Optometry is an ever-changing field. Standard safety precautions must be followed, but as new research and clinical experience broaden our knowledge, changes in treatment and drug therapy may become necessary or appropriate. Readers are advised to check the most current product information provided by the manufacturer of each drug to be administered to verify the recommended dose, the method and duration of administration, and contraindications. It is the responsibility of the licensed prescriber, relying on experience and knowledge of the patient, to determine dosages and the best treatment for each individual patient. Neither the publisher nor the author assumes any liability for any injury and/or damage to persons or property arising from this publication.
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Why another book about binocular vision? After all, there are currently available many excellent texts for the reader to choose from—Scheiman and Wick, Rutstein, Griffin, Rouse and Caloroso, etc.—each a fine text approaching the subject of binocular vision in a scholarly and comprehensive manner and differentiated by philosophy, style, and experiences of the authors. Although each is suitable for use by the student of binocular vision or the advanced clinician, none are designed to be readily available and approachable to a clinician with limited knowledge in the subject and a patient in his or her chair. This book, *Essentials of Clinical Binocular Vision*, fills that niche of a clinically useful and relevant tool in the management of the patient with binocular vision anomalies.

Optometry has undergone extraordinary progress and change during my 25+ years in pediatric optometry. When I was a student at the New England College of Optometry in the early 1970s, the diagnosis and treatment of eye disease was but a far-off dream of our profession. Clinical practice was concentrated on refractive care and binocular vision. My contemporaries all received extensive experience in these areas during our training and in our clinical practice. There were relatively few books available on binocular vision (actually few books written by optometrists at all), but there were lots of mimeographed manuals with extensive and explicit instructions on the diagnosis and treatment of binocular anomalies that were developed by our optometric faculty. We were comfortable with clinical care of patients with binocular problems, even as students.

This now seems like a long time ago (it was!). Our profession has changed tremendously. Disease happened in a far bigger way
than almost any of us could have imagined. The curriculum at all of the optometry schools transformed from a functional orientation to an intensively medical model. There was a veritable explosion of content in the basic sciences. Models of clinical care progressively emphasized more disease and less visual function. The strength that had formerly existed in the teaching and clinical care in binocular vision waned dramatically, to the point today that it is a small, narrow, and often underappreciated area of optometric education and clinical care.

However, starting a few years ago, a new trend in optometry developed. Led first by a group of optometrists who became convinced that the optometric care of the infant was the next frontier in our profession (i.e., Operation Bright Start and my text, *Eyecare for Infants & Young Children*), and now more recently through the nationwide efforts of the American Optometric Association and a number of individual state associations to mandate universal eye exams for all children entering school, children have been rediscovered by our profession. There is now active discussion about specialization and certification in pediatric optometry, and there already is in binocular vision through OEP and COVD.

Those of us who consider ourselves to be specialists in binocular vision and pediatric optometry are both pleased and a little amazed by this sudden re-awakening of interest in children. However, many of us are concerned as well. We know that within the profession as a whole, binocular vision and pediatric optometry have not been where the action was, and those optometrists educated in the last 15 or so years had relatively little didactic and clinical education in these areas. Of course this is not the case for those who have active practices in functional or behavioral optometry or those specializing in the care of the child. Nonetheless, probably a majority of practicing optometrists today have relatively little experience in binocular vision and pediatric optometry. However, as a result of the strenuous efforts of organized optometry to bring more children into our practices, this is going to change dramatically in the future. Based on manpower studies of practicing eye care professionals in the United States, it can be expected, if optometry is successful in legislating mandates for universal eye exams for children, that many optometrists will be seeing dozens, if not hundreds more children in their practices each year. Many of these children will
have binocular anomalies requiring diagnosis and treatment, and
many of the adults that are currently being seen will be newly dis-
covered to have binocular vision anomalies also requiring reme-
diation. There is a need to increase our efforts to properly
educate students and practitioners in their care.

