or a microscope.

3) As a last resort, because the right eye is more frequently the dominant eye, the assumption may be made that the right eye is the dominant eye for this client. Subsequent observation should be made to determine if this is true.
4.1.4 Test Instructions: Intermediate Acuity

Standard distance acuity charts are designed to obtain an accurate measurement of high contrast acuity in the normal (20/20) to near normal (20/80) range. This is the vision which can be corrected with lens refraction. However these charts do not accurately measure distance acuity below 20/200. When a person cannot read the largest line on the chart, the eye doctor typically switches to a less precise measurement such as the distance at which the person can count the fingers held up by the doctor (recorded as CF-abbreviation for count fingers at “X” feet). If the person is unable to see well enough to count fingers, the doctor determines if hand movements can be discerned (recorded as HMO-hand movement only) or, if that is not possible, if light can be perceived (recorded as LPO-light perception only). The challenge with this method of testing is that it does not provide information about the person's functional ability to use vision. Acuity can be accurately measured at ranges lower than 20/100 by switching to a testing chart which measures acuity at an intermediate distance rather than far distance. Using a chart designed for testing at this distance extends the measurable acuity to the 20/1000 range and assists the therapist to determine the adaptations needed to enable the client to use remaining visual acuity more effectively.

The distance acuity chart designed for the biVABA uses numbers of a specific physical size measured in metric units or M-sizes. The chart is designed to be used at 1 meter and will accurately measure acuities from 20/20 to 20/1000. The 1 meter testing distance allows the chart to be portable so it can be used bedside, in the clinic, or in the home. The acuity level for each line is printed in both metric and Snellen fraction equivalents on the left side of the chart. The denominator of the metric fraction (for example 1/50) is approximately the number of diopters of magnification needed to read 1M print (standard newsprint).

Test Materials:

- Intermediate Acuity Test Chart/Low Vision LeaNumbers Chart
- Basic Visual Function Assessment test form
- clip-on occluder or eye patch (optional)

Environment:

- Well lighted room; the light source should be directed from behind the client onto the chart; ensure that the light source is not shining directly into the client’s eyes.

Procedure:

1) The client is seated comfortably, with eyeglasses on, if worn (the client who wears eyeglasses for distance should not be tested without eyeglasses).

2) Instruct the client to hold the occluder against the eye that is not being tested. The occluder should be held so that the handle is horizontal to the ground to keep the cord from crossing the line of view. If the client is unable to hold the occluder, a clip-on occluder for the eyeglasses or an eye patch may be used.

3) Stretch the cord until it is taut to position the chart at 1 meter. If the chart occluder is not used, measure 1 meter from the client's eye and hold the chart at that distance.

4) Center the chart at the client’s midline (the chart can be held or placed on a sloped easel) make sure that the chart is fully and evenly illuminated.

5) Instruct the client to begin reading starting with the largest numbers. If the client completes the first side of the chart, raise the lower portion of the chart to show the other side and have the client continue reading the numbers down as far as possible.
6) If perceptual and cognitive deficits are present, allow the client as much time as needed to identify the numbers and encourage the client to give his or her best performance (see Section 4.1.4.1).

7) Record the Snellen and metric fractions for the last row on which the client is able to accurately identify the majority of the numbers.

8) Test the dominant eye first, then the non-dominant eye, then remove the occluder and test both eyes together (for a quick screen, omit testing the eyes individually and record performance using both eyes together).

Instructions to the Client:

“I am going to check how well you can see by having you read out the numbers to me on this chart. Please start at the top of the chart and read the numbers down as far as you can. The test will be done first with your __________ eye, then with your ______ eye and then with both eyes together. Please hold this occluder in front of your ______ eye to make sure that you can’t see anything with that eye. During the test you can turn your head from one side or another side to side if that helps you to see the numbers but you cannot lean forward or backwards.”

4.1.4.1 Modification of the Test Procedure for Clients with Limitations in Language, Cognition or Attention

Clients with limited language, cognition or attention may have difficulty following the standard test procedure. Several modifications in the test procedure can be made without significantly compromising the acuity measurement as long as test distance and illumination are not altered. The following are examples of acceptable modifications:

1) If the client has difficulty locating the target number, it can be highlighted by using a template which covers all of the other numbers on the line except the target number or by using a pointer to direct the client’s attention to the target.

2) Clients without reliable verbal skills can be given a paper with the numbers printed on it and instructed to point to the number seen on the chart.

3) If the client has limited verbal skills but good yes/no reliability, a choice of numbers can be given and the client may indicate which is the correct number.

4) It is not necessary for the client to read all of the numbers on a line. If the client is able to accurately read 1-2 numbers, credit can be given for the entire line. If this scoring system is used, the acuity measurement should be taken at the last line on which the client is able to easily identify the number.

5) The test can be given in segments over a period of days if necessary and the client may have as many rest breaks as needed.
4.1.5 Test Instructions: Reading Acuity-The Warren Text Card

Because accommodation and refractive errors can affect near and far acuity differently, acuity measurements are completed for both distances. Near acuity is best measured by looking at reading acuity as reading is the primary activity completed at near distance. Reading acuity is measured by instructing the client to read short sentences or text printed in successively smaller M units. The client reads down the lines of text on the card as far possible and acuity is recorded for the last line of print which the client reads accurately without significant effort.

The Warren Text Card has been designed so that the sentences can be read accurately by someone with a fifth grade level of reading. Several of the sentences have been phrased so that they can be misread and still make sense. For example “she has many gray chairs” could be read as “he has many gray hairs." The card was designed this way to ensure that the client is seeing all of the letters in the words to help identify the client whose reading performance may be affected by the presence of a hemianopsia. Snellen fraction equivalents are given for each line. Although reading acuity generally is measured in each eye separately and then with eyes together, to save time, this test is to be completed only using the eyes together. If the client demonstrates a significant difference in acuity between the eyes on the intermediate distance test, the examiner may wish to test each eye separately.

The reading acuity test was included in this assessment battery primarily to identify the smallest line of print a client can accurately and comfortably read without additional magnification. This knowledge enables the therapist to ensure that all written materials for the client (i.e. instructions, labels, home programs) are printed in a size that the client can read. The test can also identify if the client has difficulty using a bifocal correction, a problem frequently seen in clients with hemianopsias. Measurement of reading acuity also determines whether magnification is needed and how much magnification is required. Clients in the normal to near normal range (20/20-20/60) for reading acuity may only require stronger refraction in their eyeglasses and should be referred to an ophthalmologist or optometrist. However, clients with acuities of 20/80 or less, will probably require magnifiers and other adaptations such as enlarged print. The column on the right side of the card gives the approximate minimum number of diopters of magnification that will be needed by the client to read standard 1M print. This can be used as starting place to determine the strength of magnifier needed. A client needing magnification should be referred to a low vision optometrist or a low vision rehabilitation program for prescription of the best magnifying device.

Test Materials:

- Basic Visual Function Assessment test form
- Warren Text Card

Environment:

- Well-lighted room; the light source should be directed from behind the client onto the chart; ensure that the light source is not shining directly into the client’s eyes.

Procedure:

1) The client is seated comfortably, with eyeglasses on, if normally worn (the client who wears eyeglasses for reading should not be tested without glasses).

2) The test is completed using both eyes together (OU); each eye is not tested separately.

3) Stretch the cord until taut to position the card at 16 inches (40cm).
4) Center the card at the client's midline; the card can be held or placed on an easel, if desired; make sure that the card is fully and evenly illuminated.

5) Instruct the client to read the sentences out loud starting with the largest print on the card and to continue reading far as possible, turning the card over for the smaller print.

6) For clients with language and/or cognitive deficits, allow the client as much time as needed to identify the letters and encourage the client to give his or her best performance (see Section 4.1.4.1).

7) Record the Snellen fraction for the last line on which the client is able to read the sentence accurately and without effort. (Remember the Snellen measurement is not accurate if the card has been moved closer or farther than 16 inches).

Instructions to the Client:

"This test is to find out the smallest size of print that you can read. Please hold this card and read the sentences out loud to me beginning with the sentence at the top of the card (indicate location of the first sentence). Some of these sentences are pretty silly. When reading the sentences you can turn your head to one side if that helps you to see the word more clearly but try not to bring the card closer or farther away than this (demonstrate the distance the card is to be held) unless absolutely necessary."

### 4.2 MEASUREMENT OF CONTRAST SENSITIVITY FUNCTION

As with the measurement of high contrast visual acuity, contrast sensitivity function is evaluated by viewing optotypes printed on a chart held at a specified distance from the client. In this case, the optotypes which may be letters, numbers, symbols, or sinewave gratings, remain the same size but diminish in contrast as one proceeds down or across the chart. The client is asked to identify as many optotypes as possible. There are many forms of CSF tests from wall mounted charts to slides installed in vision testers such as the Optec 2000.

#### 4.2.1 Considerations When Measuring Contrast Sensitivity Function

##### 4.2.1.1 Room Illumination

For the chart to provide an accurate reflection of CSF function, testing must be completed in a well lighted room with full and even illumination of the chart. Eliminate any sources of glare that may affect the client's performance.
4.2.1.2 Distance

As with high contrast visual acuity, CSF measurement is not accurate unless the client is seated at the correct viewing distance from the chart. To ensure that the client is tested at the proper distance, the examiner may wish to cut a piece of ribbon or cord 40 cm (16 inches) in length and use it to measure the distance between the client and the test chart.

4.2.1.3 Client Response

Clients with brain injury may have deficits in cognition, language and perception that interfere with their ability to provide accurate and timely responses in a testing situation. Extra time may be required for the client to locate the number on the chart, process the image, and respond. Slowness in responding, therefore, does not necessarily indicate that the client has reduced CSF.

4.2.2 Test Instructions: LeaNumbers Low Contrast Screener

*Test Materials:*

- LeaNumbers Low Contrast Screener*
- Basic Visual Function Assessment test form
- cord or ribbon 40 cm (16 inches) in length
- soft tipped pointer
- bookstand easel (optional)

* NOTE: The surface of the contrast sensitivity test is extremely sensitive to environmental pollutants. Take the following precautions to avoid damaging the chart surface:
  - Always close the test after use
  - Do not leave the test exposed to light or dust
  - Do not touch the surface of the chart with fingers
  - Always keep fingers within the gray border
  - When examining clients who must touch the symbols to fixate properly, have the client wear white cotton gloves
  - For cleaning instructions see Appendix H.

*Environment:*

Well-lighted room; the light source should be directed from behind the client onto the chart; ensure that the light source is not shining directly into the client’s eyes.

*Procedure:*

1) Complete measurement of visual acuity prior to giving this test.

2) The client is seated comfortably, with eyeglasses on, if normally worn.

3) The test is completed using both eyes together (OU); each eye is not tested separately.
4) Center the chart at the client’s midline, flip the cover of the chart back so that the 
examiner’s hand fits under the binding to avoid touching the test surface. An easel 
can be used to support the chart if desired.

5) If the client has not taken the test before, explain to the client that the test uses the 
numbers 5, 6, 8, and 9.

6) Use the soft tipped pointer to point out the first number on each line in descending 
order, but do not touch the chart. Instruct the client to identify the number.

7) If the first number is read without effort, the client is given credit for the entire line.

8) If the client hesitates in reading a number or makes an error, return to the line 
previously read and instruct the client to read the entire line, then try reading the next line 
again. (Note: many clients will answer that there is nothing on the next line. If this 
occurs, encourage the client to continue to view the chart to see if the numbers slowly 
appear on the line. At threshold, the images appear and disappear and it may take a 
while to recognize the number).

9) Record the client’s response on the test form as indicated in section 4.4.2.2. Discontinue 
the test when the client is no longer able to see or distinguish the numbers on a line.

*Instructions to the Client:*

“The purpose of this test to find out how well you can see objects that are very faint. The 
reason why this is tested is because many objects in the environment do not contrast 
well from their background and are difficult to see such as water on the floor or a curb or 
step. Sometimes a brain injury will cause you to lose this kind of acuity.”

“This test measures this ability by showing you numbers on a chart which become more 
faint as you read down the chart. I will ask you to read the first number in each line that 
you can see. During the test you can turn your head to one side if that helps you to see 
the number but you cannot lean forward or backwards.”

4.2.2.1 Modification of the Test Procedure for Clients with Limitations 
in Language, Cognition or Attention

A list of acceptable test modifications can be found in section 4.1.4.1.

4.2.2.2 Recording the Test Results

Contrast sensitivity function is best characterized as a curve depicting the interaction between detail recognition (high contrast acuity) and low contrast detection (contrast sensitivity function). This is illustrated in the 
diagram in Figure 4.1. In this diagram, large, high contrast objects are represented in the lower left corner 
and small low contrast objects in the upper right corner. The line separating the objects that can be seen 
from those that cannot be detected is called the contrast sensitivity curve.
FIGURE 4.1: Graph Illustrating the Contrast Sensitivity Curve. Illustration courtesy of Lea Hyvarinen M.D.

The upper part of the contrast sensitivity curve indicates the minimum contrast needed to detect larger objects. The right hand side of the curve (as it slopes towards the bottom) indicates the difference between high contrast acuity and low contrast acuity function in the client. The normal CSF curve, as shown in Figure 4.1, is a gradual slope towards the right lower corner of the chart illustrating a gradual decline in low contrast detection as the size of the object diminishes.

Although contrast sensitivity function is most accurately characterized as a curve graphed CSF information is difficult to interpret. Therefore Dr. Hyvarinen, who developed the test used in the biVABAT, provided a line-by line interpretation that connects test performance to limitations in daily occupations. To score the test, check the box next to the last line of numbers accurately identified by the client and read the interpretation.

### 4.3 Measurement of the Visual Field

The process of measuring the visual field is known as perimetry. Several types of perimetry are available ranging from simple bedside assessments such as the confrontation test which give a gross indication of field loss, to the very precise imaging of a scanning laser ophthalmoscope (SLO). The perimetry test selected depends on the availability and cost of the test, and the ability of the client to participate in testing. For example, confrontation testing does not incur any expense and can be performed nearly anywhere, whereas SLO imaging must be completed in a center which has purchased the $120,000.00 instrument by a specially trained technician. In between these two extremes are the tangent screen, campimeter, manual bowl perimeters (the Goldmann), and automated bowl perimeters (the Humphrey) ranging in cost from $100.00 to $20,000.00.

All perimetry testing involves three parameters: 1) fixation on a central target by the client while the testing is completed, 2) presentation of a target of a specific size and luminosity in a designated area of the visual field; and, 3) acknowledgement of the target by the client. The ability of the client to maintain visual fixation on a central target over an extended period of time without moving the eye while targets are shown in different areas of the visual field is critical to obtaining an accurate measurement regardless of the instrument.
used. The need to sustain attention over an extended period of time also is the greatest limitation to testing. In some cases automated perimetry may be available to the examiner but the client does not have the attentional skills to participate in the 15 minute procedure. Testing is done with either static or kinetic presentation of the target. In static presentation, the target is shown in a specified area of the visual field without moving to that location. In kinetic testing, the target is moved in from the periphery until it is identified.

The purpose of visual field testing is not just to determine the border of the visual field but also the sensitivity within the field by measuring visual thresholds at various points within the field. Every point within the visual field has a visual threshold which is determined by the weakest stimuli that is just visible at that location under specified testing conditions. Visual threshold is the lowest at the fovea (indicating the greatest sensitivity) and highest in the periphery (indicating lower sensitivity). The sensitivity of the field is depicted with the use of isopters. An isopter is the boundary between a region where a stimulus of specified size and luminosity is visible and where it is not visible. To define the boundaries of the isopter, a target is shown in a specific area or brought in from the periphery until it becomes visible. The point at which the client sees the target marks the boundary of the isopter. All four quadrants of the visual field are measured to determine the complete isopter. Figure 4.2 shows a field diagram with marked with isopters.

The restrictions imposed by limited financial resources, time, and the mobility and cognition of the client, will prevent therapists (at least initially in the rehab process) from obtaining automated perimetry testing on many of their clients. Therefore, this battery concentrates on those tests which can be completed bedside, in the clinic, or in the home. Two tests are included, a gross measurement using confrontation testing, and a more precise measurement of the central visual field using the Damato 30 Point Multifixation Campimeter.

**General Instructions to the Client for the Visual Field Subtests:**

“I am going to give you some tests to find out if you can see objects in all areas of your visual field. The visual field is the area and all of the objects that you can see when you look straight ahead (illustrate with your hands the width of the visual field). A brain injury can cause a person to develop blindness in parts of the visual field. Sometimes one eye is affected and sometimes both eyes are affected but because not all of the vision is lost, it is difficult for a person to figure out where this loss is on their own. These tests will help me to find out if you have lost any vision in your eyes. It is important that I find out this information because hidden gaps in your vision can cause problems with reading, walking and driving. I will test one eye at a time.”

4.3.1 Considerations When Measuring Visual Field

4.3.1.1 Visual Attention

The major consideration in measuring visual field is to obtain an accurate response from the client. Because the success of perimetry testing rests on the client’s ability to sustain attention throughout the test, limitations in the client’s attentional capability will reduce test accuracy. Therefore, it is imperative that every step be taken to ensure that the client maintains attention throughout the test. Testing should be completed when the client is well rested and alert and the test environment should be free from auditory and visual distractions. If the client is able to attend only for a short period of time, the tests can and should be given in short segments extended over a period of several days if necessary.

4.3.1.2 Relative Visual Field Losses

Visual field loss can range from complete loss (an absolute deficit) where the retinal field is unresponsive to light no matter how bright to a partial loss (relative deficit) where the retinal field may respond if a bright enough light stimulus is shown. It is not uncommon for both types of deficit to be present within the affected field following brain injury. Clients with relative field losses may respond inconsistently during field testing.
depending on the brightness and location of the target. For example, the client may have difficulty seeing the red target presented on the static red dot confrontation test but respond quickly to the greater luminosity of the penlight in the kinetic two person confrontation test. Similarly, the client also may have difficulty detecting features and objects in the environment with reduced contrast or detecting features in dimly lit environments.

**FIGURE 4.2**: Schematic Illustration of a Field Diagram of the Right Eye Depicting the Isopter Boundaries of Visual Field Function. *Illustration courtesy of Josephine C. Moore OTR, PhD*
4.3.3 Use of Clinical Observations

Clinical observation of the client's behavior is especially important when VFD is suspected because of the limitations of perimetry testing. Clients with fluctuating or limited attention, language, and cognition, may give unreliable perimetry results. It also may be difficult to distinguish between VFD and inattention. However, the client’s performance of functional activities will strongly indicate the presence of a VFD. The Clinical Observations Indicating Visual Impairment form lists functional behaviors characteristic of VFD, visual inattention, and a combination of VFD and inattention which can be used to help distinguish between these conditions.

4.3.2 Test Instructions: Confrontation Testing

Although confrontation is widely accepted as a valid clinical test for measuring visual field, it has, under close scrutiny, been shown to be unreliable in consistently detecting visual field loss. Trobe, Acosta, Krischer & Trick compared the results of confrontation testing by an ophthalmologist to results from Goldmann perimetry and found that confrontation testing identified less than 50% of the visual field deficits detected by the perimeter. They concluded that confrontation testing can indicate the presence of a gross defect in the visual field but is too insensitive to stand alone as the only measurement of the visual field. When completing confrontation testing, therefore, it should be kept in mind that it is the equivalent of performing a very gross muscle test. If a significant deficit is present, the test likely will confirm its presence, however subtle or partial changes in the visual field, especially when macular sparing has occurred, easily can go undetected. Still, confrontation testing often is the only test which can be completed on clients with limited cognitive and physical ability and so it will continue to have a place in field testing. Results of confrontation testing however, should always be compared with clinical observations to help ensure that a visual field deficit has not been overlooked. If the confrontation test shows no deficit but the clinical observations suggest that a deficit is present, the clinical observations should carry the greater weight in deciding if a deficit exists.

Two procedures for confrontation testing are provided. The first procedure, which uses appreciation of red dot targets presented simultaneously in the field, is a static test taught by the American Academy of Ophthalmology in “Techniques for the Basic Ocular Examination” a training video for general practitioners (see Appendix C). The second is a kinetic test which measures peripheral visual field using two examiners. Both tests must be completed to obtain measurement of the entire visual field. If the client has limited attentional capability, either test can be broken down into short segments and given over a period of several days. Also, repeated verbal cuing can be given to remind the client to maintain fixation during the test.

4.3.2.1 American Academy of Ophthalmology Red Dot Confrontation Test

Test Materials:

Basic Visual Function Assessment test form
field targets (2 red dots placed on 2 tongue depressors-1 dot on each side of 1 end of the stick)
occluder (eye patch or hand held occluder)
**Procedure:**

*Be sure to read all of the instructions before beginning the test*

1) The client is seated comfortably with eyeglasses **off**, if worn.

2) Sit directly across and approximately 1 meter from the client.

To Test the Right Eye:

3) Occlude the client's left eye with the eye patch or hand held occluder.

4) Instruct the client to fixate on your left eye (the eye directly across from the unoccluded eye). Close your right eye (the eye directly opposite the client's occluded eye) to ensure that you have the same visual field as your client.

5) Both sides of the visual field will be tested simultaneously during the evaluation and the client is asked to indicate whether both targets are seen. The targets should be held approximately 50 centimeters (20 inches) from the client so that both targets can be easily seen with an unimpaired visual field *(Note: if the targets are held too close to the client, the client's nose could occlude one of the targets causing an invalid test). To ensure that both targets have the potential to be seen, you will use your appreciation of the targets in your own visual field to compare with the client's visual field. If you cannot see both targets, the client will probably not be able to see both targets. *(Note: this test measures only the central visual field).*

6) Hold 1 field target (tongue depressor with red dots on one end) vertically in each hand so that the dot is at the top of the target.

7) Hold up both targets successively in the areas designated on the test form (Figure 4.4). The targets are to be presented to the client a total of 5 times in the order below:

- **Position A)** Superior Field
  - Target height: at the level of the forehead
  - Target width: directly above the outside edge of the shoulders

- **Position B)** Inferior Field
  - Target height: at the level of the adam's apple
  - Target width: at the outside of edge of the shoulders

- **Position C)** Superior Field
  - Target height: at the level of the forehead
  - Target width: adjacent to the temples of the face

- **Position D)** Inferior Field
  - Target height: at the level of the adam's apple
  - Target width: adjacent to the jawline of the face
Position E) Superior/Inferior Field
One target held level with the brow line on the forehead (hold target horizontally)
The other target level with the chin (hold target horizontally)

Note: If the client does not have sufficient acuity to see the red dots, two penlights held vertically can be used. The lighting in the room also can be reduced to increase the visibility of the light.

8) Make sure that the client is fixating on your open eye when the targets are presented and maintains fixation on your eye during the presentation; if the client breaks fixation and looks for the targets, do not score the location and present the target at that location again at the end of the test.

9) When the targets are shown, ask the client to indicate whether 1 or 2 dots are seen; if the client indicates that he/she sees both dots, ask the client whether the 2 dots are equally as bright in color.

10) Record the client’s response on the test form in the designated area using the scoring key provided on the form:

Scoring Key:
+  target seen
-  target not seen
D  target seen, but color of target diminished

To Test the Left Eye:

1) Occlude the client’s right eye with the eye patch or hand held occluder.

2) Instruct the client to fixate on your right eye (the eye directly across from his/her unoccluded eye). Close your left eye (the eye directly opposite the client’s closed eye) to ensure that you have the same visual field as your client.

3) Repeat steps 1-2 and 5-10.

FIGURE 4.4: Illustration for Recording Client’s Response on the Red Dot Confrontation Test on the Basic Visual Function Assessment Test Form. (Left VFD is shown).
Instructions to the Client:

“I am going present these targets (show red dot targets) to you in different areas of your visual field. I will be showing you either one or two dots and you are to tell me the number of dots that you see. It is VERY IMPORTANT that you keep your eye focused on my eye at all times during the test and do not try to look for the dots. If you move your eye to look for the dots the test is not accurate.”

4.3.2.2 The Kinetic Two Person Confrontation Test

Test Materials:

Basic Visual Function Assessment test form
eye patch occluder
tenlight
interesting target, large enough to be seen at 1 meter without eyeglasses

Environment:

Dim illumination (to enhance the visibility of the penlight); illumination should be sufficient for the examiner to be able to view the client’s eye for movement during fixation. As this is a test which requires absolute concentration, ensure that the room is free from visual, auditory and physical distractions.

Procedure:

1) The client is seated comfortably with eyeglasses off, if worn.
2) One examiner sits directly across and approximately 1 meter from the client. The other examiner holds the penlight and stands behind the client.

To Test the Right Eye:

3) Occlude the client’s left eye with the eye patch.
4) Instruct the client to fixate on a target held by the front examiner at eye level to the client. (Note: If the front examiner wears eyeglasses they must be removed for this test so that the client does not view the reflection of the light from penlight on the examiner’s eyeglasses as it is brought forward by the rear examiner).
5) As the client fixates the front examiner’s target, the rear examiner brings the lighted penlight from behind the client to the front of the client moving slowly in an arc. (Note: If the target is moved too fast, the client will not be able to respond quickly enough to obtain an accurate field measurement).
6) The client is instructed to indicate as soon as he/she sees the penlight move into his/her field either by saying “now” or raising a hand.
7) The front examiner observes the client’s eye during the exam to ensure that the client maintains fixation on the target and does not look for the penlight.
8) When the client indicates that he/she sees the penlight, the rear examiner notes the location and records it on the test form (Figure 4.5). If the client breaks fixation and looks for the penlight, do not record the response and present the penlight in that location again at the end of the test.
9) The rear examiner moves the penlight forward using the positions of the clock as a guide. Mix the positions up and perform them randomly to prevent the client from predicting the direction of the penlight. Do not touch the client or give any cues as to the direction of the penlight. The test positions are as follows:

3 o’clock  12 o’clock  9 o’clock  6 o’clock

10) When presenting the penlight from the 6 o’clock position, move the penlight in from the client’s occluded side.

To Test the Left Eye:

1) Occlude the client’s right eye with the eye patch.
2) Repeat steps 1-2 and 4-10.

Instructions to the Client:

“We are going to use two people to give you this test. __________is going to sit in front of you and hold this target (indicate target) for you to look at. While you look at the target, I am going to stand behind you and move this penlight from behind towards the front of you. As soon as you see the light from the penlight please (raise your hand or say “now”). It is VERY IMPORTANT that you keep your eye focused on the target that __________is holding at all times during the test and that you do not try to look for the light. If you move your eye to look for the light the test is not accurate. __________will be watching your eye to make sure that you do not move your eye to look.”

4.3.3  Test Instructions: The Damato 30 Point Multifixation Campimeter

This visual field test was designed by Bertil Damato MD, PhD, FRCOphth, Royal Liverpool University Hospital, to provide a simple, portable, and accurate perimetric measurement of the central visual field. The test uses a series of numbered fixation targets to move the client’s eye in a controlled manner so as to place the test stimulus at known points in the visual field. The advantage of the test for assessing clients with brain injury is that the examiner does not move the stimulus and the client does not need to sustain fixation for more than a few seconds. This increases the reliability of the test by minimizing both examiner and client error.

4.3.3.1  Components of the Campimeter

Figure 4.6 illustrates the components of the campimeter which are described as follows:

A) **Test card.** The surface of the card is made of a hard white plastic laminate printed with a test grid of blue numbers. The surface should be kept free of dirt and smudges. See Appendix H for cleaning instructions.

B) **Side-arm.** The rigid side arm joining the eye cover helps the client maintain the correct viewing distance of 13 inches (33.3 cm) from the chart. It is important that this distance be maintained during the test to ensure the accuracy of the field measurement. (Note: The test grid for the right eye is printed on one side of the card and the test grid for the left eye is printed on the reverse side of the card). The arm also ensures that the left or right eye is examined with the correct test grid for that eye.
FIGURE 4.5: Illustration for Recording Client Performance on the Kinetic Two Person Confrontation Test on the Basic Visual Function Assessment Test Form. (Intact visual field is shown).

C) Eye-cover. The eye-cover is used to occlude vision in the eye which is not being tested. The cover is white and semi-translucent to prevent a dark shadow over the covered eye from interfering with the vision in the eye being tested. It is important that each field be tested monocularly to obtain an accurate measurement of the field. If the client is unable to keep the eye-cover in place, an eye patch can be used in combination with the cover to ensure that the eye remains occluded throughout the test.

D) Test grid. The test grid consists of 30 numbered targets providing 30 test points within the central 24 degree visual field. The notched circles in the inner part of the grid (at 4 degrees) allow testing closer to the fovea and fixation, and those at the outer perimeter of the surface
expand the measurement area to 30 degrees of the visual field. The fixation targets are numbered to simplify communication with the client and recording of the results. The numbering is random, to ensure that the client actually looks at the numbers without guessing. The lines linking the numbers direct the eye movements from one fixation target to the next.

E) **Stimulus window.** This central window frames the target stimulus for the test. The window is shaped to minimize shadow on the target and is 10 mm wide to ensure an error of less than 1 degree in placement of the target stimulus during the test.

F) **Target stimulus.** A 6 mm black circle is used as the target stimulus for the test. The circle has 100% contrast and is large enough to ensure detection by clients with reduced acuity. The circle is printed on a movable arm so that it can appear and disappear briefly within the window.

G) **The target arm and finger notches on the arm and the card.** The target arm is moved back and forth during the test to present and remove the target stimulus circle within the window. Notches on the arm and the card help the examiner position and move the finger correctly when changing the stimulus presentation to ensure that minimal cues are given to the client as to when the stimulus appears.

FIGURE 4.6: The Damato Multifixation Campimeter. Illustration courtesy of Bertil Damato M.D.
4.3.3.2 General Test Procedure

Test Materials:

Damato 30 Point Multifixation Campimeter
Damato Campimeter test form
book stand (optional)
eye patch or clip-on occluder (optional)

Environment:

Well-lighted room; the light source should be directed from behind the client onto the chart so that the chart is evenly illuminated; ensure that the light source does not shine directly into the client's eyes. As this is a test which requires absolute concentration, ensure that the room is free from visual, auditory and physical distractions.

Procedure:

1) The client is seated comfortably at a table with eyeglasses on, if worn.

2) The client is instructed to hold the campimeter upright on the table top unless the campimeter has been placed on a book stand.

3) The examiner is positioned in front of the client so that both eyes can be observed.

To Test the Left Eye:

1) Place the eye-cover in the client's right hand and the card in the client's left hand (unless the book stand is used).

2) Instruct the client to cover the right eye by holding the cover, folded inward, against the closed eyelid or against the eyeglass lens. (Note: an eye patch or clip-on occluder can be used if the client is unable to use the eye-cover to occlude the eye; continue to use the side arm to maintain the correct distance from the test). (See Figure 4.7).

3) Make sure that there are no shadows on the grid surface.

4) Make sure that neither the card or the client's head is tilted sideways (Figure 4.8).

5) Adjust the card so that it faces the client squarely, with the stimulus 13 inches directly in front of the left eye (Figure 4.7).

6) Tilt the card backward and forward until the client feels comfortable (Figure 4.9).

7) Position the stimulus arm so that the window area is blank. Instruct the client to focus on the window and to say "Now" when the black circle appears in the window. Move the stimulus arm so that the black circle appears in the window. Repeat the task several times. When the client responds every time the circle is shown, the examination is ready to begin.

8) Show the client the number “1” on the grid. Instruct the client to keep looking at number “1” and to say "Now" when the black circle appears.

9) Watching the client’s eye closely, move the stimulus arm slowly until the black circle
appears. Avoid giving any cues (i.e. noise or sudden movement of the hand). The client’s response should coincide precisely with the appearance of the circle.

10) If there is any doubt about the validity of the client’s response, immediately retest that point before proceeding onto the next point.

11) Record the client’s response on the test form (specific instructions below).

12) Return the stimulus window to the blank frame and instruct the client to read the next number aloud. As soon as the client reads the next number, present the circle.

13) Proceed through the 30 fixation points on the grid. Vary the delay before presentation of each stimulus so that the client cannot guess when the circle will appear. In addition, present a blank window periodically to ensure that the client’s responses are genuine.

To Test the Right Eye:

1) Turn the card over.

2) Instruct the client to hold the eye-cover against the closed left eye with the left hand and the right edge of the card with the right hand.

3) Repeat steps 3-13 for examination of the left eye.

Instructions to the Client:

“This test will carefully measure whether you have lost any of the visual field in the very central part of your vision which is the area that you use for reading and identifying objects. I will test this by having you focus on a number on this chart (show on chart) and then tell me when you see this black circle appear (show the black circle in the stimulus window). Each eye will be tested separately. To occlude your eye, you will hold this (show side-arm with eye-cover) against your eye. It is very IMPORTANT THAT YOU FOLLOW THESE INSTRUCTIONS, so we will practice the technique several times before you take the test.”

“Hold the occluder against your left eye.”

“Look at the number “1” and keep looking at it.”

“Say ‘now’ when you see the black dot appear.”
4.3.3.3 Modification of Test Procedure for Non-compliant Clients

The testing method can be altered a number of ways to elicit performance from low functioning or non-compliant clients without significantly altering the validity and reliability of the test.

1) The number can be highlighted to help maintain the client's attention/fixation on the number. For example, a laser pointer, or a plain pointer, or the examiner's finger can be used, or a template can be fashioned with an opening cut out to display the number.
2) The number of fixations can be reduced from 30 to 15 for clients who have significantly reduced attentional capability or limited endurance. Have the client fixate on every other number keeping the targets evenly distributed throughout the field. Reducing the number of targets will reduce the sensitivity of the test to discrete deficits but still provides a gross indication of central visual field function.

3) Use of a verbal client response can be eliminated by having the client raise a finger to indicate when the black circle comes into view and by having the client point to the target number instead of reading the number.

4) The test can be broken into short segments and given over several days if needed.

5) A client with a dilated pupil and reduced accommodation secondary to a 3rd cranial nerve injury may lack the ability to clearly focus on and read the number targets. A more reliable test performance will be obtained if such a client focuses on the examiner's finger or the beam from a laser pointer instead of the number.

4.3.3.4 Recording the Client's Response

The test form for the campimeter was designed by Dr. Damato. The information requested on the left hand side of the form is fairly straightforward and can be completed as needed. Definitions of some of the lesser known terms in this section are given below:

Eye

Distance Acuity: Record the score from the intermediate acuity chart.
Near Acuity: Record the score from the Warren Text card.
Correction: Record the refraction of the client's eyeglasses, if known.
Pupil Diameter: Record any deviations from normal size.

Method

Optical Correction: Record whether the client wore eyeglasses during the test and if a bifocal was used.
Illumination: Record the type and power of illumination: example: 50 watt halogen reading lamp.
Strategy: This test is always given as a single level suprathreshold test.

The Field Diagram

The circles printed in the center of the test form represent the field diagrams for each eye. Note that the page is turned one direction to mark the diagram during the test and the other direction to interpret test results. The box in the lower center area of the form describes the symbols used to mark the field diagram. Because this evaluation just uses suprathreshold testing, only one symbol is used to indicate that the stimulus was missed. That symbol is the small black dot (+). On the field diagram, mark each target number with a black dot if the client did not see the black circle when it appeared in the stimulus box when the client was fixating on the number (Figure 4.8).

Begin the test with the form positioned to read “This way up to record results.” Mark the form according to the preceding directions. On completion of the test, rotate the form to read “This way up to interpret the results.”
FIGURE 4.10: Example of Documentation of a Left Homonymous Hemianopsia with Macular Sparing on the Damato Multifixation Campimeter Test Form.
4.3.4 Measuring Functional Performance

The evaluations previously described only quantify the VFD. Once it has been established that a VFD is present and the size and location of the deficit is known, it is important to determine how the deficit affects functional performance and the quality of the client's compensation for the deficit.

4.3.4.1 Limitations in Activities of Daily Living

Visual field deficit can cause significant limitations in activities of daily living (see Section 2.3.4). The level of impairment in daily living skills will depend on whether the VFD occurs alone or in conjunction with visual inattention. Completion of the Clinical Observations Indicating Visual Impairment form will identify many of the limitations present. An ADL assessment also should be completed to evaluate client performance in the primary ADL areas including, dressing, bathing, grooming, home management, and shopping.

4.3.4.2 Reading Performance

The Visual Skills for Reading Test (VSRT) also known as the “Pepper” test provides an effective way to measure the interference of the VFD on reading performance. The VSRT is designed to assess the influence of macular scotoma on the visual components of reading including visual word recognition, eye movement control and placement of the scotoma in relation to fixation. The client is asked to read single letters and words printed on a card; the words are not in context and are designed so that they can be misread and still make sense (example “shot” can be read as “hot”). The test measures reading accuracy and corrected reading rate, and provides information on the prevalent types of reading errors made by the client. It is leveled at the fifth grade level of reading. Purchasing information is available in Appendix C. The client’s performance on the Intermediate Acuity chart and the Warren Text card also may indicate the influence of a VFD on reading performance (see Sections 5.2.1 and 5.2.2); and Telephone Number Copy provides information about the client’s accuracy reading numbers (see Sections 4.5.3.1 and 5.7.2.1).

4.3.5 Measuring the Effectiveness of the Strategy Used by the Client to Compensate for the Visual Field Deficit

4.3.5.1 Extrapersonal Space

To effectively compensate for the VFD when moving about in environments, the client must employ a wide scanning strategy, which is initiated on the side of the VFD and is organized, and comprehensive. In addition, the client must be able to quickly shift attention and visual search from the central visual field to the peripheral visual field. Observation of these strategies can be made using a Dynavision, an apparatus designed to evaluate and train visual motor performance in the central and peripheral visual field (see Appendix C). Projection of light stimuli from a laser pointer onto a blank wall also can be used. The beam of light is projected onto various areas of the wall and the client is instructed to locate and touch the projected red dot. The strategy used by the client to locate the dot and the efficiency of the strategy is noted.
The client’s performance on the ScanBoard subtest described in Section 4.5.4.1 also can be used to evaluate the quality of the scanning strategy. See this section for instructions on giving and interpreting this subtest. The integration of visual scanning with ambulation must be evaluated to determine if the client will be able to compensate for the deficit when moving in the environment. This is evaluated through administration of the ScanCourse subtest described in Section 4.5.4.2.

4.3.5.2 Personal Space

The type and effectiveness of the visual search strategies used to explore the central visual field can be measured using the visual search subtests described in Section 4.5.2.

4.4 MEASUREMENT OF OCULOMOTOR FUNCTION

The purpose of a therapy assessment of oculomotor function is to determine whether the client is experiencing functional limitations from dysfunction within the oculomotor system. It is not to diagnose whether the oculomotor dysfunction is the result of cranial nerve lesion, orbital blow out fracture, generalized brainstem impairment and other conditions. Determining the etiology of the dysfunction is the responsibility of the ophthalmologist or optometrist who is better qualified to make a differential diagnosis of this complex visual function. However, because occupational therapy addresses the client’s ability to perform basic daily living skills, the O.T. is often the first member of the rehabilitation team to observe that the client may be experiencing an oculomotor impairment which interferes with function. This frequently places the occupational therapist in the position of recommending further evaluation by an eye care specialist. To make an appropriate referral, it is necessary to complete a screening to identify patterns of oculomotor dysfunction which may account for the functional limitations observed in the client. If the screening indicates disruption of oculomotor function and the client is complaining of and/or demonstrating difficulty completing tasks requiring vision, then referral should be made to an ophthalmologist or optometrist for further evaluation. Examples of a cover letter and examination form which can be sent to the eye specialist can be found in Appendix D.

The biVABA Oculomotor Function Assessment is a quick screening which focuses on function. A “listen and look” approach is used wherein the therapist listens to the complaints being voiced by the client or the rehab staff working with the client, and looks for deviations in oculomotor control which may contribute to these complaints.

General Instructions to the Client for the Oculomotor Subtests:

“I am going evaluate how well you are able to move and use your eyes together to view objects. The ability to move the eyes is known as oculomotor function and the ability to use the eyes together is known as binocular function. It is important to be able to move and use the two eyes together so that objects are seen clearly when you look at them. Good binocular vision also is important to balance and eye hand coordination. Sometimes a brain injury damages the centers that control eye movements.”
4.4.1 Considerations When Measuring Oculomotor Function

4.4.1.1 Visual History

Clients with childhood histories of oculomotor dysfunction or reduced acuity often display oculomotor abnormalities as adults. However, they usually have adapted to these changes and do not experience any resulting functional limitations. Because of this possibility, oculomotor deficiencies observed in clients are not considered to be significant unless they are associated with a functional limitation.

4.4.1.2 Room Illumination

Clients with brainstem injuries can be very sensitive to illumination and may keep the eyes partially or completely shut if the room lighting is too bright. Evaluate the client in a well lit room but avoid shining light directly onto the client’s face.

4.4.1.3 Medications

Medications which relax muscle either intentionally or as a side effect may affect the client’s ability to accommodate during convergence. Anti-spasticity and anti-convulsant drugs (for example: phenobarbitol and dilantin) may have this effect.

4.4.1.4 Arousal Level

The client’s ability to maintain arousal and attend to a stimulus can directly affect binocular performance. For low functioning clients, try to schedule the evaluation when the client is most alert and well rested. If possible, break the assessment into short segments and assess the client over several days. Although this is not a long assessment, it can be fatiguing and stressful for a client with oculomotor impairment.

4.4.1.5 Visual Acuity

A certain level of visual acuity is necessary for visual fixation. If the client is unable to see the target, the eye may wander, creating the impression of oculomotor impairment. The presence of optic atrophy, vitreous hemorrhage or macular scotoma also may prevent fixation and cause eye movements which mimic paralytic strabismus. Acuity should be measured before oculomotor function is assessed. If the client has reduced acuity, larger and brighter targets should be used for fixation.
4.4.1.6 Testing with Eyeglasses On or Off

Some clients with longstanding phorias or other oculomotor deficiencies may have correction in their eyeglasses to assist fusion. Because the purpose of this oculomotor assessment is to identify new deficiencies which may be affecting function, the client should be evaluated wearing his or her eyeglasses. If the design of the eyeglasses makes it impossible to adequately view the eyes, then they may be removed for the assessment. If a client who normally wears eyeglasses is tested without them, larger and brighter targets should be used to compensate for the reduction in acuity. In addition, any deficiencies observed in eye movements should be recorded with the notation that the client was not wearing eyeglasses. If a client demonstrates deficient eye movement with the eyeglasses off but does not experience any functional limitations when wearing the eyeglasses, then he or she may have a longstanding oculomotor impairment which is corrected for with the eyeglasses.