Thus the reason for this manual. Simply stated, to provide an
accessible, maneuverable, and ready means of aiding the student
and clinician to care for patients with binocular vision anomalies.
This manual is not intended to supplant the role of the compre-
hensive text in providing a proper foundation in binocular
vision. As I said before, there are many excellent texts that do this
well. There is not, however, a single source that can be used on a
day-to-day basis to guide the student or practitioner actively
engaged in clinical practice to best serve the patient. The format
of this manual follows the style of the Wills Eye Manual, which
has become the universal handbook of ocular disease: extremely
accessible, clear, comprehensive, and perhaps most importantly,
easy to use under the pressure of active clinical practice. It is my
belief that this manual will fill a critical void in helping the clin-
ical optometrist to care for patients of all ages with binocular
anomalies, to make that care available to all ODs, even those
with minimal experience or interest, and to make them comfort-
able in providing that care by using a simple and standardized
methodology of diagnosis and treatment that is consistent with
efficient and effective clinical care.

I am delighted to have participated in the genesis and pro-
duction of this manual. For me, this has been emblematic of the
reconstitution of binocular vision and pediatric optometry to
what I believe is its central role in our profession, and specifically
to the New England College of Optometry. There has been a dra-
matic development of this department since I returned to the
College from the Boston Children’s Hospital and the Harvard
Medical School 6 years ago, where I practiced for the preceding
22 years. Senior faculty have been re-energized by the increasing
emphasis on binocular vision and pediatric optometry within
our institution and within the profession. Best of all has been the
development of an active, talented, and confident group of
young faculty with a strong commitment to providing a superior
education and patient care in binocular vision and pediatric
optometry. Watching the growth and development of this
extraordinary group of young educators and clinicians has been
the most satisfying professional experience I have had. I see this same thing happening in many other programs around the country, and can’t help but think that the next generation is in place to bring this area to the prominence within the profession that is essential for optometry’s advancement. Erik Weissberg has led our colleagues at the New England College of Optometry in a wonderful effort to produce a very important source of clinical knowledge and utility for our profession. I expect that it will fill a void that many of us believe exists, and lead to the student and practitioner becoming more comfortable and effective in delivery care to their patients.

Bruce Moore
Preface

The motivation and concept for this book was spawned from my early experiences as an optometric student and later confirmed after several years as an optometric educator. Originally I observed classmates and now I am observing my students, who leave the exam room somewhat perplexed by a binocular vision problem they may have just encountered. If the condition was of the disease variety, there were several textbooks suitable as the first book off the shelf. However, in the area of binocular vision, there was no book to serve in this capacity. With a multitude of excellent and exhaustive textbooks that explain “why”, there was an absence in the field of binocular vision of texts whose focus was simply to explain “what” to do. The purpose of this book is to fill that void. Used in conjunction with the more exhaustive types of texts, I believe that the knowledge needed to diagnose and manage patients with binocular vision problems will ultimately become more readily accessible to the clinician, leading to better and more comprehensive care for the patient.

The format and content of this book follows a unique approach to presenting clinically relevant information in this topic area. Directed at the primary care practitioner, it is suitable for anybody that has ever asked a question concerning binocular vision and wished that the person they asked would just give them the answer instead of all the background and theory. Special care has been taken to keep the text as succinct as possible while still providing the appropriate information and direction for the clinician.

The first part of the book presents specific clinical conditions organized by signs, symptoms, differential diagnosis, work-up, treatment, and follow-up. Each condition is written so it can
stand alone, but the potential to link with additional information is easily accomplished if needed. Specifically, if a clinical condition is mentioned as part of the differential diagnosis, a page number link is provided for the reader who would like more information on this topic. Furthermore, if a diagnostic or therapeutic technique is mentioned as part of the work-up or management, a page number link is provided to direct the reader who requires a step-by-step description of how to perform and interpret the technique. In this way, the original clinical condition sought after by the reader remains streamlined, with the pertinent information extracted quickly and easily.

The next major section of the book presents a step-by-step description of clinically relevant diagnostic techniques used in the work-up of binocular vision disorders. Care was taken to include those techniques that are easily performed in a primary care setting with minimal investment in special equipment. The clinical tools chosen are versatile and provide valuable information when dealing with patients of this variety.

The book concludes with two sections specially dedicated to the diagnosis and management of non-strabismic near point binocular vision disorders. These two sections were included because of the high prevalence of these conditions encountered in optometric practice. This is the area in which optometrists may be the most well suited to make the diagnosis and implement the management. First, a clinically relevant approach to diagnosing these problems is presented. The approach is specifically designed to be easily integrated into a primary care exam. The second section presents a general vision therapy program that is flexible enough to treat patients with any of the most common near point binocular conditions.

It is not a secret that optometry has slowly been shifting away from binocular vision while placing increased emphasis on ocular disease. Today’s recent graduate has vast knowledge of pathological conditions, but may be very uncomfortable when it comes to diagnosing common binocular vision disorders. Combine this with the fast pace of clinical practice, and it is not surprising that binocular vision disorders often go overlooked. Clinicians repeatedly express that they just don’t have the time to perform a binocular work-up as part of their examination. As educators, we often express our dismay and concern about this problem, but it is time to begin to do something about it. We
need to begin teaching in a way that will allow for the routine testing of binocular vision conditions in a primary care setting. We need to teach practical binocular vision for the primary care doctor as opposed to expecting everyone to be a specialist.

This book is something that I would have benefited from greatly during my early education. It is not trying to be something more than what it is: an easily referenced, concisely written manual to direct the primary care clinician in the diagnosis, management, and appropriate referral of patients with binocular vision disorders.

Erik M. Weissberg
I would like to express my sincere gratitude to the library staff of the New England College of Optometry, especially Claire Rork for her patience, humor, and expertise.

I would be remiss if I didn’t specifically thank several people that have been influential in my career thus far. Without the advice, guidance, inspiration, and opportunities afforded to me by Bruce Moore, Jack Richman, and Stacy Lyons, my career in academia may have never even begun.

Erik M. Weissberg
Non-Strabismic Binocular Vision Anomalies

RICHARD C. LAUDON AND ERIK M. WEISSBERG

1.1 Convergence Insufficiency

GENERAL INFORMATION
Convergence insufficiency (CI) is the most commonly recognized binocular dysfunction. This typically idiopathic and benign condition represents a mismatch between a patient’s visual capabilities and near point demands. Presenting symptoms may be mild to severe with a gradual onset. This may occur in elementary school, in college, or on the job as a result of increased workload. The majority of CI patients will have an associated accommodative dysfunction.\(^1,2\) In some cases, presenting symptoms may be coincident with the onset of presbyopia (reduction in accommodative function aggravating a preexisting fragile state of binocularity). CI has also been associated with reading difficulties and ADD.\(^3\)

SYMPTOMS
Some or all of the following symptoms may be reported after or during extended periods of reading:
- Double vision at near
- Words moving around the page and/or words swimming
- Eye pulling or straining
- Eye fatigue and/or eye strain
- Headaches *above the eyes*, later in the day, associated with reading and/or computer use
- Blurred vision or focusing problems at near
- Limited visual attention/concentration
- Avoidance of near point tasks

**SIGNS**

Reliable measurements should be confirmed by repeating abnormal test findings or by documentation of multiple measurements confirming the same diagnosis.

- Receded near point of convergence is greater than 6 cm. Immediate diplopia may be noted when the test is repeated while a red lens is held over one eye.
- Exophoria is present at near, typically greater than 6 to 8 prism diopters. Intermittent exotropia may be noted during near testing.
- Near lateral phoria testing may reveal higher exophoria than predicted by the cover test.
- Low positive fusional vergences based on Sheard’s criterion. (Compensating vergences must be twice the phoria measurement.)
- Low AC/A ratio (norm is 4:1).
- *Accommodative facility*: Difficulty clearing plus lenses oculus uterque (OU).
- Low negative relative accommodation (NRA)/High positive relative accommodation (PRA) (norm for NRA is +2.50, PRA −3.50).
- *Accommodative dysfunction* (p. 20): Signs of an associated accommodative dysfunction are typically present. (Some reports suggest accommodative insufficiency is most common, but it is the author’s experience that accommodative excess is most common.) Specific findings (monocular facility, amplitude, and Monocular Estimation Method [MEM] or FCC) depend on the type of accommodative dysfunction present.