4.4.1.7 Characteristics of Cranial Nerve Lesions

A specific pattern of dysfunction characterizes lesions in each of the three cranial nerves (3, 4, 6) controlling the extraocular muscles and can be used to differentiate between lesions involving these nerves. The lesion characteristics are listed in Table 4.1

<table>
<thead>
<tr>
<th>Oculomotor CN 3</th>
<th>Trochlear CN 4</th>
<th>Abducens CN 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>• impaired vertical eye movement</td>
<td>• impaired downward and outward eye movement</td>
<td>• impaired abduction of the eye</td>
</tr>
<tr>
<td>• horizontal diplopia for near distance tasks</td>
<td>• vertical diplopia for near distance tasks</td>
<td>• lateral diplopia for far distance tasks</td>
</tr>
<tr>
<td>• exotropic eye position</td>
<td>• hypertropic eye position</td>
<td>• esotrophic eye position</td>
</tr>
<tr>
<td>• ptosis of the eyelid</td>
<td>• unilateral lesions-lateral tilt of head towards shoulder on sound side</td>
<td></td>
</tr>
<tr>
<td>• fixed, dilated pupil and impaired accommodation</td>
<td>• bilateral lesions-downward head tilt</td>
<td></td>
</tr>
</tbody>
</table>

4.4.1.8 The Cardinal Directions of Gaze

The Six Cardinal Positions. To determine which cranial nerve(s) caused the strabismus, it is often necessary to test each extraocular muscle in its prime mover position. The six cardinal positions describe eye movements used in diplopia testing to determine which extraocular muscle is involved. Primary gaze occurs when the client is looking straight ahead at an object. The other six positions are shown in Table 4.2.

<table>
<thead>
<tr>
<th>Eye Position</th>
<th>Tests the Action of...</th>
</tr>
</thead>
<tbody>
<tr>
<td>• eyes looking towards the client’s right</td>
<td>right lateral rectus/left medial rectus</td>
</tr>
<tr>
<td>• eyes looking towards the client’s left</td>
<td>left lateral rectus/right medial rectus</td>
</tr>
<tr>
<td>• eyes looking downward and outward towards the client’s right</td>
<td>right inferior rectus/left superior oblique</td>
</tr>
<tr>
<td>• eyes looking upward and outward towards the client’s right</td>
<td>right superior rectus/left inferior oblique</td>
</tr>
<tr>
<td>• eyes looking downward and outward towards the client’s left</td>
<td>left inferior rectus/right superior oblique</td>
</tr>
<tr>
<td>• eyes looking upward and outward towards the client’s left</td>
<td>left superior rectus/right inferior oblique</td>
</tr>
</tbody>
</table>

The Nine Cardinal Directions of Gaze. These are the directions the eye moves as it goes through its full range of motion. The nine cardinal directions of gaze are:

- primary gaze (eyes straight ahead)
- straight down
- straight up
- towards the right
- towards the left
- up and to the right
- down and to the right
- up and to the left
- down and to the left

4.4.2 Test Instructions: Visual History

Test Materials:

- Oculomotor Function Assessment form
- Clinical Observations Indicating Visual Impairment form

Procedure:

1) Obtain a basic eye history using the first section of the evaluation form as a guide.

2) Ask a family member to supply the information if it is not possible to get it from the client.

3) Questions to ask include:

   - Did the client have good vision prior to the brain injury?
   - Has the client had an eye examination since the brain injury?
   - Does the client wear eyeglasses; all of the time, or just for reading or distance?
   - How long has the client worn eyeglasses?
   - Does the client have a history of congenital strabismus, lazy eye or amblyopia? *(Note: this may be best ascertained by asking the client whether as a child he or she wore an eye patch, or had surgery on an eye, or saw an optometrist for eye exercises).*
4) Ask whether the client is experiencing diplopia.

5) If the client is experiencing diplopia, ask the following questions about the characteristics of the diplopia:

- Does the diplopia disappear when one eye is closed?
- Do objects split side to side (laterally) or on top of one another (vertically)?
- Is the diplopia present in near gaze (20 inches or less) or far gaze (greater than 20 inches)?
- Is the diplopia present all of the time (constant) or does it only occur during certain hours of the day or with certain activities (intermittent)?
- Does the client experience diplopia in primary gaze when looking straight at an object, only with right or left gaze, or in all directions of gaze?
- Is there an area within the range of focus where the client can achieve one image (a.k.a. the area of fusion)?
  - How far is it from the bridge of the nose - 6 inches? 40 inches?
  - How long can the client maintain fusion within this area?
- Is the client’s area of fusion sufficient to enable completion of needed daily activities such as reading or driving?

6) Complete the visual history section by identifying the activities the client has difficulty performing which could be due to oculomotor dysfunction. Examples of activities which are frequently affected by oculomotor impairment are listed on the assessment form and also on the clinical observation form.

7) Look for a pattern in the client’s response, such as difficulty completing activities that require sustained focus in near space (reading, writing, quilting). Pay attention to whether the client’s visual difficulty seems to change with the focal length of the task and whether the client’s level of fatigue and concentration appears to be related to activities requiring sustained focusing. (Note: The observations in this section should be supplemented by the more comprehensive list on the Clinical Observations Indicating Visual Impairment form to obtain a complete picture of the client’s limitations).

4.4.3 Test Instructions: General Appearance

Test Materials:

Oculomotor Function Assessment form
penlight
distant target large enough to be seen easily at 6 plus feet and interesting to look at

Environment:

Well lighted room with ambient light source; ensure that the light source is not shining directly into the client’s eyes.
Procedure:

1) The client is seated comfortably with eyeglasses on, if worn.

2) Observe the client’s eyes as they focus on the target held at eye level.

3) Complete the observation checklist on the form (symmetry, size, eyelid function, eye position, head position).

4) Record asymmetries in pupil size, eyelid function and eye position on the eye diagram on the form.

Example

Instructions to the Client:

“I am going to look at your eyes to see if they look the same. Please look straight ahead and keep your eyes fixed on the ______________ as I check your eyes.”

4.4.4 Test Instructions: Observation of the Corneal Reflections (Hirschberg Technique)

The corneal reflection is the spot of light reflected off of the cornea of the eyes. Observation of the corneal reflections is one of the simplest methods to observe ocular alignment and is also known as the Hirschberg technique.

Test Materials:

Oculomotor Function Assessment form
penlight
distant target large enough to be seen easily at 6 plus feet and interesting to look at

Environment:

Well lighted room with ambient light source; ensure that the light source is not shining directly into the client’s eyes. If the client is having difficulty seeing the penlight or if the examiner is having difficulty seeing the client’s corneal reflections, room illumination can be reduced.

Procedure:

1) The client is seated comfortably with eyeglasses on, if worn.

2) Instruct the client to focus on the target held at eye level.

3) Hold the penlight centered in front of the client’s face approximately 12 inches from the tip of the nose; hold the penlight vertically so that the light is directed upward and not directly shining into the client’s eyes.
4) Observe the corneal reflection in each eye as the client fixates the target and record the position of the reflection on the eye diagram on the form. *(Note: if eyelid ptosis prevents observation of the reflection, the eyelid can be taped up for the evaluation).*

Example

![Corneal Reflection Diagram]

5) If the corneal reflections do not match, record the direction of the deviation on the test form.

- **outer:** the reflection is on the outer rim of one iris
- **inner:** the reflection is on the inner (medial) rim of one iris
- **upper:** the reflection is on the top of one iris
- **lower:** the reflection is on the lower portion of one iris

*Instructions to the Client:*

“I am going to look at your eyes to see if they line up together. I am going to do this by holding this penlight so that I can see the reflection of the light off of your eyes to see if the reflection is the same place on both eyes. Please look straight ahead and keep your eyes fixed on the _____________ as I check your eyes.”

4.4.5 Test Instructions: Eye Movements

Deviations in strength and function of the extraocular muscles usually can be identified by observing the client’s eye movements. Just as it is more difficult to move the upper extremities in unison than it is to move one arm at a time, binocular movement of the eyes is more difficult to produce than monocular eye movement. Because of this, most deviations in eye movements are more readily observed on a binocular test as opposed to occluding one eye and completing a monocular test. Therefore, for the purposes of this screening, only binocular eye movements will be tested.

Although full range of motion of the eyes is assessed, it is the client’s control of eye movements through the central part of the range that is functionally important. Eye movements exceeding 10 degrees from primary gaze are rarely made as it is more efficient to use head movement when a greater deviation in gaze is needed.  

4.4.5.1 Binocular Smooth Pursuit Eye Movements

*Test Materials:*

Oculomotor Function Assessment test form
penlight
Environment:

Well lighted room with ambient light source; ensure that the light source is not shining directly into the client’s eyes. If the client is having difficulty tracking the penlight room illumination can be reduced to increase the contrast of the penlight.

Procedure:

1) The client is seated comfortably with eyeglasses on, if worn.

2) Hold the penlight vertically so that the lighted tip can be viewed. Instruct the client to focus on the lighted tip of the penlight.

3) Maintaining a distance of approximately 16 inches, move the penlight slowly and smoothly in an arc through the 9 cardinal directions of gaze.

4) Nine cardinal directions of gaze:

   Primary Gaze: Hold the penlight directly in front of the bridge of the nose.

   Horizontal-Right/Left: Start with the penlight in front of the nose, move the penlight toward the right shoulder, then back towards left shoulder.

   Vertical-Up/Down: Start with the penlight in front of the nose, move it vertically toward the top of the head, then down towards the chest.

   Diagonal-Left/Right: Start with the penlight by the left shoulder and move it diagonally toward the top of the right side of the head. Stop when the penlight is above the right shoulder. Reverse directions.

   Diagonal-Right/Left: Start with the penlight by the right shoulder and move it diagonally toward the top of the left side of the head. Stop when the penlight is above the left shoulder. Reverse directions.

5) When moving the penlight, be sure to maintain an arc around the client’s head to avoid changing the focal distance of the target.

6) Observe the symmetry of the eye movement.

   • The eyes should move an equal distance in each direction.

   • The corneal reflections should match in both eyes during movement.

   • The proportion of iris to sclera [white of eye] should be equal in both eyes in both directions.

   • The eyes should stay on target with minimum jerking eye movement throughout the mid range of the arc.

   • The client should be able to hold a deviated eye position without significant effort for 2-3 seconds.

7) If eye movement is difficult to observe because of ptosis of the eyelid, the lid can be held up with surgical tape during the test.
8) If asymmetries are observed, record the direction of the deficient movement on the eye diagram on the test form by drawing in the iris and corneal reflection.

Example

```
eyes moving toward left
```

*Instructions to the Client:*

“I am going to look at how well you can move your eyes together by having you follow this penlight (show penlight) with your eyes as I move it. Please keep your eyes on the penlight at all times as I move it.”

### 4.4.5.2 Convergence

*Test Materials:*

- Oculomotor Function Assessment form
- Penlight

*Environment:*

Well-lighted room with ambient light source; ensure that the light source is not shining directly into the client’s eyes. If the client is having difficulty tracking the penlight, room illumination can be reduced to increase the contrast of the penlight.

*Procedure:*

1) The client is seated comfortably with eyeglasses on, if worn.

2) Hold the penlight vertically so that the lighted tip can be viewed. Instruct the client to focus on the tip of the penlight.

3) Beginning at a distance of approximately 20 inches, move the penlight slowly toward the bridge of the client’s nose.

4) As the penlight is moved toward the nose, observe the convergent eye movements. Both eyes should maintain fixation on the penlight and move inward to follow the penlight as it nears the bridge of the nose *(Note: observation can be aided by viewing the corneal reflections)*.

5) Record the distance from the bridge of nose at which the client breaks fixation in one or both eyes. Observe for pupillary constriction as the eyes move inward and observe the amount of effort used and the ability to maintain fixation. Fixation is broken when one or both eyes move outward or when the client reports double vision.
6) The near point of convergence in an adult is approximately 2-3 inches from the bridge of the nose and should be achieved without a break in fixation and with minimum effort (Note: older adults will have a farther near point than younger adults and children).

Instructions to the Client: eyes moving toward left

“I am going to see how long you can stay focused on this penlight as I move it towards your nose. As I move the penlight in towards your nose your eyes will begin to cross and pretty soon you will find that the light appears to double or gets blurry. Please let me know as soon as this happens.”

4.4.6 Test Instructions: Diplopia Testing

Diplopia testing is completed only if the client is complaining of diplopia. It is used to determine the severity of the diplopia and whether it is due to a tropia or a phoria. Tropia is the suffix applied when there is a deviation of the position of one eye in relation to the other when the client is viewing objects. Phoria is the suffix used when there is a deviation of the eye that is held in check by fusion and is, therefore, not noticeable when the client is focusing on an object. These terms are used in conjunction with a prefix describing the direction of the deviation. There are four prefixes used: eso-meaning a turning in of the eye; exo-a turning out the eye; hypo-a turning downward of the eye and hyper-a turning upward of the eye. Esotropia therefore, describes an observable, inward, deviation of the eye commonly described as “crossed eyes”; whereas esophoria indicates that the eye drifts inward when the client is not focusing on an object but the drift is held in check when the client is focusing on an object.

Diplopia testing is based on the principle that when an eye is required to fixate on an object it will do so with the fovea. If an eye, which is not fixating on a target, is suddenly required to foveate, it will achieve foveation by making a saccade toward the target. By requiring the client to fixate with both eyes on a target and then covering one eye during fixation, the examiner can determine whether both eyes are aligned in focusing on the target and, if not, which eye is the deviant (strabismic) eye. If both eyes are aligned equally and fixating on the target, no movement of either eye will be observed when one is covered; if the eyes are not aligned, the deviating eye will move to take up fixation when the non affected eye is covered. If a significant strabismus is present, it will be identified with testing in primary gaze.

4.4.6.1 Cover/Uncover Test

This test is completed when a tropia is suspected.

Test Materials:

Oculomotor Function Assessment form
target
hand held occluder

Environment:

Well-lighted room with an ambient light source; ensure that the light source is not shining directly into the client’s eyes.
Procedure:

1) The client is seated comfortably with eyeglasses on, if worn.

2) Test the client as he or she fixates in primary gaze. Instruct the client to focus on the target which is held at eye level and at midline (the target can be the examiner’s nose or the examiner can hold up a target).

3) While the client is fixating the target, use the hand held occluder to quickly cover the eye which appears to have intact oculomotor function.

4) As the eye is covered, observe the uncovered eye to see if it moves to take up fixation on the target.

5) If eye movement is observed, record the direction in which the eye moved on the corresponding eye diagram on the form.

   Example
   
   ![Eye Diagram]
   
   6) Repeat the test with the other eye.

Instructions to the Client:

“I am going to see if your eyes can stay focused on the __________ (indicate target) as I cover and uncover each eye. It is important that you keep your eyes focused on the target at all times during the test.”

4.4.6.2 Alternate Cover Test

This test is used to detect a phoria. Because phorias are held in check by fusion, a phoria only is observed if fusion is prevented. To prevent fusion while the client fixates on the target, the occluder is moved quickly back and forth between the eyes.

Test Materials:

- Oculomotor Function Assessment test form
- target
- hand held occluder

Environment:

- Well lighted room with ambient light source; ensure that the light source is not shining directly into the client’s eyes.

Procedure:

1) The client is seated comfortably, with eyeglasses on, if worn.
2) Test the client as he or she fixates in primary gaze. Instruct the client to focus on the target which is held at eye level and at midline (the target can be the examiner’s nose or the examiner can hold up a target).

3) Quickly switch the occluder back and forth between the eyes leaving the occluder over the eye for 2 seconds before switching.

4) Observe whether the eye under cover moves to take up fixation once the cover has been removed.

5) If eye movement is observed, record the direction in which the eye moved on the corresponding drawing on the form.

Example

eye moved out-

6) Repeat the test with the other eye.

Instructions to the Client:

“I am going to see if your eyes can stay focused on the ________ (indicate distant target) as I cover and uncover each eye. It is important that you keep your eyes focused on the target at all times during the test.”

**4.4.7 Assessing Clients with Visuo-Vestibular Dysfunction**

When the visual system is affected by an imbalance in the visual/vestibular/proprioceptive sensory triad which controls balance, the client may experience oscillopsia; the continuous, uncontrolled perception of motion in the (primarily peripheral) visual field. The presence of oscillopsia can be objectively identified by measuring the client’s performance on a dynamic visual acuity test and comparing it to the results obtained on a standard (static) visual acuity test. To measure dynamic visual acuity, repeat the intermediate distance acuity test (the Intermediate Acuity test chart) instructing the client to continuously move the head back and forth (as if gesturing “no”) while reading out the letters on the chart. If the client is experiencing oscillopsia, he or she will read at least three fewer lines on the dynamic visual acuity test because of the gaze instability resulting from the deficiency in visuo-vestibular function. If visuo-vestibular dysfunction is suspected, the client should be referred to a specialist for further evaluation.

**4.5 MEASUREMENT OF VISUAL ATTENTION**

The basis for evaluation of visual attention is the belief that how efficiently, and completely a person attends to and takes in visual information determines how effectively the information can be used for adaptation. Tests designed to measure visual inattention should provide the following information about the client’s scanning ability:

1) can the client initiate an organized search strategy?
2) can the client carry out the search pattern in an organized, efficient way?
3) does the client scan the visual array completely and obtain all necessary visual information?
4) does the client’s performance decrease as the complexity of the visual array increases? In other words, is there a limit to the client’s capability to employ attention for visual search.

The subtests included in this section are structured as task analysis to provide an opportunity to observe how the client searches for information and whether his or her ability to initiate and carry out an efficient scanning pattern changes with the structure and complexity of the visual task. The section is divided into subtests that measure visual attention to near/personal space (the space immediately surrounding the body) and subtests that measure attentional strategies for the exploration of extrapersonal space (the environment surrounding the body). The subtests, when given in the order on the test form, place increasing demands on visual attentional processing. This enables the examiner to determine whether the client’s attentional capability will break down under increased stress.

The subtests go from simple to complex visual arrays with structured and unstructured formats. They are printed in the wider format of legal size paper (8.5 x 14 inches) to make them more sensitive in detecting deficiencies in visual search due to hemi-inattention and VFD. The size of the subtests makes them more difficult to file, but hopefully this disadvantage will be offset by the advantage of an increased opportunity to observe the client’s strengths and weaknesses. If possible, all subtests should be given in the order listed on the form. Doing so will provide the best indication of the client’s ability to modify visual attention to meet the demands of increasingly difficult tasks. However, single subtests can be selected at the examiner’s discretion; the more complex versions for high functioning clients; simpler versions for low functioning clients. It will take approximately 30-45 minutes to give all of the subtests. Make copies of the subtests from the master templates to use during the assessment. Do not mark on master templates.

General Instructions to the Client for the Visual Attention Subtests:

“To read and find things in your environment and to drive you have to take in visual information in a sequential and organized way. For example, to make sense of a book, you have to read the words and pages in order; if you skip over words and pages you can’t understand what you’ve read. Brain injuries sometimes affect the organization of how visual information is taken in and causes the way someone searches for information to become disorganized and incomplete. These tests look at how you use your vision to search for and find information to see if you’re experiencing any of these changes.”

### 4.5.1 Considerations When Measuring Visual Attention

As a process found at the intermediate level of the visual perceptual hierarchy, visual attention can be affected by deficits in lower level functions such as visual acuity, oculomotor function and visual field. Therefore, these functions should be evaluated prior to measuring visual attention. The presence of aphasia and motor impairment also can affect performance on these subtests. The following sections address these issues.

#### 4.5.1.1 Hemi-Inattention vs. Hemianopsia

Hemi-inattention often is confused with the presence of a hemianopsia. Although both conditions may cause an individual to remain unaware of visual information on one side, they are distinctly different conditions and will not have the same long term effect on performance. Therefore, it is necessary to distinguish between the two conditions when evaluating the client. This can be accomplished by observing the client’s performance on tasks designed to measure the effectiveness of visual search strategies.
Clients with VFD, when required to complete a task involving visual search, will attempt to compensate for the loss of vision by engaging visual attention. They will direct eye movement towards the side of the vision loss in an attempt to gather visual information from that side. They will initiate and carry out an organized search pattern. However, the VFD may limit scanning towards the blind side causing an abbreviated search pattern that diminishes visual input from that side and causes the client to make errors. Some of the errors will be corrected as the client rescans the area to check the accuracy of his or her performance. The amount of time taken to complete the task and the amount of effort used are appropriate to the task's level of difficulty.

In contrast, clients with true hemi-inattention or neglect lose the attentional mechanisms that drive the search for visual information. The client makes little or no attempt to search for information on the left side of the visual space; no eye movement or head turning is observed toward the left side. When completing a search task, the client will use a disorganized, random pattern which usually is asymmetrical; initiated on and confined to the right side. The amount of effort given to the task will be less than is needed resulting in a quickly completed performance with many errors. Little or no rescanning to check the accuracy of the performance will be observed. The differences between these two approaches to a search task are listed in Table 4.3.

<table>
<thead>
<tr>
<th>Visual Field Deficit</th>
<th>Hemi-inattention</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Search pattern is abbreviated toward blind field</td>
<td>• Search pattern is asymmetrical; initiated/confined to the right side</td>
</tr>
<tr>
<td>• Client attempts to direct search toward blind side</td>
<td>• Client makes no attempt to direct search toward left side</td>
</tr>
<tr>
<td>• Search pattern is organized and generally efficient</td>
<td>• Search pattern is random, and generally inefficient</td>
</tr>
<tr>
<td>• Client rescans to check accuracy of performance</td>
<td>• Client does not rescans to check accuracy of performance</td>
</tr>
<tr>
<td>• Time spent on task is appropriate to level of difficulty</td>
<td>• Client completes task quickly; level of effort applied is not consistent with difficulty of task</td>
</tr>
</tbody>
</table>

The greatest challenge in evaluation and intervention occurs with the client who has both conditions. When this happens, visual information is missed on the left side because of the VFD and the client is unable to compensate for the vision loss by directing attention towards the left side. The presence of a VFD will exaggerate the inattentive behavior observed causing severe neglect to be observed. When the two conditions occur together it is important to determine the severity of the inattention as this will determine whether the client is able to learn the strategies needed to compensate for the VFD.

### 4.5.1.2 Test Environment

**Room illumination:** Testing should be completed in a well-lighted room with full and even illumination of the test materials. Eliminate any shadow or sources of glare which may affect the client's performance.  
**Distance:** All test materials should be placed at the client's midline and positioned within reading distance (40 cm or 16 inches). The client is allowed to reposition the materials as desired after the initial placement. Any changes made by the client should be noted in the comments section on the test form.

**Distractions:** To obtain the client's best performance, it is strongly recommended that the client be tested in an area free of distractions.
### 4.5.1.3 Client Response

**Acuity:** The test materials have been designed to accommodate clients with visual acuities as low as 20/200 (20/100 on the Telephone Number Copy subtest) and have been printed in high contrast formats to reduce interference from either acuity or reduced contrast sensitivity function.

**Time Limit:** Field testing with the instrument shows that most clients will complete each subtest within 3 minutes. However a few clients took as long as 9 minutes to complete some of the subtests. Therefore, there is no limit on the amount of time a client may take to complete a subtest as long as his or her concentration on the subtest remains good. Do not stop timing until after the client is completely finished, including checking and correcting his or her work. *(Note: this includes corrections made after the client is cued).*

**Cuing:** Because the purpose of this evaluation is to determine the client’s strengths and limitations in attending to and searching for visual information, it is important to determine whether a client, who is unable to initiate an efficient pattern on his or her own, would benefit from cuing. Therefore, both physical and verbal cuing are allowed and, if used, should be noted on the test form. Descriptions of permissible cues, listed in the order they should be given, are included with the specific test instructions. Cuing should be used sparingly and given only when it is apparent that the client will not correct his or her performance without assistance.

**Self Correction of Errors:** If a client makes an error (example: crosses out the wrong target) but immediately corrects the mistake without cuing it is **not recorded** as an error on the test form.

Client’s with aphasia may have difficulty completing the subtests containing letters and words and may perform better on the subtests using shapes. Clients experiencing diplopia should have the non-dominant eye occluded during completion of the subtests.

### 4.5.2 Test Instructions: Search Strategies for Near Space

**Test Materials:**

- Visual Attention Assessment Form
- Copies of the following subtests:
  - Single Letter Search-Simple
  - Single Letter Search-Crowded
  - Word Search
  - Structured Complex Circles Search
  - Random Plain Circles-Simple
  - Random Plain Circles-Crowded
  - Random Complex Circles Search
- red felt tip marker
- stopwatch
- card with the example of the complex circle target

**Procedure:**

1) The client is seated comfortably at a well illuminated writing surface. The client should be wearing eyeglasses if needed for reading.

2) Place the test form at the client’s midline.

3) Hand the client the marker and instruct the client to mark the subtest form as designated for each subtest and to place his or her pen down when he or she is finished.
4) The client may reposition the subtest to see it better. Note any changes the client makes in the position of the subtest on the test form.

5) Begin timing when the client initiates the search pattern.

6) Observe the search strategy used by the client to complete the subtest and mark the test form accordingly. *(Note: the most commonly used effective search patterns are indicated on the form with italics and a graphic illustration of the patterns is provided on the last page of the form).*

7) Stop timing when the client places his or her pen on the table (see Section 4.5.1.3).

8) Physical and verbal cuing of a client who is struggling with the test is permitted but should be noted on the test form. *(Note: test time includes cuing)*

9) Count the number of correct responses made by the client and record this number on the test form. Refer to the template showing the location of the correct targets on the test form to accurately count the number of correct responses. *(Note: cancellation of the wrong target such as crossing out an E instead of an F is counted as an error).* On the open circle tests; double numbering a circle is considered an error. Misnumbering circles (i.e. going out of sequence) should be noted on the test form but not counted as errors.

10) Divide the subtest sheet into thirds and document the number of errors which occurred in the left portion, right portion and center portion of the subtest.

11) To calculate the percentage correct, refer to the Table in Appendix E and record this percentage on the test form.

**4.5.2.1 Structured Visual Array**

On these subtests the client is asked to search through test stimuli which have been arranged in an organized, structured format. The design of the array should cue the client to complete visual search by using a linear pattern and searching either row by row or column by column.

*Instructions to the Client:*

**Single Letter Search-Simple and Crowded**

“There are seven rows of letters on this page. Please read through the letters and cross out the P’s and the F’s every time you see them (point to the examples of the letters at the top of the page). Remember to cross out only the P’s and the F’s. When you have finished, place your pen on the table.”

**Word Search**

“There are seven rows of letters on this page. Included among the letters are the words at and the (point to the 2 words at the top of the page). Please search for these two words and underline the words when you see them. Remember: only underline at and the. When you have found all of the words, place your pen on the table.”
Structured Complex Circles Search

“There are 6 rows of circle shapes on this page. Please search through the circles and cross out the one that looks like this (point to the examples of the circle on the card and at the top of the page). Remember to cross out only the circle that looks like this. When you have finished, place your pen on the table.”

Examples of Permissible Verbal Cues:

- “Remember the sheet is very wide.”
- “There are more circles/letters/words on your left/right side.”
- “There are insert number circles/letters/words on the sheet.”
- “There are insert number circles left.”
- “There are insert number letters/words left.”

Examples of Permissible Physical Cues:

- Gently turning the head towards the left or right.
- Placing a hand on the left or right side of the page to draw attention to that side.
- Pointing to the left or right border of the page.

4.5.2.2 Unstructured Visual Array

In these subtests the client is asked to search through test stimuli which have been arranged in a random format. The client must figure out and impose his or her own structure in searching the array. The random plain circle subtest is designed to provide tangible documentation of the search structure chosen by the client. By numbering the circles, it is possible to see the pattern used by the client in shifting gaze from target to target.

Instructions to the Client:

Random Plain Circles-Simple and Crowded

“There are circles scattered across this page. Please number the circles in order as you see them. Place the number inside of the circle. When you have numbered all of the circles that you can see, place your pen on the table.”

Random Complex Circles Search

“There are circles that look like this one (show the card with the circle) mixed in with the other circle designs on this page. Please search through the circles and cross out all of the circles which look like this one. Remember to only cross out the circles that look like this. When you’ve crossed out all of the circles that you can find, place your pen on the table.”

Examples of Permissible Verbal Cues:

- “Remember the sheet is very wide.”
- “There are more circles on your left/right side.”
- “There are insert number circles on the sheet.”
Examples of Permissible Physical Cues:

- Gently turning the head towards the left or right.
- Placing a hand on the left or right side of the page to draw attention to that side.
- Pointing to the left or right border of the page.

4.5.3 Test Instructions: Attention to Visual Detail

These subtests present a more complex visual array and demand greater selective attention from the client. Therefore a client with disruption of visual search due to inattention or VFD may commit a greater number of errors on these subtests.

4.5.3.1 Telephone Number Copy

Test Materials:

- Visual Attention Assessment form
- Telephone Number Copy subtest
- black felt tip pen
- stopwatch

Procedure:

1) The client is seated comfortably at a well illuminated writing surface with eyeglasses on, if worn.

2) Place the subtest at the client's midline.

3) Hand the client the pen and instruct the client to copy the telephone numbers and to place his or her pen on the table when finished.

4) The client may reposition the subtest form to see it better. Record any changes the client makes in the position of the subtest on the test form.

5) Begin timing when the client begins reading the numbers.

6) Stop timing when the client places his or her pen on the table (Note: timing includes self corrections made when checking work).

7) Physical and verbal cuing of a client who is struggling with the test is permitted but should be recorded on the test form. (Note: test time includes cuing).

8) Count the number of errors (omissions and misidentifications) made by the client in copying the numbers. Inform the client of the number of errors and instruct him or her to find the errors and correct them. (Note: an omission is leaving a number(s) out of the sequence and misidentification is writing down an incorrect number. If a client copies down a number incorrectly but immediately corrects the error without cuing, note his or her performance on the test form but do not count it as an error). Do not time this process.
9) Record the number of omissions and misidentifications made both before and after self-correction.

10) Record the percentage of correct telephone number sequences before and after self-correction. *(Note: each telephone number is considered a single item in calculating the percentage).*

11) To calculate the percentage of correct responses, refer to the Table in Appendix E.

**Instructions to the Client:**

“There are 10 telephone numbers on this page. Please read each telephone number carefully and copy it down on the blank line next to the number (show the line to the client) When you have finished, place your pen on the table.”

If the client makes errors in copying the numbers, when the subtest is completed, count the number of errors and then say to the client:

“You have made _____ errors in copying down the numbers. Please recheck your work and see if you can find the errors and correct them. When you have finished, place your pen on the table.”

**Examples of Permissible Verbal Cues:**

“Remember there are 7 numbers in a telephone number.”
“Remember to look at the numbers closely.”

**Examples of Permissible Physical Cues:**

• Gently turning the head towards the left or right.
• Placing a hand on the left or right side of the page to draw attention to that side.
• Pointing to the left or right border of the page.
• Pointing to the copying line.

### 4.5.3.2 Design Copy

**Test materials:**

Visual Attention Assessment form
3 design cards (house, flower, clock)
3 sheets of white, blank 8.5” x 11” paper
pencil
stopwatch

**Procedure:**

1) Place one sheet of paper and the design card at the client’s midline. *(Note: the client is given one sheet of paper per design).*

2) Instruct the client to copy the design as accurately as possible.

3) The client may position the paper or design card in anyway he or she wishes. Record any changes made by the client in the position of the paper or card on the test form.
4) Present the cards in the order listed on the test form (house, flower, clock).

5) Time how long it takes for the client to complete each drawing. Begin timing when the client picks up the pencil and stop timing when the client places the pencil on the table.

6) Review the accuracy of the client’s performance and record on the test form accordingly. (Note: leaving out very small details such as a loop on the smoke or the dot in the center of the hands on the clock are not considered errors as long as the primary detail [i.e. smoke, hands of the clock] are present).

Instructions to the Client:

“Copy this drawing as accurately as you can. Please include all of the details in the drawing. But draw only what is on the drawing, do not add extra details (such as a sidewalk to the house). How well the figure is drawn is not as important as including all of the details in the drawing. You may take as long as you wish. Put your pencil on the table when you have completed the drawing.”

Examples of Permissible Verbal Cues:

“Look carefully at the figure to make sure you have seen everything.”
“Does your drawing look complete?”

Examples of Permissible Physical Cues:

• Placing a hand on the left or right side of the page to draw attention to that side.

4.5.4 Test Instructions: Search Strategies for Extrapersonal Space

The two subtests included in this section provide an opportunity to observe the scanning strategy used by the client to view the extrapersonal space adjacent to the body and how the client incorporates visual search into ambulation. The first subtest, the ScanBoard, evaluates the search pattern used to view extrapersonal space when the person is stationary. The second subtest, ScanCourse, evaluates the search pattern used during ambulation.

4.5.4.1 ScanBoard

This subtest is designed to assess whether the client is able to employ an organized and symmetrical strategy in searching for visual information presented in extrapersonal space. Research completed on this test has shown that adults without brain injury will employ an organized, sequential search pattern to identify the numbers on the Board using one of three patterns.31 These patterns: clockwise, counterclockwise and rectilinear, are illustrated in Figure 5.3 in Section 5.7.3.1.1. The most commonly employed strategy is the clockwise pattern used by 55% of the control subjects in a research study using the test; followed by the counterclockwise pattern which was used by 41% of the subjects. Most of the control subjects initiated their search
on the upper left side of the board (65%) and proceeded from left to right and top to bottom. In contrast, subjects with visual inattention demonstrate disorganized, random and often abbreviated search strategies frequently missing numbers on one side of the board. Those with hemi-inattention often showed an asymmetrical pattern, initiating visual search from the right side rather than the left and confining all search efforts to the right side. Whereas subjects with normal visual attention never omitted or repeated a number on the test, those with inattention committed both of these errors.

The test uses a simple design format which is not challenging enough to detect subtle deficits in inattention. It should always be used in conjunction with the more demanding ScanCourse subtest to identify deficits in visual search of extrapersonal space.

**Test Materials:**

- Visual Attention Assessment form
- ScanBoard
- easel (optional)

**Procedure:**

1) The client is seated in a posturally secure position with good midline orientation (straddling a low bench is best). The ScanBoard is positioned at eye level at the client’s midline and within arm’s reach so that the client can touch each number on the Board.

2) Instruct the client to point out the numbers on the Board as he or she sees them.

3) On the test form, record on the line under each number, the order in which the numbers were identified by the client.

4) Do not cue the client during the test; allow the client to indicate to you when he or she is finished.

**Instructions to the Client:**

“There are 10 numbers on this board. Point out the numbers to me as you see them. Do not go in any particular order just as you see them. Point slowly because I will be writing down the numbers you see. Stop when you have seen all of the numbers.”

### 4.5.4.2 ScanCourse

The ScanCourse is an informal observational test which provides an opportunity to observe the client’s ability to combine visual search with ambulation. The course is set up in a hallway (preferably a long hallway such as a corridor in the clinic). Cards containing single letters and/or numbers are placed randomly on the walls and floor of the hallway at various heights and distances from one another. To simplify calculation of the client’s accuracy, 10 cards are placed one side of the hallway and 10 on the other side. The client is then asked to walk down the hallway pointing out and reading each card during ambulation. Missing cards on one side or stopping ambulation to search for and read cards indicates that the client is having difficulty integrating visual scanning with ambulation.
Test Materials:

Provided:

Visual Attention Assessment form

Not Provided:

20 3" by 5" plain index cards (20)
20 1 inch black vinyl stick on letters and/or numbers or a black marker to draw letters and numbers on the cards
tape or mounting putty to attach the cards to the wall

Procedure:

1) Assemble the cards by placing one letter or number on each card (Note: stick on “Post it” notes can be used for temporary cards).

2) Attach 10 cards to one side of a long hallway or corridor and 10 cards to the other side. The cards should be placed randomly, some at floor level, some at eye level, some in between at different distances. One or 2 cards can be placed on the floor. (Note: the client should not view this step).

3) After the course is established, bring the client to one end of the hallway.

4) Instruct the client to read out the numbers/letters as he or she walks down the hallway. The client is to continue to walk and read the cards while ambulating. He or she is not to stop to read the cards.

5) Follow the client as he or she ambulates down the hallway and keep a silent count of the number of cards missed on each side of the hallway.

6) If the client did not find all of the cards, calculate the percentage of correct responses made viewing each side of the hallway (i.e. 8/10 cards located on the right hand side indicates 80% accuracy in locating the targets on the right side during ambulation).

7) Record the number and percentage of targets located by the client on the test form under Trial 1.

8) If the client does not locate 100% of the targets, report the percentage to the client and instruct the client to walk down the hallway again, to see if this time he or she can find more cards.

9) Repeat the test by having the client reverse course and walk down the hallway in the opposite direction from the first trial.

10) Re-calculate the percentage of accurate results and record the percentage on the test form under Trial 2. (Note: it is not necessary for the client to read the letter/number on the card accurately; the client only must locate the card).

Instructions to the Client:

“This is a test to see how well you are able to search for targets when you are walking. Twenty cards with number/letters on them like this one (show example)
have been placed in various positions on the walls and floor of this hallway. You are to read out the number/letters on the cards as you walk by them. Do not stop and look for the cards, you are to continue walking and to read the number or letter on the card as you walk by.”
5 INTERPRETATION OF TEST PERFORMANCE

Test interpretation is undertaken basically with two goals in mind. The first goal is to determine whether to refer the client to an eye care specialist for further evaluation. Because ophthalmologists and optometrists are not yet members of the rehab team, the therapist likely will be the first professional to observe that the client may have a visual impairment. Therapists do not have the medical skills to diagnose a visual condition or to know whether the condition may be permanent or progressive, correctable or vision threatening. Diagnosing is also outside the scope of practice of therapists. The skills of an eye care specialist are needed but referral is unlikely to occur without recommendation from a member of the rehab team (see Section 3.10).

The second goal of test interpretation is to determine how the observed impairment affects performance so that effective intervention can be designed. Ideally, once a visual impairment is identified on screening, additional assessment is completed by an eye care specialist and, together, the specialist and the therapist work out an effective treatment plan. Realistically, it may take weeks to obtain an assessment from an eye care specialist. In the meantime, it is left to the therapist to address the visual impairment. Information gained from test interpretation of the biVABA can enable the therapist to implement measures to improve occupational performance until additional consultation can be obtained.

Because the biVABA is concerned with occupational performance, test interpretation does not rely on assigning rating points and cut off scores but instead on observation of the client’s performance on tasks that require visual processing. It is strongly recommended that the therapist is thoroughly acquainted with the contents of Section 2 before using this Section to interpret client performance.

5.1 PUPILLARY RESPONSES

Normal pupils are round, regular, and centered within the iris. The size of the pupil is determined by the amount of ambient illumination available. In a well illuminated room, the normal size of the pupil in an adult is approximately 3mm and may be up to 5mm in a child. Older adults may have smaller pupil sizes. Some medications such as those prescribed for glaucoma may also reduce pupil size. Approximately 20% of the adult population have asymmetrically sized pupils (a condition known as physiologic anisocoria) but the difference in pupil size is less than 1mm and the pupils respond consensually (equally) to light.

Impaired pupillary responses have many different etiologies. Pupillary assessment, when completed by a physician, determines whether there are unilateral afferent abnormalities in the visual pathway that may be caused by such conditions as optic neuritis, optic atrophy, or retinal detachment. Exact determination of the cause of the impairment is made by an ophthalmologist, neuro-ophthalmologist or neurologist and the client should be referred to one of these specialists if abnormalities are observed. In contrast, a therapist observing impaired pupil function should consider how the impairment will affect the client’s functional performance (i.e. ability to read, adjust to changes in lighting etc.) to determine the modifications needed to compensate for the impairment.
5.1.1 Observation of Size and Symmetry

*Presence of a very small pupil on observation.* This indicates that diminished light is coming into the eye that may reduce retinal function (in the way low light affects exposure of camera film); the client may require brighter light for optimal functioning.

*Presence of a dilated pupil on observation.* This may indicate blindness in the eye (amaurosis), optic atrophy, or a 3rd cranial nerve lesion. If the client has vision, and the pupil remains dilated during accommodation, he or she may experience blurring of vision in the eye when focusing at a near distance causing difficulty reading and completing other near vision tasks. Increased sensitivity to light also may be present.

5.1.2 Response to Light Stimulation

*The pupil responds sluggishly during direct light stimulation.* This indicates the presence of a complete or partial impairment of the unilateral afferent or efferent system. In daily activities, it may indicate that the client will have difficulty adapting to changes in lighting conditions such as when going from a dark hallway into a brightly lit room. The client may require a period of adjustment when transitioning between environments with different levels of lighting.

*The non-stimulated pupil reacts sluggishly or is unable to maintain constriction and begins to dilate during direct stimulation of the fellow eye.* This indicates impairment of the consensual light response and is an indication of an afferent abnormality. Functionally, it may cause the client to experience sensitivity to bright light and the client may have difficulty maintaining a clear focus during sustained near viewing.

*The pupil does not constrict to direct light stimulation but constricts consensually with stimulation of the other eye.* This may indicate blindness in the eye (amaurosis). Because an amaurotic pupil reacts to light stimulation of the other eye, with both eyes open there will be no difference in the diameter of the two pupils and the amaurotic pupil will constrict consensually during accommodation.

5.1.3 Response to Accommodation

*The pupils do not constrict with convergence.* Inadequate pupillary constriction during accommodation will reduce the quality of the image on the retina during near viewing and the client may experience blurring of vision. Inadequate pupillary constriction during accommodation is suggestive of brainstem impairment.

*The pupils do not respond to direct light stimulation but constrict with accommodation.* This is known as light-near dissociation and may result from such conditions as diabetes, optic nerve disorders or a tumor. The client may be sensitive to bright light but should not experience blurring with near vision.²

5.2 VISUAL ACUITY

Visual acuity is measured to determine whether magnification is needed to see visual detail and, if it is needed, the amount of magnification required. For clients with visual acuity in the normal to near normal range
(20/20-20/60) stronger refraction in their eyeglasses should be sufficient. The client should be referred to an ophthalmologist or optometrist for refraction. If the client has an acuity less than 20/80, magnifiers and other adaptations such as enlarged print may be needed. When acuity is measured in metric units (as given on the intermediate acuity chart) the denominator of the metric fraction indicates the approximate minimum number of diopters of magnification needed to enable the client to compensate for the reduction in acuity. As such it can serve as a guide in selecting a magnifier (see Sections 4.1.4 and 4.1.5). *(Note: the strength of magnifiers is often given in X units rather than diopters, the formula for roughly converting diopters into X is that 4 diopters equals one X power).* However, unless a member of the rehab team has experience in low vision and an understanding of optics, the client should be referred to a low vision optometrist or a low vision rehabilitation program. Whenever acuity is reduced beyond the normal range, referral should be made for an eye exam to determine the reason for the reduction and to determine if, and how, vision can be enhanced.

### 5.2.1 Distance Acuity: The Intermediate Acuity Chart

**The client omits numbers on one side.** Clients with left homonymous hemianopsia or hemi-inattention may make errors such as starting to read in the middle of the line rather than on the left side. Clients with right homonymous hemianopsia may not finish reading a line of print. When errors such as these are observed, the omitted numbers should be pointed out to the client and the client asked to identify them. If a VFD is found during perimetry testing, the client may require intervention to learn to compensate for the VFD when reading (see Section 6.3.2).

**The client misreads numbers with similar configurations.** Generally, errors in misreading similar numbers such as a "8" for an "3", an "6" for a "5", indicate reduced acuity rather than deficits in than cognition, perception or language. The client may require additional magnification to read.