**DIFFERENTIAL DIAGNOSIS**

- *Uncorrected refractive error*: Hyperopia, myopia, astigmatism, and especially anisometropia may be obstacles to visual effi-
ciency. After a prescription has been determined, a progress evaluation should reassess the patient’s near point function before one considers additional intervention.

- **Pseudoconvergence insufficiency**: The primary problem is an accommodative insufficiency that causes a secondary convergence insufficiency. Use of a plus add will improve the patient’s near point of convergence. Vision therapy may still be needed to resolve any residual difficulties.

- **Basic exophoria**: Large exophoria, equal in deviation at distance and near. Occasionally an intermittent exotropia may be present. If the deviation is intermittent and the patient’s condition is symptomatic, vision therapy is the preferred intervention. Prism spectacles may be a helpful alternative in certain cases.

- **Divergence excess**: Exophoria or exotropia is more significant at distance than near.

- **Convergence palsy**: Typically an acute onset of severely limited convergence with associated neurological signs and symptoms.

- **Myasthenia gravis**: May result in reduced convergence secondary to weakness of the medial rectus muscle. Ptosis, diplopia, blurred vision, and incomplete lid closure may also be present.

- **Vertical phoria**: A vertical imbalance from a CNIV paresis can cause a secondary binocular dysfunction. A head tilt indicates the possibility that this type of deficit is present.

**WORK-UP**

1. **History**: Are symptoms consistent with the functional etiology (onset, type, association with eye use)? Severity of symptoms (do they interfere with school or office work)? Associated neurological symptoms?

2. **Correct any refractive error**: If a significant refractive error is present, recommend a progress evaluation in 1 to 2 months to reassess binocular and accommodative function with spectacles.

3. **Distance binocular profile**: Measurement of distance phoria and compensating vergence range should be performed to rule out divergence excess and basic exophoria.

4. **Near point binocular vision work-up**: Cover test, near lateral phoria, near point of convergence (NPC) (light, red glass and through +1.00), AC/A ratio, fusional vergence ranges,
accommodative facility, amplitude of accommodation, and monocular estimation method or FCC.

5. **Stereopsis**: Local (Wirt circles) and random-dot stereopsis should be assessed. Absence of or reduced stereopsis should raise one’s suspicions about the presence of a strabismus.

6. **Cycloplegic refraction (p. 179)**: Rule out latent refractive error when indicated.

**TREATMENT**

- **Home/Office-based vision therapy (p. 197)**: Considered to be the treatment of choice for CI, vision therapy has been shown to be effective.\(^5\)\(^-\)\(^7\) The duration of treatment may vary, but approximately 2 to 3 months with good compliance are usually adequate. One-hour office visits every 1 or 2 weeks to monitor progress and implement changes are required.

- **Pencil push-up therapy (Box 1.1-1)**: An easier and quicker approach to the treatment of CI. This therapy requires minimal office visits, but the lack of patient compliance and motivation can be a major obstacle. This therapy has been shown to alleviate symptoms in some patients.\(^8\)

- **Visual hygiene**: Patient education concerning multiple breaks of short duration during near point tasks. Fixation should be

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**BOX 1.1-1**

**Directions for Pencil Push-up Therapy**

1. Hold and fixate on pencil tip at 40 cm.
2. Slowly move pencil tip toward the nose until it “doubles.”
3. Move pencil tip 1 to 2 cm away from nose until it is “single” again.
4. With pencil tip held at the distance determined in step 3, shift fixation to a distance target (approximately 3 meters away).
5. Shift fixation between the pencil tip and distance target 10 times, holding fixation on each for 3 seconds.
6. Repeat steps 1 to 5 for a total of 3 to 5 minutes daily until symptoms are alleviated.