**The client has more difficulty identifying larger numbers than smaller numbers.** This may indicate that the client has a significant VFD with only a small “island” of visual field remaining as may occur following central retinal artery occlusion or optic nerve injury. For clients with macular degeneration, it can indicate the presence of a ring scotoma where the client has a small island of intact retina surrounded by a donut shaped macular scotoma. Specialized low vision reading techniques will be needed to enable the client to read and referral should be made to a low vision reading specialist.

### 5.2.2 Reading Acuity: The Warren Text Card

**The client omits letters or words on one side.** Clients with left or right homonymous hemianopsia and those with macular scotomas may make errors where they omit the beginnings or endings of words or transform words (change the word into a similar word) because they do not see the entire word when viewed. They may also omit words at the beginning or end of sentences. Clients with hemi-inattention also may make similar errors on the left side of words or sentences and may start reading a sentence in the middle. Generally these errors are more frequent on larger text and less frequent as the text diminishes in size. If a VFD is found during perimetry testing, the client may require intervention to learn to compensate for the VFD when reading (see Section 6.3.2).

**The client has difficulty reading words in larger print sizes and less difficulty as the words decrease in size.** This may indicate the presence of a central VFD where only a small “island” of visual field remains as may occur following central retinal artery occlusion or optic nerve injury. For clients with macular degeneration, it can indicate the presence of a ring scotoma where fixation is surrounded on three to four sides by
dense scotoma. Specialized low vision reading techniques will be needed to enable the client to read and referral should be made to a low vision reading specialist.

**The client complains of inability to focus or see print clearly within the bifocal.** This may indicate that the bifocal is not strong enough. However, for clients with hemianopsias or visual field restrictions, it also may indicate that the bifocal is not wide enough to allow the client to maneuver around the field cut and still stay within the focusing area of the bifocal. Referral should be made to an optometrist or ophthalmologist to evaluate the need for a change in the bifocal.

5.3 **EYE DOMINANCE**

**The client uses the right eye to view the flower through the hole in the card.** This indicates that the client's right eye is the dominant eye.

**The client uses the left eye to view the flower through the hole in the card.** This indicates that the client's left eye is the dominant eye.

*Note: Eye Dominance is an important factor in applying occlusion to eliminate the diplopia associated with oculomotor dysfunction. See Section 6.4.2.1.2 for additional information.*

5.4 **CONTRAST SENSITIVITY FUNCTION**

5.4.1 **LeaNumbers Low Contrast Screener**

Dr. Lea Hyvarinen, the designer of the LeaNumbers screener, does not believe that there is any value in using classifications such as mild, moderate, severe, and profound impairment to describe CSF. Therefore, she has not assigned such values to the scores obtained on her tests. She recommends instead that therapists think in terms how a decrease in high or low contrast information will impair the client's performance in various activities. Because of Dr. Hyvarinen's bias, interpretation of the client's performance on the LeaScreener is subjective and based on the client's overall visual function and performance of daily living activities.

It is unlikely that a client will demonstrate a decrease in CSF in isolation. Because CSF represents just one aspect of a client's visual function, Dr. Hyvarinen suggests that the therapist carefully assess the client's functional performance, as measured by the clinical observations, and combine that information with the results from the intermediate and reading acuity tests, visual field testing, the LeaScreener CSF test and a color vision test (if needed) to develop an overall picture of the client's visual performance. The impression gained from this analysis will assist the therapist to determine the modifications (in lighting, magnification and contrast) to improve the client's functional performance. If a significant reduction in contrast sensitivity function is observed, referral should be made for an eye exam to determine the reason for the reduction and to determine if, and how, vision can be enhanced.
5.4.1.1 Interpreting the Client’s Accuracy in Identifying the Numbers on the Chart MAKE

A person with normal contrast sensitivity function should be able to identify 25 symbols at 40cm, 20-25 symbols at 1 meter and 15 symbols at 3 meters. Dr. Hyvarinen offers the following examples of test performance as a guide to determining the functional limitations of the client.63

**The client does not see any of the numbers.** Contrast sensitivity function is extremely limited and enhancement of contrast is needed for the client to function. The client may require assistance to ambulate safely in environments. Ability to resume driving is highly questionable and should be carefully evaluated.

**The client recognizes numbers only at the 25% level.** Enhancement of contrast is needed for the client to function safely and independently. The client may require assistance to ambulate safely in environments. Driving performance should be carefully evaluated especially with regards to night driving and driving in cloudy conditions.

**The client recognizes numbers to the 10% level.** The client likely will have difficulty detecting subtle changes in the support surface, reading materials printed in low contrast formats, seeing black and white photographs, facial features, water, and other low contrast materials. Magnification and increased illumination may assist the client to recognize low contrast features. Driving performance should be carefully evaluated especially with regards to night driving and driving in cloudy conditions.

**The client recognizes numbers to the 5-2.5% level.** The client likely will have difficulty seeing facial expressions and recognizing friends across the street. He or she may have difficulty detecting curbs and other low contrast drops off. Increased illumination may assist the client to recognize low contrast features and modification of the environment to increase the contrast of important environmental features is recommended.

5.5 VISUAL FIELD

5.5.1 Confrontation Testing: Red Dot and Two Person Kinetic Tests

**The client consistently misses targets presented in the lower area of the visual field with both eyes.** This indicates the presence of a homonymous visual field deficit in the inferior field. If it appears to affect only the right or left inferior visual field then it is characterized as a quadrantanopsia. If it affects both the left and right halves of the inferior field, it is characterized as an altitudinal defect. Presence of a lower VFD affects the client’s ability to monitor the support surface during ambulation and may cause significant limitations in mobility (see Section 2.3.4).

**The client consistently misses targets presented in the upper area of the visual field with both eyes.** This indicates the presence of a homonymous visual field deficit in the superior field. If it appears to affect only the right or left superior visual field then it is characterized as a quadrantanopsia. If it affects both the left and right halves of the superior field, it is characterized as an altitudinal defect. Presence of a superior VFD may affect the client’s ability to orient to the environment causing difficulty moving about independently without getting lost. Driving performance should be carefully evaluated.

**The client consistently misses targets presented in the left or right half of the visual field with both eyes.** This indicates the presence of a homonymous hemianopsia. The presence of a hemianopsia can create a variety of functional limitations which will require treatment intervention (see Section 2.3.4).
The client appreciates the targets presented on the red dot test but fails to appreciate the penlight on the kinetic test until it is almost directly in front of the shoulder on the left side. This suggests that only the peripheral visual field is impaired on the left side and the client has central visual field function. The deficit could be characterized as a left homonymous hemianopsia with macular sparing or as a left homonymous peripheral VFD. Deficits confined to the peripheral visual field usually do not affect reading and performance of near vision tasks, but can create significant problems in mobility (see Section 2.3.4).

The client appreciates the targets presented on the red dot test but fails to appreciate the penlight on the kinetic test until it is almost directly in front of the shoulder on the right side. The interpretation is the same as above except that the right peripheral visual field is affected instead of the left.

The client misses some of the targets in one area of the visual field. If a few targets are missed in the left half of the visual space, it may indicate the presence of hemi-inattention. It also may indicate the presence of a relative VFD also known as a depression in the visual field where the retina has diminished sensitivity but has not lost function completely. It also may indicate the presence of a partial deficit in that area of the field. Inconsistent performance in locating targets on the affected side may be observed in functional activities. When a relative VFD is present, additional illumination and contrast often improves the client’s performance.

The client misses targets in random areas of the visual field. This often indicates the presence of a global reduction in visual attention. However, with severe brain injuries, it may indicate the presence of a “Swiss cheese” VFD, where the client retains “spotty islands” of vision which are scattered throughout the blind field. Often a client with this type of deficit is misdiagnosed as cortically blind. If this type of deficit is suspected, the client should be referred for more sophisticated visual field testing such as that provided by the SLO (see Section 4.3).

The client misses targets only with one eye. This indicates that the field deficit is only in one eye and suggests a lesion of the optic tract anterior to the chiasm, or damage to the retina. Central retinal artery occlusion can cause this kind of deficit as can unilateral optic nerve injury. Most individuals do not experience significant functional limitations when only one visual field is affected.

The client only misses targets on the red dot test but not on the kinetic test. The retina is more sensitive to detection of a moving target than a static target which may permit a client with a relative VFD to perform better on a kinetic test. If a relative VFD is present, the client may demonstrate inconsistent performance on tasks and may benefit from increased illumination and contrast in the environment and on tasks.

The client sees both red dot targets but indicates that one dot appears faded in comparison to the other. Diminishment or washing out of color on one side indicates a reduction of field sensitivity and can indicate a relative VFD. The client may benefit from increased illumination and contrast in the environment and on tasks.

The peripheral visual field appears to be completely affected in both eyes. This deficit creates tunnel vision. It is a rare deficit but can occur with anoxic brain injuries, tumors and other neurological and retinal conditions. Depending on the size of the intact central visual field, the client will have minimal problems reading and seeing visual details but significant problems with mobility. Driving is not an option for a client with this deficit.

The superior visual field appears to affected in both quadrants. An altitudinal defect affecting the superior quadrants of both eyes is a frequent corollary of traumatic brain injury. Depending on the depth of the deficit, the client may experience difficulty with orientation because he or she does not see overhead signage. Driving performance should be very carefully evaluated.
The client repeatedly breaks fixation and continually has to be redirected back to the test procedure. This indicates that the client has a poor attention span and the results of the test may not be accurate. The therapist may need to rely more on clinical observations to determine if a VFD is present.

The client does not see the red dot target but does see the handle of the target and/or the client perceives the dot to be black in color rather red. This may indicate that the target has been held too close to the client and the client’s nose is occluding part of the target.

5.5.2 Damato 30 Point Multifixation Campimeter

Interpretation of the test results is fairly straightforward. The form is turned so that the phrase “this way up to interpret results” is at the bottom of the page. The area on the form containing the black dots indicates the area of the field deficit. This area can be shaded in if desired to provide a clearer picture of the size and boundaries of the deficit. A nose also can be drawn between the two circles to facilitate interpretation for the client and family.

The client and family should be shown the field diagram and the area of the deficit. It is very important that the client and family understand the size and location of the deficit and whether it is in both eyes. This is a good time to educate the client and family regarding the nature of VFD following brain injury and to emphasize that the lesion occurs in the hemisphere on the opposite side of the field deficit, that it is in both eyes, and that it is not a problem with the eye but rather a problem with the brain receiving the image from the eye. Likening the geniculocalcarine tracts to a super highway which has a bridge missing may help to facilitate understanding.

The deficit encompasses the entire half of the visual field on one side in both eyes splitting right down the vertical meridian. This is a classic hemianopsia with macular field involvement and is the most severe form of hemianopsia. The fact that the border of the central scotoma is right next to fixation usually indicates that the client will experience difficulty reading and may miss small visual details. Functional mobility is likely to be affected because of the restriction in the more peripheral visual field (see Section 4.3.2).

The deficit is confined to a superior quadrant (quadrantanopsia). This type of deficit usually causes the least amount of functional deficits and is the most easily compensated for by the client. If the deficit extends into the macular area, the client may experience some difficulty reading, and driving performance should be carefully evaluated.

The deficit is confined to an inferior quadrant. Any compromise of the lower visual field affects mobility as the client is unable to accurately monitor changes in the support surface and obstacles in the affected field. The client also may experience difficulty reading if the deficit extends into the macular area (see Section 4.3.2).

The deficit skirts around the very center of the field leaving a circle of intact vision around the fovea. This is known as macular sparing and it occurs in about 30% of all hemianopsias.\textsuperscript{6} The client should experience few, if any, problems with reading and seeing visual detail but may have mobility deficits. A deficit of this nature often poses great risk to the client’s safety because the client has more difficulty developing an awareness of the existence of the field deficit because the central field is unimpaired.

The peripheral visual field is completely affected in both eyes. This deficit creates tunnel vision. It is a rare deficit but can occur with anoxic brain injuries, tumors and other neurological and retinal conditions. Depending on the size of the intact central visual field, the client will have minimal problems reading and seeing visual details but significant problems with mobility. Driving is not an option for a client with this deficit.
The superior visual field is affected in both quadrants. An altitudinal defect affecting the superior quadrants of both eyes is a frequent corollary of traumatic brain injury. Depending on the depth of the deficit, the client may experience difficulty with orientation because he or she does not see overhead signage. Driving performance should be very carefully evaluated.

The deficit is observed only in one eye. This indicates that the lesion site is anterior to the optic chiasm and can have a variety of causes including central retinal artery occlusion (a stroke of the eye), optic nerve injury, or retinal detachment. If only a portion of the visual field is affected, the client should experience few functional limitations. If the entire visual field has been affected, the client is monocular and may experience difficulty with mobility due to the reduced peripheral visual field on the involved side and the reduction in depth perception. If the involved eye also is the dominant eye, the client may experience fatigue and stress when attempting to complete near vision tasks especially reading.

The deficit affects all four quadrants. Some brain injuries can cause involvement of the entire visual field usually producing a “Swiss cheese” type deficit with pockets of intact visual field. The client with this kind of deficit will have significant functional limitations in all activities of daily living from reading to mobility.

The deficit is on the side of the client’s dominant hand. The client may experience reduced eye hand coordination and have difficulty writing legibly, pouring, cutting and completing other eye/hand tasks (see Section 4.3.2).

5.6 Oculomotor Function

Much of the interpretation of client performance on this assessment is used to justify referral to an ophthalmologist or optometrist for further evaluation and diagnosis.

5.6.1 Visual History

The responses made by the client can reveal much information regarding the type and severity of oculomotor dysfunction. This information can be used to direct the rest of the assessment and to determine which tests need to be given.

The client reports a history of congenital strabismus, lazy eye or amblyopia. Deficiencies in oculomotor function may be observed which are long standing and were not caused by the client’s brain injury. Generally, these oculomotor deficiencies do not interfere significantly with function as the client has adapted to them. If the client has a longstanding oculomotor impairment, he or she will be more likely to perceptually suppress visual information from the strabismic eye if ocular misalignment occurs. A client, who suppresses visual input from one eye, may not complain of diplopia even when a tropia is present.

The client reports sustaining trauma to the eye or orbit. Damage to the eye or orbit may cause several deficits. Impingement or entrapment of extraocular muscles can occur which may reduce ocular motility and cause the client to experience pain with eye movement. Acuity may be reduced in the eye as a result of retinal detachment or other injury. A significant reduction in acuity may cause dyscoordinate eye movement. The client should have had an ophthalmology exam following the injury and if so, the results of that exam should be obtained if possible. If the client has not had an exam and subsequent deficits are observed on the assessment, the client should be referred to an ophthalmologist for an exam to rule out any damage to the eye (see Appendix D).

The diplopia disappears when one eye is closed. This suggests that the diplopia is due to a muscular
imbalance such as may result from paralytic strabismus.

The diplopia does not disappear when one eye is closed. This suggests that the diplopia is due to damage to the anterior structures of the eye or the retina and a referral to an ophthalmologist for further evaluation is recommended.

The diplopia is characterized by objects splitting side to side (horizontally). This may suggest either 3rd or 6th cranial nerve involvement.

The diplopia is characterized by objects splitting one on top of the other (vertically). This may suggest 4th cranial nerve involvement.

The diplopia is present only in near vision. This may suggest either 3rd or 4th cranial nerve involvement.

The diplopia is present only in distant vision. This may suggest 6th cranial nerve involvement.

The diplopia is present only with gaze in one direction. This may suggest that the diplopia is due to muscle paresis.

The diplopia is constantly present. This may suggest the presence of a tropia.

The diplopia comes and goes throughout the day. This may suggest the presence of a phoria.

The client has an area where he or she is able to obtain fusion and perceive one image. This indicates that some binocular capability is present. If the client’s injury is recent (less than 6 months) it may suggest that the muscle paresis may be resolving.

The client reports difficulty achieving focus in near vision for tasks requiring a sustained focus in near vision. This suggests possible difficulty with one of the components of accommodation, or the presence of convergence insufficiency, or the presence of muscular weakness as a result of 3rd or 4th cranial nerve involvement.

The client performs activities without difficulty at one focal length but has difficulty at another focal length. This suggests either difficulty with accommodation, if the client is experiencing problems with near distance, or a muscle imbalance due to paralytic strabismus. Involvement of the cranial nerves is suspected.

The client experiences past pointing or reaching. This suggests that the strabismic eye is the dominant eye.

The client experiences nausea and blurring of vision with head movement. This suggests the presence of oscillopsia and visuo-vestibular dysfunction.

5.6.2 General Appearance

Presence of a dilated pupil with a lowered eye lid (ptosis). Both of these signs are characteristics of a 3rd cranial nerve palsy. Fixed dilation of the pupil will interfere with the process of accommodation and cause the client to experience blurring vision when focusing on tasks in near space. The presence of ptosis reduces the available superior visual field but also may occlude enough vision to prevent diplopia.

Noticeable deviation in the position of one eye with complaint of diplopia. This indicates a tropia and paralytic strabismus.
Noticeable deviation of the eye without complaint of strabismus. This may indicate severely reduced acuity in the eye such that fixation of the eye is prevented and the eye wanders. It also may indicate the presence of a strabismus to which the client has adapted by perceptually suppressing the vision from one eye. Although it is possible for adults to use suppression, especially if the strabismus is congenital or long standing, most adults are unable to suppress visual information and must use a head position to eliminate the diplopia. An acuity test should be completed to determine if the client has sufficient acuity to see and fixate a target.

The client assumes a deviated head position to view the target. This suggests the presence of paralytic strabismus and diplopia due to a tropia. A “chin down” position suggests bilateral 4th cranial nerve involvement; the head turned toward the left or right suggests the presence of a 6th cranial nerve lesion; head tilt towards a shoulder suggests the presence of a unilateral 4th cranial nerve lesion. Use of a deviated head position will eliminate diplopia but may interfere with the client’s postural adaptation and mobility.

Nystagmus (quivering of the eyes) is observed. This may indicate cerebellar and/or brainstem involvement. If the nystagmus is present in primary gaze, the client may experience degradation of visual images and state that objects appear blurry.

5.6.3 Corneal Reflection

The position of the corneal reflections on the eyes indicates whether the eyes are in alignment when focusing on an object. The reflections should appear in identical corresponding areas in each eye. Asymmetry in the position of the reflections between the two eyes may indicate the presence of a tropia and paralytic strabismus. (Note: some persons, because of irregularity in the cornea, will have unequal corneal reflections despite normal ocular alignment; therefore, unequal corneal reflections are not significant unless there are other indications of misalignment such as complaint of diplopia or deviations in eye movement).

The light reflection is positioned on the outer (lateral) rim of the iris in one eye. This indicates esotropia and possible 6th cranial nerve lesion.

The light reflection is positioned on the inner (medial) rim of the iris in one eye. This indicates exotropia and possible 3rd cranial nerve lesion.

The light reflection is positioned on the upper rim of the iris in one eye. This indicates hypotropia.

The light reflection is positioned on the lower rim of the iris in one eye. This indicates hypertropia and a possible 4th cranial nerve lesion.

If the corneal reflections show an obvious misalignment of the eyes but the client denies diplopia, the client may have a history of congenital or long standing strabismus with sensory suppression of the deviant eye or may have very poor acuity in one eye.

5.6.4 Eye Movements

5.6.4.1 Binocular Smooth Pursuit Eye Movements

Unequal corneal reflections are observed as the eyes move. This indicates restricted movement of one
eye in one direction of gaze and suggests paresis or paralysis of the muscle initiating that movement. In cases of orbital blow out fracture, restriction of movement may be due to impingement of the muscle.

**Unequal ratio or proportion of sclera to iris is observed as the eyes move.** As the eye moves towards the end of it's range in a direction of gaze (example looking towards the left) the proportion of sclera (white of the eye) to iris should be about 2:1 (two thirds sclera visible to one third iris) and the proportion should be equal in both eyes. A noticeable deviation from this ratio in either eye suggests a restriction in eye movement which could be due to paralysis or entrapment of muscle. The deviation in proportion may be due to paralysis of the prime mover in the direction of gaze, preventing the affected eye from moving as far as it should. It also may indicate a secondary deviation where the non-affected eye over reacts and moves too far as the affected eye attempts to move in the direction of its paralyzed muscle. In cases of secondary deviation, the non-affected eye may appear as though it is the eye with the muscle paresis. The client will experience diplopia when the eye is moved in the direction where the unequal proportion is observed. Observation of this disproportion should be correlated with complaints made by the client with regards to the presence of diplopia and functional limitations.

**Gaze evoked nystagmus is observed.** This is observed as a quivering of the eye when it moves into an eccentric (off centered) position and indicates that the client is having difficulty maintaining this position probably because of mild residual muscle palsy. The presence of this symptom during abduction of the eye in conjunction with an inability to adduct the other eye may indicate an intranuclear ophthalmoplegia (INO) due to a midbrain lesion. The symptom is used for diagnosis and does not have a significant effect on function.

**Jerking movements of the eyes as they track an object.** This is an indication that the target has temporarily slipped off of the fovea and a saccade has been initiated to catch up and re-establish focus (the jerk is the saccadic eye movement). Some jerking of eye movements is normal, especially in children and older adults, and does not significantly impair focusing of the image. Continuous jerking as the eye tracks an object disrupts the focusing of the image and may cause images to blur as they move. The ability of the CNS to obtain fast and precise visual information regarding moving targets will be decreased by excessive eye jerking (often observed with cerebellar involvement).

### 5.6.4.2 Convergence

The primary observation is an inability or difficulty converging the eyes as the target moves inward. Because convergence is part of the accommodation process, inability to converge the eyes disrupts clear focusing of images at near distances. For adults, most objects (including printed materials) are held at a distance of 13-16 inches from the face when viewed. This distance provides the best and most comfortable focus and allows a sustained period of viewing. Although the near point of convergence is 2-3 inches from the bridge of the nose, few adults ever view objects that closely. Being able to converge to this distance provides convergence reserve and enables the person to maintain convergence for several minutes. An inability to converge the eyes to this distance and maintain convergence for several seconds while focusing on an object may cause the client to have difficulty performing tasks in near vision, especially those which require a sustained focus such as reading. Observation of convergence insufficiency on testing should be correlated with complaints made by the client regarding such tasks as reading, writing, quilting or sewing. If screening indicates convergence insufficiency, the client should be referred to an ophthalmologist or optometrist for further evaluation and diagnosis.

### 5.6.5 Diplopia Testing

The presence of diplopia may create significant functional limitations in daily living activities ranging from reading to driving (see Section 2.4.4). Because diplopia may occur secondary to either a tropia or a phoria testing is completed to differentiate between the two conditions. If testing indicates the presence of either condition, the client should be referred to an ophthalmologist or optometrist for further evaluation and diagnosis.
5.6.5.1 Cover/Uncover Test

Movement of the uncovered eye towards the target when the other eye is covered indicates the presence of a tropia. Clients with tropias generally complain of constant diplopia when viewing objects and need to have one eye occluded to eliminate the diplopia so that functional activities can be completed (see Section 6.4.2.1).

**The uncovered eye moves inward to fixate on the target.** This indicates an exotropia and possible 3rd cranial nerve involvement. The client may have difficulty achieving convergence and experience blurring or double vision when completing near vision tasks.

**The uncovered eye moves outward to fixate on the target.** This indicates an esotropia and possible 6th cranial nerve involvement. The client may have difficulty achieving divergence and experience blurring or double vision when completing distance tasks such as monitoring the support surface during ambulation and driving.

**The uncovered eye moves downward to fixate on the target.** This indicates a hypertropia and possible 4th cranial nerve involvement. The client may experience blurring or double vision when reading or when monitoring the support surface when descending steps or curbs.

**The uncovered eye moves upward to fixate on the target.** This indicates a hypotropia. The client may experience blurring or double vision when viewing at a distance or, when switching viewing distance from near to far as when copying notes from a blackboard.

Movement of the eye on either of the tests indicates the need for a referral to an ophthalmologist or optometrist for further evaluation. To quantify the severity of the diplopia, the ophthalmologist or optometrist may repeat the cover/uncover test using prisms. Prisms of successive strengths are placed over the deviating eye and the test is repeated until no eye movement is observed when the other eye is covered. The dioptric strength of the prism is recorded to quantify the extent of the deviation.

5.6.5.2 Alternate Cover Test

Movement of the covered eye towards the target as the cover is removed and the other eye is covered indicates the presence of a phoria. Clients with phorias often complain of diplopia only intermittently, usually when fatigued or stressed by sustained viewing of a target. Although the client may complete most activities without diplopia, he or she may be experiencing significant visual stress which can manifest itself as headaches, eye strain, or decreased concentration. If a phoria is detected, the examiner should review any complaints the client has made regarding activities which require a sustained focus. As with tropias, the ophthalmologist or optometrist may use prisms to quantify the severity of the phoria.

**The eye that has been covered moves inward to fixate on the target when the other eye is covered.** This indicates exophoria and possible 3rd cranial nerve involvement. The client may experience blurring or double vision when reading especially after a period of sustained viewing.

**The eye that has been covered moves outward to fixate on the target when the other eye is covered.** This indicates esophoria and possible 6th cranial nerve involvement. The client may experience blurring or double vision when viewing at a distance especially after a period of sustained viewing.

**The eye that has been covered moves downward to fixate on the target when the other eye is covered.** This indicates hyperphoria and possible 4th cranial nerve involvement. The client may experience blurring or double vision when reading, especially after a period of sustained viewing or when looking downward to monitor the support surface.
The eye that has been covered moves upward to fixate on the target when the other eye is covered. This indicates hypophoria. The client may experience blurring or double vision when viewing at a distance or when switching viewing distance from near to far as when copying notes from a blackboard.

5.7 VISUAL ATTENTION

One of the ways that visual attention is measured is by the accuracy of a client's visual search for specific targets. It has been shown that adults with adequate visual attention skills are able to complete visual search tasks with high accuracy. However, it is also known that deficits in oculomotor function, visual field and visual acuity also can affect accuracy in visual search as can the presence of aphasia, medications, a noisy environment and a good night’s rest. Therefore, it is not possible to state unequivocally that reduced accuracy on a visual search task indicates visual inattention unless all other cognitive, physical, environmental and visual functions have been found to be intact. To determine whether inaccurate search performance is due to visual inattention rather than other factors, it is best to observe the search strategy used by the client to locate targets. Research has shown that subjects with normal visual attention approach a visual search task using varied strategies, but all effective search strategies have certain characteristics which result in an accurate performance. Research also has shown that persons with inattention demonstrate ineffective search strategies which result in errors. Therefore, it is possible to identify visual inattention by observing the effectiveness of the search strategy used by the client.

Interpretation of a client’s performance on the biVABA visual attention subtests is based on two factors: 1) observation of the search strategy used by the client to complete the subtest and 2) the accuracy of the client’s performance as measured by the percentage of correct responses on the subtest. A correlation should be observed between the two, in that use of effective search strategies should result in good accuracy and use of ineffective search strategies should result in reduced accuracy. If this correlation is not observed, the examiner should suspect that other factors may be influencing the client’s performance such as the presence of a VFD or fatigue, and evaluate accordingly.

5.7.1 Search Strategies: Near Space

Two types of strategies are described in this section, those that are effective in directing visual search reflecting good visual attention and those that are ineffective. It is necessary to understand the characteristics of successful strategies in order to identify ineffective strategies. Therefore, carefully read section 5.7.1.1 before moving onto Section 5.7.1.2 which provides interpretation of the client’s test performance.

5.7.1.1 Effective Search Strategies

The seven subtests for evaluating the scanning strategies used for near space were field tested on a sample of control subjects consisting of equal numbers of males and females between the ages of 16 and 83 (see Appendix G for an analysis of control subject performance on the subtests). Despite a variation in age, education and vocational background, the subjects in the field test all used a linear, symmetrical search strategy where the person sequentially progressed from target to target in an organized and predictable pattern. All of the subjects (100%) used a left to right, top to bottom, linear search sequence, with comparable attention and time given to scanning both sides of the subtest form. The linear pattern was horizontal or vertical.
depending on the structure of the visual array. For example, a horizontal linear pattern generally was used to search the structured arrays of the single letter, word, and complex circle search subtests whereas horizontal and vertical linear strategies were used to search the random plain circle and complex circle subtests. Regardless of the direction of the search pattern, the one consistent trait of the effective scanning strategies was that the search was carried out in a predictable and symmetrical fashion. In observing the person scanning, the examiner was able to predict where the person next would direct his or her attention. The other consistent trait shown by all control subjects was consistency in performance despite differing levels of difficulty. That is, the organization and accuracy of the subject's search pattern did not decrease as the difficulty of the visual array increased. In fact, a slightly greater accuracy was observed on the subtests with the more challenging visual array (the single letter search-crowded and random complex circles search). This increase in accuracy generally was attributed to the observation that subjects were more likely to slow down and recheck their work for accuracy on the more challenging arrays to make sure that they did not miss a target. All of the subjects rechecked at least some of their subtests for accuracy. However, rechecking did not occur as often on the subtests with simple arrays (32% of the subjects rechecked their work on the word search) but increased in frequency on the subtests with more complex arrays (75% of the subjects rechecked their work on the random complex circle search). Women and students (both men and women) were more likely to automatically check their work; men were less likely. Because persons with good attentional abilities generally rescan to check their accuracy, observation of the use of this strategy on the subtests indicates a strength in the client's attentional ability. Several of the control subjects also used their finger to keep their place and direct their search and those who did generally showed higher accuracy, therefore use of this strategy is considered normal and helpful.

The use of efficient search strategies resulted in completion of each subtest within an average time range of 23 seconds (on the random plain circles-simple) to 112 seconds (on the single letter search-crowded). The longest time taken to complete a subtest was 3.5 minutes on the letter searches. See Appendix G for average time and time ranges for individual subtests.

On the test form the preferred search strategies for each subtest have been placed in italics. For the structured visual arrays (single letter search-simple and crowded, word search and structured complex circle search) 96% of the subjects used either a symmetrical horizontal left to right or a symmetrical horizontal rectilinear pattern; the other 4% used a vertical left to right strategy. The majority of the subjects used the same strategy to search the unstructured visual arrays (random plain circles-simple and complex and random complex circle search); 80% used either a horizontal left to right or horizontal rectilinear pattern and 20% used vertical left to right strategies. These preferred search patterns are illustrated in Figure 5.1.

![Search Strategies Diagram](image)

**FIGURE 5.1:** The Most Frequently Used Search Strategies on the Visual Attention Subtests.

The search strategies used by the control subjects generally resulted in accurate performances. Average percentages of accuracy on the subtests ranged between 97% and 100%; only one subject on one subtest scored below 90% accuracy scoring 85% on the single letter search-crowded subtest. The average percentage of accuracy for each subtest is given in Appendix G.

When evaluating clients with VFD, especially hemianopsia, remember that persons with visual field deficits often need to reorganize their search pattern to compensate for the vision loss. When given unstructured visual arrays (random circles or shapes), the client often chooses a vertical linear search pattern beginning on the “seeing” side of the visual field and progressing towards the “blind” side of the field. This enables the
client to control and organize the amount of visual information taken in. When given tests with structured visual arrays (letter cancellation), a left to right scanning strategy is usually observed. The client also may use the index finger to help maintain place on line; this is considered to be an effective strategy for the client with VFD although it may reduce search speed.

### 5.7.1.2 Ineffective Search Strategies

Persons with visual inattention or significant VFD often employ ineffective search strategies and demonstrate incomplete or abbreviated patterns where only a portion of the visual array is searched. However they differ in the organization and accuracy of the search pattern. Persons with VFD search the restricted space using a structured, predictable pattern, whereas persons with hemi-inattention employ random and unpredictable search strategies. On the biVABA search subtests this results in reduced accuracy and increased time for completion. Subjects with brain injury who were field tested on the biVABA subtests showed accuracy as low as 25% on individual subtests and took as long as 9.5 minutes to complete a subtest. A client using ineffective search strategies may not acquire sufficient visual information for perceptual processing or acquire the information in such a haphazard way that it cannot be used to complete perceptual processing. The subsequent disruption of perceptual processing may cause errors in decision making which, in turn, may adversely affect the performance of a variety of daily occupations (see Section 2.5.4).

**The client demonstrates an abbreviated search pattern.** Clients with VFD demonstrate an organized and predictable, but abbreviated search pattern towards the side of the vision loss. On structured arrays (letter search), the pattern will be a left to right pattern; on unstructured arrays (random circle search), it may be a right to left pattern if the VFD is on the left side. The pattern is abbreviated because the subject does not see the border of the paper or the visual array on the blind side, and is unaware that he or she has not scanned far enough to find all of the targets on that side. Usually, if given a verbal cue that there are targets remaining on the blind side, the client will initiate a head turn to search that side again and locate the remaining targets. If, when given this cue, the client fails to search that side, it is an indication that the client has visual inattention in addition to the VFD. Use of a random, unpredictable search pattern in addition to an abbreviated pattern also is an indication of visual inattention. Regardless of cause, use of an abbreviated search pattern causes the client to miss some of the visual information needed for accurate reading, orientation and decision making.

**The client demonstrates an asymmetrical search pattern.** This is a search pattern initiated on and confined to the right side of the visual array. It is a strong indication of the presence of hemi-inattention, especially when observed on tasks with structured visual arrays using words or letters as the target. Instead of using the reading pattern and initiating visual search on the left side of the array and moving towards the right, the client initiates the pattern from the right side and stays on the right side, generally not searching past the midline of the page. For example, on the word search subtest, the client begins scanning for the words from the right side of the page and searches just to midline instead of beginning on the left side of the page and searching across the entire page. The pattern results in the loss of a significant amount of visual information and provides the client with an incomplete perception of the visual array, often disrupting reading and decreasing the accuracy of decision making and orientation.

**The client demonstrates a random search pattern.** Observation of a random, unpredictable search pattern is the strongest indicator of the presence of visual inattention and creates the most disruption in the search pattern. Clients who display random search patterns generally have very limited ability to complete visual processing and will demonstrate significant perceptual deficits. The old adage of “garbage in; garbage out” applies in this case. Without organization to the search pattern, the incoming visual information does not make sense. It would be as though one tried to comprehend a novel by reading one sentence on page 34, another on page 67, and another on page 23. If the random search pattern occurs in conjunction with an abbreviated scanning pattern and/or an asymmetrical scanning pattern, it may indicate the presence of VFD.
and/or hemi-inattention. The severe disruption of information processing often will result in difficulty locating and analyzing visual information and cause significant limitations in daily living tasks.

The client completes all subtests very quickly with multiple errors. This performance indicates that the client has reduced ability to concentrate. It also confirms the presence of visual inattention especially if the client also demonstrates a random search pattern. It is highly likely that the client will have difficulty staying on task and completing activities which require sustained attention.

The client completes the subtest very slowly with multiple errors. Clients with significant visual impairment (acuity, visual field, oculomotor) or language deficits may take several minutes to complete each subtest and also make numerous errors. However, the fact that they are able to maintain concentration on a difficult task over an extended period of time suggests that their attentional skills generally are adequate and their difficulties are more visual than attentional. As the visual or language impairment is remediated, the client’s performance on visual search tasks should spontaneously improve.

The client is able to accurately complete the structured search subtests but makes numerous mis - takes on the unstructured search subtests. This is an indication that the client has limited attentional capability that breaks down as the demands on visual search increase. It is important to compare the client’s performance in a cluttered environment, such as a grocery store, to that in a less cluttered environment such as a bedroom; and, on tasks with relatively simple, uncluttered arrays (grooming) versus tasks with more cluttered, complex visual arrays (meal preparation). Simplification and structuring of tasks may be needed to facilitate independent performance.

The client’s performance improves in response to cuing. This is an important observation because it suggests that the client will benefit from intervention. It is important to determine the type of cuing that works best with the client so that it can be incorporated into treatment.

The client crosses out letters/shapes similar to the target. This indicates that the client may be unable to retain the target’s salient features in short term memory and so becomes confused and crosses out the wrong target. If combined with a very quick performance, it may indicate that the client is unable to sustain fixation long enough to identify all of the salient features of the target. Both of these behaviors are associated with injury to the prefrontal lobes. In clients with identified deficits in acuity or visual field it may indicate that the client does not see the targets clearly or completely. The client may have difficulty with activities that require processing of dense visual detail such as reading a bill or locating an item on a shelf in a grocery store.

The client skips lines on the structured search tests. Clients with left VFD often have difficulty finding the next line of print because of difficulty executing an accurate long saccade toward the blind field. This may cause the client to inadvertently skip lines of print. A client with hemi-inattention also may skip lines and lose his or her place on line. Either condition may result in difficulty maintaining one’s place when reading a page of print or a computer screen.

The client skips over and does not cross out targets. If the targets are omitted only on one side, this observation suggests the presence of either a VFD or hemi-inattention or a combination of the two conditions. If targets are randomly omitted throughout the test form and the client has difficulty executing an organized and efficient search pattern, it is an indication of decreased selective attention, especially if the client has sustained a left hemisphere lesion. A few clients with severe VFD also will randomly omit targets throughout the test form but their search pattern generally is organized.

The client initiates a structured and organized search pattern at the start of the subtest but the pattern becomes disorganized and random as the test progresses. This suggests that the client has the capability to employ visual attention but is unable to sustain attention over an extended period of time. The client may be unable to accurately complete activities which require sustained attention and may benefit from breaking tasks down into shorter segments.

The client’s overall performance declines as the test progresses. Whereas field testing of the attention subtests showed that normal subjects maintain a consistent level of performance throughout the evaluation
session and often improve in accuracy with repetition, clients with limited capacity to sustain attention may begin to show increasing difficulty engaging and maintaining attention as the length of the testing session increases. A decrease in performance as the testing session progresses may indicate a reduction in vigilance and the ability to sustain attention, especially if other behaviors are observed such as increased irrelevant conversation, looking around, yawning etc.

The client double-numbers the circles on the simple and crowded plain circle subtests and/or does not sequence the numbers correctly or repeats or perseverates on certain numbers. All of these behaviors suggest that the client has difficulty using short term memory to direct sequencing which is suggestive of a language or cognitive deficit.

The client combines visual search strategies or switches from one strategy to another during completion of the subtest. Field testing shows that subjects with effective visual scanning sometimes will combine or switch strategies if they feel that their initial strategy is too slow or inaccurate. As long as the client completes the subtest with acceptable accuracy, combining or switching strategies is considered effective.

The client uses a vertical search strategy on the letter search and word tasks. While most persons will, out of learning and habit, initiate a left to right horizontal linear search pattern on visual arrays involving letters, numbers or words, field testing showed that a few “maverick” thinkers will use a vertical strategy. As long as the client completes the subtest with acceptable accuracy, use of a vertical strategy is considered effective.

The client initially misses a target but then immediately goes back and crosses it out. This behavior was frequently observed in the control subjects on the field test and is not considered to be significant.

The client is unable to cross out the target accurately and places the mark to one side of the target. This is not an indication of reduced visual attention but may indicate reduced eye hand coordination secondary to diplopia or other oculomotor dysfunction (see Section 5.6.1), or the presence of central VFD (see Section 2.3.4).

The client completes the subtest accurately using good strategies but very slowly, taking several minutes to complete each subtest. This indicates slowness in visual processing which could be due to a generalized reduction in processing speed, the presence of a language deficit such as aphasia, or reduced acuity. However, the fact that the client used good search strategies and was able to sustain attention indicates a strength in visual processing ability.

5.7.2 Attention to Visual Detail

Note: All of the control subjects in the field testing of these two subtests completed both subtests with 100% accuracy.

5.7.2.1 Telephone Number Copy

Inability to accurately copy down a sequence of numbers may have significant impact on the client’s ability to independently manage finances and complete written communications.

The client copies a number incorrectly but immediately corrects the error. This is not considered significant as persons with good visual attention sometimes write down wrong numbers or transpose numbers but immediately realize and correct their mistake.

The client omits one digit in the number sequence. This is most suggestive of the presence of a VFD. Persons with VFD sometimes leave out a digit when copying a sequence of numbers and do not detect the
error until they recheck their work.

**The client misidentifies a number and writes down a similar but incorrect number.** This may indicate the presence of a VFD. Persons with VFD frequently write down a number similar to the one they are looking at because they do not see all of the number. For example a client with a left VFD may see a 3 or 9 when viewing an 8 and a client with a right VFD may see a 6 when viewing an 8. The numbers most often misidentified are 3, 6, 5, 8, 9, and 4.

**The client omits the first digit(s) in the sequence.** This may indicate the presence of a left VFD or hemi-inattention or a combination of these two conditions. If the error is due to VFD only, the client usually will locate the error when rechecking his or her work and correct it. If hemi-inattention is present, the client may not locate the error on the recheck without cuing.

**The client makes 4 or more errors (omissions or misidentifications) on the test.** This is an indication of the presence of visual inattention or a combination of VFD and inattention. Clients with inattention or with a combination of inattention and VFD often make four or more errors in copying down the numbers. The greater the number of errors, the more likely it is that the client has both inattention and VFD. The client generally does not correct all of the errors when rechecking his or her work.

**The client makes 1-3 errors (omissions or misidentifications) on the test.** Clients with significant VFD may make up to three mistakes on this subtest. The client should be able to locate and correct the errors when rechecking his or her work.

**The client is unable to stay on line when writing down the numbers.** This may indicate the presence of a VFD. Clients with VFD have a tendency to drift on line if the VFD is on the same side as the dominant hand. Clients with central scotomas secondary to eye diseases such as macular degeneration may also drift on line.

**The client doesn’t find his or her errors when rechecking performance.** This may indicate visual inattention. A client with inattention often is unable to locate errors when attempting to recheck work.

**5.7.2.2 Design Copy**

Because of the simplicity of the drawings, the client should be able to reproduce a recognizable and complete drawing even using the non-dominant hand. Clients with motor planning deficits or significant aphasia may be the exception to this observation. The significance of the drawings in identifying deficiencies in visual attention is not in the quality of the drawing, but in whether all of the details of each figure are reproduced in the drawing. Clients with inattention often leave out multiple visual details from their drawings. In contrast, control subjects on the field test never left out a detail and those with VFD made no more than two errors. Field testing with the instrument, showed variation in the order in which the control subjects chose to draw the design. For example, some began the flower with the pedals; others with the stem. However, all of the control subjects drew sequentially, copying down one section of the design before moving onto another section. For example, a subject would draw in the walls of the house, the door and the windows before moving onto the roof and chimney; another would draw in the roof, chimney and smoke before drawing the walls, windows and doors. The significance of design copy to functional daily performance is that it helps to uncover deficiencies in the organization and accuracy of the client's visual search which may in turn affect orientation and decision making.

*Note: examples of various types of drawing errors on the test are illustrated in Appendix F.*

**1-2 details are missing from the drawing.** This generally is not considered to be a significant observation. Persons with VFD sometimes leave out a detail because they did not see it.
More than 2 details are missing from the drawing. This indicates the presence of inattention. If all of the details are left out on the left side of the figure (example: the numbers on the left side of the clock) it suggests the presence of hemi-inattention. If details are left out on both sides of the figure, (example: pedals from both sides of the flower) it suggests inattention associated with frontal lesions.