**Goal:** Move pencil tip 2 to 3 cm from nose and retain single and comfortable vision. Patients can be further instructed to note that when they look at the pencil tip, the distance target should appear double and vice versa. This phenomenon is normal and serves as a suppression check during this exercise. If this observation is not appreciated by patients, they should be encouraged to pursue a complete vision therapy program (p. 197).
upon a distance target during the frequent rests of 1 to 2 minutes. The patient’s attention can be drawn to the importance of maintaining an adequate and consistent working distance (40 cm or Harmon’s distance) throughout near point work. Harmon’s distance is the length between the elbow and the middle knuckle of the index finger.

- **Spectacles:** Although not the treatment of choice, lenses can improve visual efficiency and adequately alleviate symptoms in certain cases.

- **Addition lenses:** The use of plus lenses for reading can benefit those CI patients with an associated accommodative insufficiency. A proper binocular work-up (p. 186) will clearly identify those patients who may fall under this category. The power of the lenses falls typically between +.75 and +1.25, with the optimal prescription determined through trial framing and the repetition of abnormal binocular tests through the addition lens (i.e., NPC, NRA/PRA, facility testing, MEM).

- **Prism:** The use of a base-in prism in combination with plus lenses or by itself may benefit certain CI patients. First perform a prism adaptation test (p. 172). Only consider a prism prescription if the patient is not a prism adapter. Magnitude typically falls between 2 to 6 total prism diopters, split between the two eyes (e.g., 3 prism diopters would be prescribed as 1.5 pd base-in OD and 1.5 pd base-in OS). Satisfy Sheard’s criterion to determine the starting prism power (Box 1.1-2). Refine power through trial framing for comfort. Patients who are going to benefit from a prism typically have a positive reaction during trial framing.

**FOLLOW-UP**

Because CI, with the exception of symptoms, is considered a benign condition, cases can be followed depending on treatment.

- **Vision therapy:** Followed every 1 to 2 weeks until completion
- **Spectacle intervention:** Initially followed in 1 to 2 months to evaluate effectiveness of glasses
- **Education or visual hygiene only:** Followed yearly or as needed if symptoms increase
BOX 1.1-2
Sheard's Criterion and Determination of Prism Spectacles for CI Patients

1. According to Sheard’s criterion, the compensating vergence should be twice the phoria. If the criterion is not met, the patient is likely to have symptoms. If the criterion is satisfied, symptoms are likely to be relieved.  
2. The least amount of prism that satisfies Sheard’s criterion should be the starting point for the trial framing of a prism prescription.  
3. A patient with an exophoria of 12 and a base-out break point of 18 is likely to be symptomatic, because Sheard’s criterion has not been met.  
4. Prescribing 3 prism diopters base-in would reduce the exophoria to 9 and increase the base-out break point to 21. This prescription would satisfy Sheard’s criterion and should be used as the starting point for trial framing.  
5. If satisfying Sheard’s criterion necessitates the use of greater than 10 to 12 total prism diopters, a prism prescription is not likely to prove successful. The patient should be strongly encouraged to pursue a complete vision therapy program (p. 197).

REFERENCES

1.2 Convergence Excess

GENERAL INFORMATION
Convergence excess (CE) is a common binocular dysfunction that can cause significant visual symptoms. Symptom onset is typically experienced during or in association with extended near point tasks, such as reading or computer work. It is not uncommon to find an associated accommodative dysfunction (p. 20) when convergence excess is present. Symptoms resulting from CE can often be alleviated by the use of plus lenses for reading, or sometimes by vision therapy.