The drawing is noticeably elongated or diminished on one side. Clients with hemi-inattention sometimes elongate features on the right side of the figure and diminish the features of drawings on the left side of the figure (see examples in Appendix F).

The client completes a half drawing. Drawing only the right half of the figure (right side of the clock or house or flower) usually is only completed by a client who has both hemi-inattention and VFD and helps confirm the presence of the combination of these deficits.

The client perseverates in drawing over certain features of the figure. When this behavior occurs in conjunction with omission of features on the left side of the figure, it confirms the presence of hemi-inattention. If it occurs without regard to side, it may indicate a motor planning deficit where the client does not know how to physically proceed. If it occurs on a completed drawing, it may indicate that the client does not know or does not remember what to do when the drawing is completed.

The client embellishes the drawing with additional details. If the client adds details to the right side of the drawing while ignoring details on the left side of the figure, it confirms the presence of hemi-inattention. If the client produces a complete drawing but then adds details, it may suggest poor impulse control or a creative streak, or visual inattention.

5.7.3 Search Strategies: Extrapersonal Space

These subtests do not require as precise focal processing and selective visual attention from the client as the subtests addressing near space. However they do demand that the client orient to a larger area of space and to combine visual search with movement, which may challenge a client beyond his or her capability. Difficulty executing an organized and accurate search of extrapersonal space will have a direct impact on the ability to orient and safely move through space. Clients with deficits in this area will have difficulty completing community activities such as shopping and driving. ADD REF

5.7.3.1 ScanBoard

5.7.3.1.1 Effective Search Strategies

Figure 5.2 illustrates the most common search strategies used by persons with good visual attention to complete this subtest (see Section 4.5.4.1). Clients with good visual attention may present variations on these patterns but their search patterns should contain the following elements:

- The pattern is organized and predictable.
- The pattern is initiated from left to right.
- All number targets are located and identified only once.
5.2: Examples of Effective Search Patterns on the ScanBoard Subtest.

5.7.3.1.2 Ineffective Search Strategies

Figure 5.3 illustrates examples of ineffective search strategies. The characteristics of these strategies are the opposite of the effective strategies shown in Figure 5.1 on the ScanBoard test. They demonstrate a lack of organization, an unpredictable search pattern, and an asymmetrical search pattern.

FIGURE 5.3: Examples of Ineffective Search Strategies on the ScanBoard Subtest.
The client demonstrates an unpredictable and random search pattern. A random search pattern is a strong indication of visual inattention. A client who is unable to employ an organized strategy to search such a simple target array likely will have significant difficulty locating and remembering information in the environment and will experience a number of functional limitations as a result.

The client initiates the search pattern from the right side of the Board. This generally indicates hemi-inattention as the normal search strategy is a left to right strategy. If the client continues and executes an organized, predictable and complete pattern in searching the Board, this deviation from the norm probably will not interfere with functional performance. However, if the rest of the pattern is disorganized and incomplete, the client may have significant difficulty locating objects in the environment.

The client misses numbers on the left side of the Board. This can be an indication of a left VFD, especially if the client initiated a left to right search pattern which was organized but abbreviated on the left side. If, however, in addition to missing numbers on the left side, the client uses a disorganized search pattern initiated from the right side, it is suggestive of hemi-inattention.

The client misses numbers on the right side of the Board. If the client's search pattern is organized and initiated from the left, this abbreviated pattern suggests the presence of a right VFD. If it was observed in combination with a disorganized, random search pattern, it suggests inattention.

The client identifies the same number more than once. This may indicate that the client's search pattern is so random that he or she does not realize that the number was previously identified. If the client has poor short term memory, it may indicate the influence of the memory deficit. If the client repetitively selects the same number, it may indicate perseveration. Any of these conditions will result in employment of ineffective search strategies and subsequent functional limitations.

5.7.3.2 ScanCourse

A person must be able to combine visual scanning with ambulation in order to traverse an environment safely. Inability to combine visual search with ambulation contributes to topographical disorientation and can cause significant limitations in mobility. The client who walks without monitoring the surrounding environmental features is at risk for collisions and falls and will require supervision in community environments. Driving is not an option for clients who perform poorly on this test.

The client misses cards only on one side of the hallway. This is an indication of either inattention to one side or the influence of a VFD or a combination of both conditions. If the client knows that he or she has a VFD and is able to complete the second test trial with fewer than 3 errors, the errors probably are a result of inadequate compensation for the VFD and not inattention. If the client is informed of the errors made on the first trial and makes as many or more errors on the second trial, it is an indication of visual inattention or the combination of visual inattention and VFD. If errors occur only on the left side of the hallway, hemi-inattention is suspected. Regardless of the cause, the client is at increased risk for collisions on the side of the errors.

The client randomly misses cards on both sides of the hallway. The most likely reason for this behavior is a general inattention to task as is often observed with frontal lobe injuries. A much less likely interpretation would be that it indicates the presence of tunnel vision, possibly resulting from an anoxic injury or bilateral optic nerve injury. Regardless of the cause, the client is at risk for collisions and likely will miss a lot of visual information in the environment.

The client must stop to locate and read the card. The client is unable to integrate vision with ambulation and must do one or the other. It is an indication of slow visual processing placing the client at risk for colli-
sions, especially in dynamic environments.

**The client misses cards placed in unexpected locations.** This suggests that the client is not monitoring the complete visual environment and is only attending to a small portion of it. The client will be at risk for collisions in environments where there are unexpected obstacles.
INTRODUCTION PLANNING BASED ON TEST PERFORMANCE

REDUCED VISUAL ACUITY

Establishing Intervention Goals

Reduced acuity limits the ability to see small or distant visual details in the environment which will make it difficult for the client to complete some of the components of daily living tasks. For example, the face may not be seen clearly enough to accurately apply make up; the numbers on the temperature dial may not be seen to accurately set the oven or burners; or the amount due on a monthly bill may be read inaccurately. Generally, the more the daily task relies on vision for completion, the greater the limitations experienced by the client. Thus eating (other than food identification) usually is not affected, nor is dressing, once clothing is identified. But reading recipes, medication and food labels, thermostats, watch and clock faces, telephone key pads, appliance dials, overhead signs and traffic lights often is significantly impaired. The inability to read or difficulty reading and writing impacts performance of a variety of daily activities as illustrated in Table 2.1.

The first step in intervention is to refer the client to the appropriate eye care specialist to determine if visual acuity can be restored to the normal range. Both ophthalmologists and optometrists are skilled in making this determination. If the client's vision can not be corrected, the next step is to determine which activities are limited by the reduction in acuity. If a therapist on the rehab team has training in low vision rehabilitation, treatment goals can be established for regaining independence in ADLs using the appropriate treatment techniques. If no one on the rehab team has low vision expertise and the client's acuity is significantly reduced (less than 20/100), referral to a specialized low vision rehabilitation program should be made.

Intervention Suggestions

Regardless of whether specialized low vision rehabilitation is needed, there are some interventions that always can be completed to enable the client to use his or her remaining visual acuity more effectively. These passive techniques involve manipulation of the environment and objects to make them more visible to the client with limited acuity.

Increasing Visibility of the Environment

Background Contrast

Objects or features that do not differ significantly in color or shading from their background can be difficult to see when visual acuity has been reduced. For example, persons with reduced acuity often complain of difficulty recognizing facial features because the nose, mouth, cheeks and forehead all blend together as one color. Increasing contrast by changing the background color to differ from the object can assist the client to see an object more clearly. This process can be as simple as using a black cup for milk and a white cup for coffee. In cases where background color can't be readily changed, such as on carpeted steps, color can be
applied to provide a marker. For example, a line of bright fluorescent tape can be applied to the end of each step riser on the carpeted stairs to distinguish between them.

6.1.2.1.2 Illumination

Increasing the intensity of available light enables objects and environmental features to be seen more readily and reduces the need for high contrast between objects. Facial features, for example, can be more easily identified if the person’s face is fully illuminated. The challenge in providing light is to increase illumination without increasing glare. Halogen, fluorescent, and full spectrum lighting provide the best sources of high illumination with minimum glare and generally are recommended over standard incandescent lighting for both room and reading illumination. Lighting should be strategically placed to provide full, even illumination without areas of surface shadow. For example, if a 50 watt halogen lamp is used for reading, it should be positioned behind the client’s shoulder so that the page of print is fully illuminated without the light shining directly in the client’s eyes. (add lighting resource)

6.1.2.1.3 Background Pattern

Patterned backgrounds have the effect of camouflaging the objects lying on them (see Figure 6.1). The detrimental effect of pattern on object identification can be minimized by using solid colors for background surfaces such as bedspreads, placemats, dishes, countertops, rugs, towels, and furniture coverings. Background pattern also is created by objects in the environment. Cluttered environments with haphazardly placed objects challenge even a person with very good acuity. If possible, the number of objects in the environment should be reduced and those remaining arranged in an orderly fashion. Closets, drawers, shelves, and counter tops should be reorganized and simplified along with sewing baskets, desks, refrigerators and freezers.

FIGURE 6.1: Illustration of the Detrimental Effect of Background Pattern on the Visibility of an Object.  
Illustration courtesy of Rebecca Bothwell OTR.
6.1.2.2 Enlargement

If possible, increase the size of the object to make it more visible. Instructions can be reprinted in larger print; medications and other items relabeled, and calendars enlarged. The last line of print easily read on the Warren text card indicates the minimum size to enlarge print for the client. Contrast also should be increased as it does little good to enlarge print if the print is faint. Black on white or white on black print usually is seen with greater ease than any other color combination. Many items now are manufactured with larger print including calculators, clocks, watches, telephones, check registers, glucose monitors, scales, playing cards, games, and puzzles. These items are available through specialty catalogs (see Appendix C).

6.1.2.3 Organization

Organization and structure in the environment reduce the amount of visual scanning needed. Once closets and shelves are rearranged and simplified, every effort should be made to keep them organized. Putting items back where they belong and maintaining organization reduces frustration and facilitates independence. Establishing routines for everything from filing fingernails to paying bills prevents daily tasks from becoming overwhelming. Steps that require visual monitoring should be eliminated as much as possible. For example, use prechopped and premeasured food ingredients, wrinkle free clothing, electronic fund transfer, and voice activated telephone dialing.

6.1.2.4 Community Services

There are a variety of national and local services available to persons with vision loss. These services generally are free of charge and can be found by going through the resource section of public library or by contacting advocacy organizations such as the American Foundation for the Blind (www.afb.org) or Lighthouse International (www.lighthouse.org). Some examples of available services include The National Library Service for the Blind and Physically Handicapped which offers books and magazines on cassette tape through its Talking Books program and local telephone companies which may offer free directory assistance to persons with disabilities (see Appendix C).

6.1.2.5 Collaboration With Other Disciplines

For clients with permanent and severe loss of acuity, collaboration with the rehabilitation professions who work with persons with visual impairment and blindness often is the key to a successful outcome. Most of these professionals are not licensed health care providers and therefore typically do not work in medical programs because their services are not reimbursed by medical insurance. Instead, they are found in state and private agencies which provide services to the blind and visually impaired or in special education programs. A brief description of these professions are provided in the following sections.
6.2.1.5.1 Orientation and Mobility Specialists

Orientation and mobility specialists (O & M) are trained to address travel needs related to vision loss. O & M specialists work in a variety of settings including public school systems, private agencies, and state supported programs serving people throughout the lifespan. Services usually are community based. Aspects of treatment addressed by these professionals include use of efficient visual skills, optical devices, and electronic travel aids, assertiveness and self advocacy training, and use of a long cane.

6.2.1.5.2 Certified Vision Rehabilitation Therapists

CVRT’s (aka rehabilitation teachers) address deficiencies in daily living skills that are directly related to vision loss. They work in a variety of settings including private agencies, itinerant state services, residential schools, and independent living centers and serve all age groups.

6.2.1.5.3 Low Vision Optometrists/Ophthalmologists

Currently, optometrists and ophthalmologists specializing in low vision rehabilitation are the only disciplines who work in both the health care system and with private agencies and therefore may be the easiest with which to collaborate. These specialists evaluate the person’s visual function and prescribe optical devices and training to compensate for the vision loss. Optometrists are more likely to specialize in this area than ophthalmologists.

6.2 REDUCED CONTRAST SENSITIVITY

6.2.1 Establishing Intervention Goals

Because so much of the environment is made up of low contrast objects and features that are often viewed in low illumination, reduced contrast sensitivity function can have a significant impact on the client’s safety and independence. A client with reduced CSF may not detect objects or environmental features well enough to identify them. For example, the client may be unable to recognize the facial features of a friend or to see the level of insulin drawn into a syringe. The client also may not detect environmental features and objects in sufficient time to respond safely. For example, he or she may not see a curb until directly upon it. Because bright illumination increases the ability to detect low contrast features and low illumination reduces this ability, the client’s performance of activities may fluctuate depending on the lighting conditions of the task. The client may be able to negotiate a curb safely on a bright, sunny day but be unable to detect the curb on a cloudy, rainy day. The client may be able to detect water spilled on the floor in a well lighted kitchen but not in a dimly lit bathroom.

In establishing achievable goals the fluctuating nature of the client’s performance, because of changes in illumination and contrast, must be taken into consideration. For example, it may be feasible for the client to resume driving if he or she is willing to restrict driving to clear, sunny days. Or the client may be able to accurately dial the telephone if a phone is purchased with black numbers printed on a white background.
Knowledge of the client’s environment is critical to successful performance and it is not possible to assume that a client who can perform a task in a well lit clinic will be able to repeat the performance at home.

Unlike reduced acuity, there are no optical devices that increase CSF and enable the client to see low contrast features more clearly. Therefore, it is not appropriate to set a goal to improve contrast sensitivity function. Instead, the intervention approach is compensatory with independence achieved by modifying the environment and making the client more aware of low contrast features that may impede performance.

### 6.2.2 Intervention Suggestions

The treatment suggestions given for clients with reduced acuity also work well in enabling clients with reduced CSF to complete needed daily living tasks. The reader is referred to Sections 6.1.2.1 to 6.1.2.3 for a description of these suggestions.

### 6.3 VISUAL FIELD DEFICIT

#### 6.3.1 Establishing Intervention Goals

In establishing intervention goals, it is important to focus on how the VFD interferes with occupational performance. Identifying the presence of a VFD is not in itself justification for intervention unless the deficit affects the client’s independence in completing daily activities. Safety and accuracy are the two aspects of performance most affected by VFD. The client generally is able to complete all activities, however the safety and accuracy of the performance may be marginal. The emphasis in intervention is on teaching the client how to compensate for the VFD rather than on stimulating the blind field in hopes of regaining visual function. Research to date has not been able to show conclusively that improved functioning of the blind visual field can occur with stimulation. However, research has shown that training in compensatory techniques can improve functional performance even in cases of longstanding deficits.

The goal for therapy is an occupational goal such as safe and accurate completion of meal preparation and shopping, accurate and independent completion of financial management and so on. Clients will experience the greatest limitations in activities completed in dynamic environments such as shopping or activities which require monitoring of a wider visual field such as meal preparation or yardwork. Resuming driving may or may not be a goal depending on the state’s driving statutes. Some states do not specify a certain number of degrees of visual field for licensure. In these states, a client may be able to safely resume driving if given the proper training. Reading and writing accuracy may be addressed on the plan of care as specific goals but also contribute to independent performance of other goaled areas including financial management and meal preparation.
6.3.2 Intervention Suggestions

The most important aspect of treatment is education of the client as to the nature of his or her vision loss and the resulting limitations. Compensation for VFD requires adoption of a conscious, cognitive strategy of using head movement to broaden the visual field. Because the CNS exercises perceptual completion, the client is prevented from having a marker delineating the boundary of the field loss (see Section 2.3.4). To succeed, the client must believe that the deficit exists and that the visual input coming from the hemianopic side cannot be trusted. The client who is able to develop this level of insight will be able to learn to effectively compensate for the deficit. Every effort must be made through activities and educational materials to make the client aware of the location and extent of the deficit.

6.3.2.1 Increasing the Effectiveness of the Search Pattern

A combination of strategies are in intervention (add new references). Intervention should first focus on increasing the speed and scope of the search pattern. The client must learn to turn the head to compensate for the limitation in visual field and to do so as quickly as possible. The desired components of the scanning strategy used by the client are: 1) initiation of a wide head turn towards the blind side, 2) an increase in the number of head and eye movements towards the blind field, 3) faster completion of head and eye movement toward the blind side, 4) execution of an organized and efficient search pattern which begins on the blind side, 5) attention to and detection of visual detail on the blind side, and 6) ability to quickly shift attention and search between the central and peripheral visual field on the blind side. The Dynavision 2000 apparatus (see Appendix C) has been shown to be effective in teaching clients the components of an effective search pattern and is strongly recommended as a treatment tool.(ref) Other therapeutic activities that facilitate head turning to compensate for the VFD include: ball games where balls are passed quickly from player to player, balloon batting, projection of the light from a laser pointer onto various locations on a white wall for the client to search and find, or “Post-it” brand stick on notes with numbers and letters printed on them widely scattered over a wall for the client to search and find. Use of a circular strategy is taught to search broad, unstructured space while linear strategies are used for reading and for searching structured space. Employment of the search strategy can be reinforced through the use of games such as concentration, solitaire and checkers, and in daily activities such as walking on a crowded street, finding clothes in a closet, or locating items needed for meal preparation.

6.3.2.2 Functional Mobility

For clients experiencing limitations in functional mobility, practice in dynamic and in unfamiliar environments is beneficial. The client should be taught to be observant and predictive of obstacles in the environment such as steps and curb cuts, and also changes in the support surface such as a transition from carpet to vinyl flooring. Becoming more observant of the structures/features that serve as landmarks such as a picture on a wall or a change in wall color, should be stressed. Use of a support cane can provide additional tactile feedback and help reduce the client’s desire to fix gaze on the floor during ambulation.
6.3.2.3 Reading and Writing

The client's primary challenges in reading involve difficulty locating and maintaining the correct line of print and accurately identifying words and numbers. Clients with left VFD often experience difficulty accurately locating the next line of print on the left hand margin of the reading material and lose their place. Drawing a bold red line down the left hand margin provides the client with a visual cue to use as an “anchor” to find the left margin. The same technique used on the right hand margin assists the client with right VFD who may be uncertain as to the location of the end of the line of print. If the client has difficulty staying on line or moving from line to line, a ruler or card can be used to underline the line of print and keep the client’s place.

Accuracy in reading numbers, letters, and words can only be reestablished through practice. The prereading and writing exercises designed by Warren, the LUV Reading series by Wright and Watson, or commercially available word and number searches can be used to teach the client to make the precise eye movements needed see words completely (see Appendix C). Many clients who wore bifocals prior to the VFD now may be unable to focus clearly through the bifocal because of its restricted field of view and may need to be fitted with single lens reading glasses or executive line bifocals which provide a wider field of view.

Difficulty staying on line when writing is addressed by teaching the client to monitor the pen tip as the hand moves across the page and into the blind field. Activities that require the client to trace lines towards the side of the VFD are effective in re-establishing eye hand coordination (see Warren Pre-Reading and Writing exercises, Appendix C). Practice in completing blank checks and check registers also is helpful. Blank practice checks often can be obtained free from the companies that print checks for banks such as Deluxe Check Printers.

All clients will benefit from compensatory strategies that reduce visual noise and make the environment more visible (see Section 6.1.2.1). Adding color and contrast to the key structures in the environment needed for orientation (door frames, furniture etc.) will assist the client in locating these structures. Contrast in writing materials can be heightened by using black felt tip pens and bold lined paper to assist the client in monitoring his or her handwriting. The simple addition of more light often will increase reading speed and reduce errors. Reduction of pattern in the environment by clearing out clutter and using solid colored objects will enhance the client's ability to locate items.

6.4 OCULOMOTOR DYSFUNCTION

6.4.1 Establishing Intervention Goals

Oculomotor dysfunction reduces the speed and precision of eye movements resulting in slower, less accurate, visual processing. When diplopia is present, perceptual distortion may be experienced, making it difficult to quickly and accurately identify visual details, and also reducing postural control. Because of the difficulty in using the eyes binocularly, the client may experience visual stress which may reduce concentration and shorten participation in activities. Complaints of extreme fatigue and agitation by the end of the day are common due to the constant visual stress.

With the exception of reading and tasks requiring precise eye hand coordination, the presence of oculomotor dysfunction usually does not prevent completion of most daily activities but it makes completion of all daily activities tedious and fatiguing. The client may reduce participation in some activities because of the constant visual stress. Motor and postural control also may be compromised reducing safety in navigation of the
environment. For these reasons, oculomotor dysfunction must be addressed in intervention although it is not specifically identified as a goal. The goal addresses occupational performance such as safe and accurate completion of meal preparation, shopping or bill paying, and management of the oculomotor dysfunction becomes one of the methods used to achieve the goal.

Information gathered from the oculomotor assessment should be compared with the client’s visual complaints and the clinical observations to determine if the oculomotor dysfunction is contributing to the client’s functional limitations. For example, the presence of convergence insufficiency may help explain the difficulty the client is experiencing in maintaining concentration when reading; or the observation of downward movement of the left eye during the cover/uncover test may explain why the client complains of feeling off balance and unsure when descending stairs. If oculomotor deficiencies are observed that appear to limit function, referral should be made to an ophthalmologist or optometrist for further evaluation to determine the cause of the deficiency, the prognosis for improvement, and treatment options (see Appendix D).

### 6.4.2 Intervention Suggestions

Intervention can be divided into four types: 1) occlusion to eliminate diplopia, 2) eye exercises, 3) application of prism, and 4) surgery. The last three interventions are used to reestablish fusion and binocularity and are completed by ophthalmologists and optometrists. Most oculomotor dysfunction clears up within six to twelve months after the brain injury without treatment intervention. Because of this, many ophthalmologists do not believe that it is necessary to provide any intervention other than to eliminate the diplopia for the client’s comfort during the recuperation period. If the diplopia persists and becomes chronic, surgery can be used to reestablish fusion. Optometrists often choose a different approach and prescribe eye exercises to reestablish binocularity in addition to occlusion and prism.\(^{86,91,93}\) Brief descriptions of these interventions follow. The option selected for the client depends on the prognosis for recovery, the client’s ability to participate in therapy, family and financial resources, and the eye specialist providing consultation.

#### 6.4.2.1 Occlusion

The presence of diplopia causes perceptual distortion which, in turn, creates confusion for the client and limits participation in therapy. Therefore, diplopia must be eliminated, at least in primary gaze, if the client is to benefit fully from rehabilitation. Diplopia is eliminated by occluding the image presented to one eye. It can be achieved by assuming a head position or by covering one eye. Because assuming a deviant head position often affects motor and postural control, the preferred method is to cover one eye. Occlusion of the eye can be achieved through either full or partial occlusion.\(^{78,80,110}\) The advantages and disadvantages of these two types of occlusion are discussed in the following sections.

#### 6.4.2.1.1 Complete Occlusion

With complete occlusion, vision is completely occluded in one eye by application of a “pirate” eye patch, a clip-on occluder, or opaque tape. Generally the client will not tolerate long periods of occlusion of the normal eye (because of past pointing) or of the dominant eye (because of discomfort). Therefore, for the comfort of the client, the period of occlusion is alternated between the eyes every hour. Alternating occlusion between the eyes also reduces the likelihood of the development of secondary contracture of the muscles antagonistic to the paretic muscle.
Advantages:

1) Cheap
2) Easy to apply

Disadvantages:

1) Eliminates peripheral visual input, disrupting the normal CNS mechanisms for control of balance and orientation to space. This often causes the client to feel off balance and disoriented and reduces depth perception.

2) Poor client compliance because of the discomfort of monocularity, especially when the dominant eye is occluded.

6.4.2.1.2 Partial Occlusion

For partial occlusion, a strip of opaque material (such as Transpore surgical tape) is applied to a portion of the lens to block visual stimulation of the central visual field while the peripheral visual field is left unoccluded (see Figure 6.2). Because the client is bothered most by the presence of diplopia in the central visual field the tape is applied to the nasal portion of the eyeglass lens of the non dominant eye. The client is instructed to view a target within the diplopic field while the tape is applied. Tape is applied from the nasal rim towards the center of the lens until the client reports that the diplopia is gone when viewing the target. The non-dominant eye is chosen for the greater comfort of the client. The width of the tape is gradually reduced as the muscle paresis resolves.

Advantages:

1) The client is more comfortable and compliance is increased.

2) Peripheral vision is left intact and available for use in orientation to space and balance.

Disadvantages:

1) The client must either wear prescription lenses or have tape applied to a pair of frames with plain, non-refractive lenses.

FIGURE 6.2: Example of the Application of Tape to the Nasal Side of the Left Lens to Provide Partial Occlusion.
Either type of occlusion can be accompanied by daily range of motion exercises. To complete the exercises, the client covers the non affected eye and practices moving the affected eye towards the direction of the paresis and then repeats the range of motion exercises binocularly (using the eyes together) in all directions of gaze. These exercises can be done for 4-5 minutes several times a day.

**NOTE:** Because children are susceptible to developing sensory suppression and amblyopia, **OCCLUSION SHOULD NEVER BE USED WITH CHILDREN UNDER THE AGE OF 16 WITHOUT THE DIRECTION OF AN OPHTHALMOLOGIST OR OPTOMETRIST.**

### 6.4.2.2 Prism

Prisms are used to reestablish single vision in the primary directions of gaze: straight ahead and looking down. Application of a prism displaces the image to one side in space causing the disparate images created by the strabismus to overlap and fuse into a single image. The prism can be ground into the eyeglass lenses worn by the client or temporarily applied to the lens of the glasses using, for example, a Fresnel press on prism. Prism strength is measured in diopters. Sufficient prism strength is applied to enable the client to maintain fusion without discomfort. Prism is used only as long as it is needed to maintain fusion. If the paresis is resolving, the client is gradually weaned from the prism by reducing the dioptric strength of the prism over a period of time commensurate with the rate of recovery. An optometrist or ophthalmologist determines the strength of the prism and directs the treatment program.

### 6.4.2.3 Eye Exercises

There is no research evidence demonstrating that the use of eye exercises will restore binocular function following adult onset acquired paretic strabismus. However, eye exercises also do not appear to adversely affect muscle function and the use of eye exercises can empower the client by providing a greater role in directing the recovery process. Prescribing and implementing an eye exercise program is the role of optometry and is NOT within the scope of practice of occupational therapy. Referral to an optometrist is required.

### 6.4.2.4 Surgery

Surgery is recommended when the angle of deviation of the strabismus is too large to be overcome consistently and easily by fusional effort, or when there is a significant non-concomitant condition that does not resolve in 12 months. The general approach to surgery is to make the action of one of the muscles either weaker or stronger by changing the position of it’s attachment on the eyeball. The position of the eye in the socket is changed by the procedure and the image is realigned. Surgery is completed by an ophthalmologist specially trained in strabismus surgery.

### 6.5 VISUAL INATTENTION

#### 6.5.1 Establishing Intervention Goals
Visual inattention disrupts the assimilation of visual information. Instead of taking in visual information in an orderly, sequential, and comprehensive fashion, clients with inattention use haphazard, incomplete, and often asymmetrical search patterns. As a result the client receives insufficient and/or incorrect visual input with which to make decisions and solve problems reducing adaptation to the environment. This is observed as an inability to safely and independently complete needed daily living activities such as grooming, dressing, meal preparation, and functional mobility (see Section 2.5.4 and Table 2.4).

Analysis of the information gathered from the visual attention subtests should reveal specific deficiencies in the client's search pattern for acquiring visual information. For example, it may be observed that the client does not search towards the left side of visual arrays. If the deficiency is significant, a similar performance should be observed when the client completes a daily activity such as an inability to locate items placed to left side of the sink in grooming, or a tendency to begin reading a line of print in a recipe in the middle of the page instead of at the left margin. Depending on the severity of the deficit, some clients with inattention are able to complete simple and practiced daily activities easily and only experience difficulty on tasks that are unfamiliar or require search of a complex visual array. Others, especially those with a combination of inattention and visual field deficit, may have difficulty with such a simple task as finding all of the food on their plate. By combining information from the visual attention subtests with that gained from completion of the Clinical Observations Indicating Visual Impairment form, it should be possible to determine whether and how the client's performance of daily activities has been compromised. The exception to this may be the high functioning client with mild inattention whose performance is affected only when completing complex, dynamic activities. It is important to observe how this client functions in the more demanding environments of work and community. In all cases, the goal in working with clients with inattention is the safe and independent completion of daily living activities. The goals on the intervention plan should be worded to reflect the specific daily activities compromised by the inattention. For example, "the client will be able to complete grooming independently" or "the client will be able to prepare a simple meal independently."

6.5.2 Intervention Suggestions

The goals established for independent performance of daily activities are achieved by ensuring that the client is taking in visual information in an organized, complete and efficient manner. Insight, an understanding of how visual search and attention has changed, is considered to be critical in enabling the client to learn strategies to compensate for the deficit. To assist in achieving insight, the results of the client's performance on the subtests should be carefully reviewed on completion of the evaluation. The client should be shown how his or her search pattern was ineffective and caused errors. If, after receiving this feedback, the client wishes to retake one of the subtests, he or she should be allowed to do so. If the client's performance improves on the retest, it is an indication of the capability to benefit from therapy intervention and serves as a justification for therapy services. Likewise, if the client's performance does not improve, it helps to verify the significance of the deficit and also may indicate reduced rehabilitation potential.

The primary compensatory strategy taught to the client with hemi-inattention is to reorganize the scanning pattern to begin visual search on the left side of a visual array and progress towards the right. Use of this pattern will counteract the tendency of the client to restrict all visual search to the right side and increase the symmetry of the search pattern. Activities should be selected that encourage and reinforce the use of this pattern. Two patterns are taught: a left to right linear pattern for reading and inspection of small visual detail, and a left to right clockwise or counter-clockwise pattern for viewing unstructured and extrapersonal visual arrays. The strategies can be taught more effectively if the activities are designed so that the client is required to physically interact with the target once it is located. Ideally, treatment activities will be large enough to require head turning to complete the visual search and will emphasize conscious attention to visual detail and careful inspection and comparison of targets. The following are examples of activities that fulfill these requirements:
1) Lay out a deck of playing cards (face up) in wide rows. Hand the client another deck of playing cards and instruct him or her to match the cards in hand to the cards on the table. Be sure that the client initiates a left-to-right, top-to-bottom, organized scanning pattern when searching for the matching cards.

2) Play games such as solitaire, double solitaire, dominoes, triominoes, checkers and others that cover a wide playing surface. Ensure that the client uses an organized search strategy when playing the game.

3) Have the client complete a large, 500-piece puzzle. Spread the pieces out over the left side of the table and ensure that the client executes an organized left to right search pattern to locate the pieces.

4) Have the client complete enlarged word or number searches or exercises such as those found in the Warren Pre-reading and Writing Exercises as homework (see Appendix C).

Once the concept of the compensatory strategy is understood, the client should be taught to incorporate the strategy into the completion of daily activities such as grooming, dressing, meal preparation, and shopping.

6.5.3 Working with Clients with Severe Inattention and Limited Cognition

Some clients, because of the severity of their deficits, lack the cognition and insight to benefit from training in compensatory strategies. Although intervention is limited, these clients may benefit from modification of the environment to assist them in using their limited attentional capabilities. The environment should be modified to reduce the factors that place stress on visual processing. Suggested environmental modifications include the following.

*Reduce background pattern so that objects in the foreground can be seen more easily.* The more dense the background pattern, the greater the amount of selective attention required to locate the desired object. Clients with severe brain injuries may not be able to sustain the effort required to complete this level of processing and may view their environments as filled with “visual noise” rather than meaningful objects. Backgrounds can be simplified by eliminating patterned designs and using solid colors on support surfaces such as rugs, carpets, placemats, and bedspreads. Eliminating superfluous objects such as knickknacks and old magazines, and organizing frequently used items on shelves and in containers, also simplifies the background. As a general rule, environments should be spartan and contain only the items needed by the client for completion of daily activities. Items which inherently contain a lot of pattern, such as printed reading materials, can be enlarged in size to decrease the density of the pattern.

*Ensure that room and task illumination is adequate.* Both too little and too much illumination can impair visual processing. However, environments usually contain too little rather than too much light. The type of illumination used should provide brightness without glare. Halogen or full spectrum light generally provide the best illumination (see Section 6.1.2.1.2).

*Increase contrast between background and foreground objects to enhance the visibility of items in the environment which need to be noticed.* For example, the edge of a white plate placed on a black placemat is more visible than it would be if placed on a white placemat, and milk in a black cup is more visible than in a white cup. The use of glass or clear plastic items should be avoided as these items absorb whatever pattern or color is around them, reducing contrast.
APPENDIX A

REFERENCES


New References


APPENDIX B

TERMS LIST

Accommodation. A three step process mediated by the brainstem which enables near objects to be viewed clearly.

Altitudinal hemianopsia. Visual field deficit involving either the superior or inferior visual fields.

Amaurosis. Condition of blindness.

Astigmatism. Unequal curvature in the cornea or the anterior or posterior surfaces of the lens which causes differences in the refractive power of the eyes and results in blurring of images.

Central scotoma. See macular scotoma.

Conjugate. Simultaneous parallel movement of the eyes (versions) together in any direction.

Convergence. Eye movement which brings the eyes in toward each other to view a near object.

Convergence insufficiency. A condition associated with brainstem injury which results in the inability to converge the eyes sufficiently to achieve and/or maintain focus on an object held in near space.

Diopter. A unit of measurement; 1 prism diopter will bend a ray of light 1 centimeter at a 1 meter distance.

Divergence. Eye movements which restore the eyes to primary gaze following convergence.

Dominant eye. The preferred eye for viewing, usually leads and controls the other eye during binocular eye movements.

Enophthalmos. Sinking in of the eye ball into the orbit.

Eso. Inward or medially deviated.

Exo. Outward or laterally deviated.

Fovea. Area of the retina located in the center of the visual field which has only cones and the highest visual acuity. Foveation is placement of objects of interest on the fovea achieved by eye movements.

Hemianopsia. Loss of one half of the visual field. Homonymous Hemianopsia: loss of one half of the corresponding retinal field in each eye.

High contrast acuity. Visual acuity measured using a high contrast (black on white) test format.; a.k.a. a standard visual acuity.

Low contrast acuity. Visual acuity measured using a low contrast test format; a.k.a contrast sensitivity function.

Macular degeneration. Also known as age related macular degeneration or ARMD. An age related disease which gradually destroys retinal function within the central (macular) area of the retinal visual field. The disease does not progress beyond the macular area of the retina and is the leading cause of low vision in older adults.
Macular scotoma. An area of depressed or absent retinal function found within the central 5-10 degrees of the visual field.

Macular “central” sparing. Sparing of the central 10 degrees of retinal function within the blind area of the visual field.

Oscillopsia. The perception of constant swirling and movement of the peripheral environment which may accompany visual vestibular dysfunction.

Paralytic strabismus. Deviation of an eye(s) secondary to acute onset of paralysis of the extraocular muscle(s)

Phoria. Deviation of the eye which is held in check by fusion.

Practical field of vision. The area visible to the eye with head movement. Larger than the visual field.

Quadrantanopsia. Loss of one quarter of the visual field.

Sensory fusion. Enables perception of a single object despite separate visual images from the eyes.

Sensory suppression. Condition where the CNS ignores (suppresses) sensory input from one eye usually associated with visual conditions beginning in childhood such as congenital strabismus or amblyopia.

Strabismus. A noticeable deviation of one eye in relation to the other. Can be congenital or acquired.

Tropia. Observable deviation of the eye due to extraocular imbalance.

Vergence. Simultaneous movement of the eyes in opposite directions to maintain binocular vision such as convergence in movement of the eyes inward or divergence in movement of the eyes outward.

Visual field. The area visible to the eye when one is focusing straight ahead.

Sources:


APPENDIX C

RESOURCES

TECHNIQUES FOR THE BASIC OCULAR EXAMINATION TRAINING VIDEO

American Academy of Ophthalmology (AAO)
655 Beach St
San Francisco, CA 94109
(415) 561-8500 www.eyenet.org

INFORMATION RESOURCES

The Lighthouse Information and Resource Service
111 East 59th St.
New York, NY 10022
(800) 829-0500 www.lighthouse.org

American Foundation for the Blind
11 Penn Plaza Suite 300
New York, NY 10001
(800) 232-5463 wwwafb.org

CONSUMER SERVICES

Library of Congress National Library Service for the Blind and Physically Handicapped
1291 Taylor Street, N.W.
Washington, D.C. 20542
(800) 424-8567 fax: (202) 707-0712
www.loc.gov/nl

Bible Alliance inc.
P.O. Box 621
Bradenton, FL 34206
(941) 748-3031
fax: (941) 748-2625
aurora@auroraministries.org

ADAPTIVE EQUIPMENT

Optelec US, Inc
3030 Enterprise Court
Vista, CA 92801
800-826-4200
www.optelec.com

LS & S Group
P.O. Box 673
Northbrook, IL 60065
(800) 468-4789
fax: (847) 498-1482

Independent Living Aids
27 East Mall
Plainview NY 11803
(800) 537-3135
fax: (516) 752-3135
www.independentliving.com

Maxi-Aids
PO Box 3209
Farmingdale, NY 11735
(800) 522-6294
www.maxiaids.com

DYNAVISION

Performance Enterprises
76 Major Buttons Drive
Markham, Ontario, Canada
L3P3G7
(905) 472-9074 fax: (905) 294-6327
www.dynavision2000.com

VISUAL SKILLS FOR READING TEST (VSRT) and WARREN PRE-READING AND WRITING EXERCISES

Optelec US, Inc
3030 Enterprise Court
Vista, CA 92801
(800) 826-4200
www.optelec.com
Sample Cover Letter

Dear Dr. _______________________

________________________ has an appointment with you for an eye exam on ________________. I am an occupational therapist at __________________ where _____________ is receiving inpatient or outpatient therapy services for disabilities resulting from a _____________________________. I have the responsibility of providing therapy to ________________ which will enable him/her to regain the ability to independently complete _____________________________. In working with ________________, I have noticed several behaviors which may indicate that he/she has a visual impairment. These include: ________________ _____________________________. I am concerned that these behaviors may be the result of _____________________________.

I requested that an appointment be scheduled with you to determine whether ________________ may have a visual impairment which limits his/her function and, if so, to obtain recommendations for further evaluation and treatment. I am aware that you maintain an extremely busy schedule and so, to facilitate communication with your office and to minimize your consultation time, I have enclosed a brief form which contains the information that I am interested in receiving. If you would be so kind as to complete the form during the evaluation and return it to me, I will not require an additional formal consultation letter from you. I have enclosed a self-addressed envelope for return of the form.

Thank you very much for your assistance in our efforts to provide ________________ with the best possible rehabilitation. I look forward to receiving the results of your exam. If you have any questions or concerns regarding the exam and wish to speak to me directly, I can be reached ________________ at _________________.

Sincerely,
Sample Form

Patient’s Name: ___________________________________________ Date of Birth: ______________

Visual Acuity (with correction)

OD: 20/       OS: 20/       OU: 20/

If visual acuity is reduced:

cause of the impairment:

is the impairment permanent?

can acuity be restored to normal range with glasses?

Visual Field

Type of perimetry test completed:

_____confrontation  _____tangent screen  _____ manual  _____automated  _____central full

Please attach a copy of the visual field diagrams for both eyes.

If a visual field deficit is present:

cause of the visual field deficit:

is the impairment permanent?

Ocular Motility

_______within normal limits  ______right gaze palsy  _______ left gaze palsy

Convergence:  _________ within normal limits  ______limited
Patient’s Name_________________________________________ Date _______________ page 2

If ocular motility is impaired:

cause of the impairment:

is the impairment permanent?

If diplopia is present:

cause of the diplopia:

is the diplopia a permanent condition?

can the diplopia be eliminated with prism?

is surgery recommended?

Any other pertinent ocular diagnosis: (example glaucoma, AMD)

Recommendations for Follow Up and Treatment:

__________________________________________________________________________Physician’s signature
APPENDIX E

PERCENTAGE CONVERSION CHART FOR VISUAL SEARCH SUBTESTS

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APPENDIX F

EXAMPLES OF DEFICIENT PERFORMANCE ON THE DESIGN COPY TEST

Figures A and B: Drawings completed by clients with ineffective search strategies secondary to a right hemisphere lesion showing missing visual detail on the left side.

Figure C: Drawing completed by a client with an ineffective search strategy secondary to a right hemisphere lesion showing missing visual detail on the left side and elongation of features (the middle pedal) on the right side.

Figure D: Drawing completed by a client with an ineffective search strategy secondary to a left hemisphere lesion showing a symmetrical omission of visual details (the window panes).
### APPENDIX G

**ANALYSIS OF NORMATIVE DATA ON THE VISUAL SEARCH SUBTESTS**

N = 25  
Age Range: 16-83 years of age  
Males: 12  
Females: 13

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<tr>
<th>Subtest</th>
<th>Average Time (in seconds)</th>
<th>Time Range (in seconds)</th>
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<th>Median % Correct</th>
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APPENDIX H

TEST MATERIALS AND CARE INSTRUCTIONS

The biVABA contains the following test materials:

Assessment Forms:

- Clinical Observations Indicating Visual Impairment
- Basic Visual Function Assessment
- Damato 30 Multifixation Campimeter recording form
- Oculomotor Function Assessment
- Visual Attention Assessment

Test Charts:

- Intermediate Acuity Test Chart/Low Vision LeaNumbers Chart
- Warren Text card
- LeaNumbers Low Contrast Screener and soft tipped pointer
- Damato 30 Point Multifixation Campimeter
- ScanBoard
- Design Copy Figures: House, Flower, Clock

Subtest Forms:

- Single Letter Search-Simple
- Single Letter Search-Crowded
- Word Search
- Structured Complex Circles Search
- Random Plain Circles-Simple
- Random Plain Circles-Crowded
- Random Complex Circles Search
- Telephone Number Copy

Scoring Templates:

- Single Letter Search-Simple
- Single Letter Search-Crowded
- Word Search
- Structured Complex Circles Search
- Random Complex Circles Search

Miscellaneous:

- penlight
- eye patch occluder
- clip-on occluder
- hand held occluder
- card with 8mm hole
- tongue depressors
- red stick on dots
- complex circle target example
- carrying case

Materials Not provided:

- distant and near targets
- red and black felt tip markers
- pencil
- stopwatch
- 8.5 x 11 sheets of white paper
- black 1 inch stick on letters/numbers
- 3 x 5 white plain index cards
- mounting putty
- bookstand easel

Care Instructions

The surface of the test charts should be kept free of dirt and smudges and can be cleaned with a mild solution of non-abrasive liquid detergent and warm water with a soft cloth if soiled.

*If test materials are lost or damaged, contact visABILITIES (888) 850-5416 for replacement.*