SYMPTOMS/BEHAVIORS
Symptoms typically experienced after or during prolonged near point tasks include the following:
- Print swimming or moving around, and/or words running together
- Diplopia
- Eye strain/fatigue
- Pulling sensation around the eyes
- Headaches above the eyes late in the day
- “Over-focusing” problem
- Blurred vision (may be reported at distance or near)
- Avoidance of near point activities

The following behaviors may be observed in CE patients:
- Holding reading material close
- Tendency to close an eye
- Possible head tilt after visual fatigue (may be noticed at the end of the exam)

SIGNS
The magnitude of esophoria has been shown to correlate with the presence of symptoms.
- Esophoria is greater at near than at distance.
- High AC/A ratio (greater than 5:1).
- Low divergence ranges (BI) in comparison with the phoria and/or highly elevated convergence ranges (BO) at near.
- Near point of convergence (NPC): To the nose.
- Accommodative facility: Difficulty or inability clearing minus lenses OU.
- High NRA/Low PRA (less than 1.25): May be associated with convergence excess but does not exclude other possible binocular vision disorders.
- Accommodative dysfunction (p. 20): Signs of an associated accommodative dysfunction are typically present (most commonly accommodative excess). Specific findings (monocular facility, amplitude, and MEM or FCC) depend on the type of accommodative dysfunction present.

**DIFFERENTIAL DIAGNOSIS**

- **Refractive error**: An uncorrected refractive error (typically hyperopia or overcorrected myopes) can mimic a convergence excess. Symptoms and signs will typically be alleviated once the refractive error is corrected. Cycloplegic refraction should be performed.
- **Basic esophoria**: The magnitude of the esophoria is similar at both distance and near. Treatment should be focused on eliminating the esophoria through lenses or vision therapy.
- **Divergence insufficiency (p. 53)**: Esophoria is greater at distance than at near. Occasional diplopia in the distance may be reported. This is a rare condition; suspect lateral rectus weakness and consider a neurological consult.
- **Pharmacological causes**: Certain drugs can cause overconvergence and an accommodative spasm (e.g., Eserine, Pilocarpine). Careful patient history should elicit a connection between the onset of symptoms and the beginning of or change in the dosage of the medication.
- **Convergence spasm**: Characterized by intermittent episodes of esophoria at near, accommodative spasm, and pupil constriction. The spasm may result from a serious underlying pathologic cause, from local inflammation, or more commonly as a result of a “hysteric” or neurotic personality. Tubular fields may be present in the latter scenario.
WORK-UP

1. **History:** Are symptoms consistent with the functional etiology (onset, type, association with eye use)? Severity of symptoms (do they interfere with school or office work)? Recent change in medications?

2. **Correct any refractive error:** If a significant refractive error is present (especially hyperopia), recommend a progress evaluation in 1 to 2 months to reassess binocular and accommodative function with spectacles.

3. **Cycloplegic refraction (p. 179):** Needed in cases in which latent hyperopia is suspected or refractive error is fluctuating. Esophoria at near may be a sign of latent hyperopia.

4. **Distance binocular profile:** Distance phoria testing should be performed and compensating vergence range measured to rule out divergence insufficiency (p. 53) and basic esophoria.

5. **Near point binocular vision work-up (see p. 186):** Cover test, near lateral phoria, NPC (light, red glass, and through +1.00), AC/A ratio, fusional vergence ranges, accommodative facility, amplitude of accommodation, and monocular estimation method or FCC.

6. **Stereopsis:** Local (Wirt circles) and random-dot stereopsis should be assessed. Absence of or reduced stereopsis should raise one’s suspicions about the presence of a strabismus.

7. **Pupils:** Rule out miosis associated with a convergence spasm.

8. **Visual fields testing:** Performed in cases when a “hysterical” cause is suspected.

TREATMENT

- **Plus reading lenses for near:** Treatment with plus reading lenses is considered to be the most effective. The magnitude of the esophoria at near has been directly correlated to the likelihood of symptoms, and as such the effort to alleviate symptoms should be focused on eliminating the esophoria.\(^3\)\(^4\) A typical near prescription ranges from +.75 to +1.25 if hyperopia is not present. (This may be higher if the patient is hyperopic.) Repeat the modified Thorington (p. 153) or cover test to ensure elimination or adequate reduction of esophoria at near while the patient is wearing the spectacles. Perform a trial framing of the near prescription to ensure the patient’s comfort and recheck near visual acuity (VA). The response to near point