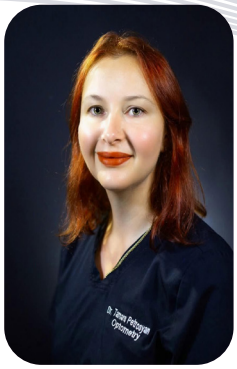
Student Corner • An Approach to Understanding Strabismus Diagnosis: Part 2 – Clinical Testing and Evaluation

Tamara Petrosyan, OD • SUNY College of Optometry • New York, New York



Tamara Petrosyan, OD
New York, New York

Associate Clinical Professor, SUNY College of Optometry and East New York Diagnostic and Treatment Center

OD, SUNY College of Optometry, 2009

BA, Ithaca College, 2006

Residency, Northport Veterans Affairs Medical Center

Director Trustee, OEPF

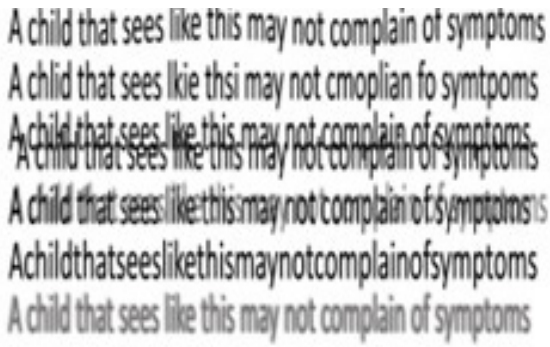
Introduction to Strabismus

In previous installments, we established that strabismus is rarely a simple muscle issue; it's a complex disruption in the interplay between sensory input and motor output. We now shift to the objective rigor of clinical examination. The aim isn't just data collection—a raw measure like "30$^{\Delta}$ constant right esotropia" lacks context without understanding why the brain permits it or how the visual system adapts. The clinician must analyze visual behavior.

Strabismus often stems not from inherent muscular defects but from disruptions in the brain's visual-motor learning. This view moves focus from anatomy to neuroadaptive processes, where the system compensates via suppression or altered retinal correspondence. In young children, plasticity enables quick adaptations, but untreated cases can lead to amblyopia in up to half of congenital instances. Risk factors like prematurity, genetics, or neurological conditions heighten susceptibility, with higher prevalence in developmental delay groups. A developmental perspective guides practice: many cases feature reshapable adaptive responses.

Classification of Strabismus

Goal	Description	Key Components Assessed	Clinical Importance	Integration with Diagnosis and Treatment
Quantify Deviation Magnitude, Comitancy, and Frequency	Measure in prism diopters (Δ); assess if consistent across gazes (comitant) or varies (>5$^{\Delta}$ incomitant)	Primary/9 gazes, distance/near; prisms for neutralization	Differentiates central (comitant) from peripheral (non-comitant, e.g., palsies/tumors)	Guides DDx (comitant refractive vs. incomitant paretic); informs surgery or VT
Assess Binocularity and Fusion Potential	Evaluate levels (simultaneous/flat/stereopsis); test reserves/amplitudes	Stereopsis (nil = constant tropia); fusion ranges (30-40$^{\Delta}$ convergence); Worth 4-Dot/Bagolini	Identifies hardware for fusion vs. software workarounds (suppression/ARC); principal objective: functional binocularity potential	Predicts VT success (intact stereopsis = strong potential; absent = limited plasticity); anti-suppression before fusional work
Detect Sensory Adaptations	Identify suppression (central/peripheral), ARC (harmonious/unharmonious), eccentric fixation	Worth 4-Dot (2-3 dots = suppression); Bagolini for rivalry/ARC; visuoscopy for eccentric fixation locus and stability	Reflects neuroplasticity; suppression avoids diplopia but risks amblyopia (40-50%); ARC enables pseudo-fusion (30% infantile)	Influences prognosis (shallow suppression 75-85% VT; deep eccentric 50-60% poorer); guides sequencing (non-dissociative first)
Rule Out Underlying Pathology	Exclude organic causes (tumors/palsies 5-10%, macular anomalies)	Dilated fundus/OCT; motility for restrictions; neuroimaging red flags (acute/incomitance)	Prevents misattribution; early detection averts complications (amblyopia 1-5% untreated)	Mandatory minimum: fundus/optic/macula/pupil/motility; ancillary if suspicions (e.g., three-step for vertical)
Align Patient's Intervention Goals with Realistic Expectations	Identify patient's priorities (e.g., cosmetic alignment for appearance/self-esteem in 20-30% school-age, more control over intermittent turn for daily function, gain stereopsis for depth perception/hand-eye coordination) and ensure they match clinician's assessment of achievable outcomes based on age/onset/plasticity	History-taking (FLORIDAS associations/severity); discussion of functional vs. cosmetic aims; prognostic indicators (e.g., early onset/harmonious ARC = good for peripheral stereopsis gain; late/deep suppression = limited, focus on control/cosmetics)	Bridges patient-centered care with evidence-based reality; long-term success relies on functional gains (e.g., binocularity maintenance) over pure cosmetics; addresses psychosocial impacts (bullying/low esteem) and sets expectations to avoid dissatisfaction	Integrates with overall plan: e.g., VT for stereopsis/control in responsive cases (75-85% success if shallow adaptations); surgery + VT for cosmetics in limited plasticity; regular follow-ups to refine goals and monitor alignment between patient desires (e.g., no diplopia for driving) and feasible results (e.g., cosmetic success with adjustable sutures)



Key Principles

A foundational principle in strabismus evaluation is the "minimal disruption" sequence: prioritize tests that preserve natural binocular function before introducing elements that separate the eyes' inputs. Many patients maintain fragile fusion in everyday settings, which can collapse under dissociation (occlusion), leading to misleading results, such as diagnosing constant deviation when it is actually intermittent. Starting with non-invasive, open-space observations and progressing to more dissociative methods avoids artifacts that skew the assessment.

Another key tenet is integrating objective and subjective data to gauge functional improvement potential. Evaluations must go beyond measuring deviation angle to probe the brain's drive for unified vision, evidenced by signs of ocular synergy/fusion. Patient adaptations (head tilts, suppression) provide critical clues to mechanisms and prognosis. Age-appropriate modifications are essential: engaging stimuli and gamification for children, clear explanations and rationales for adults to build rapport and reduce anxiety. Watch the patient during testing instead of relying on just the numbers: a patient might have a 'normal' NPC but under great distress, strain, and grimacing, with signs of discomfort such as head or eye rubbing after the test.

Cultural sensitivity and communication adaptations are also core. Tailor interactions to diverse backgrounds, using interpreters when needed and avoiding assumptions about family dynamics or stigma around eye conditions. Finally, the evaluation must rule out pathology (ocular, systemic, neurological) through dilated fundus exams, pupil reflexes, motility analysis, and imaging when indicated, differentiating sensory strabismus from serious causative etiologies early. A careful anterior segment evaluation to rule out ocular surface disease is also critical. With the rise of dry eye syndrome and ocular surface disease in both the pediatric and adult populations, many patients suffer from decreased BCVA due to tear film instability or superficial punctate keratitis (SPK), leading to a breakdown in fragile binocular systems.

We are not simply measuring a deviation; we are probing a living, adapting visual system. Every test asks the brain: Do you have the hardware for fusion? Have you developed workarounds like suppression? Is the deviation driven by accommodative effort or alignment failure? Accurate answers require a least-to-most dissociative sequence to protect fragile binocularity.

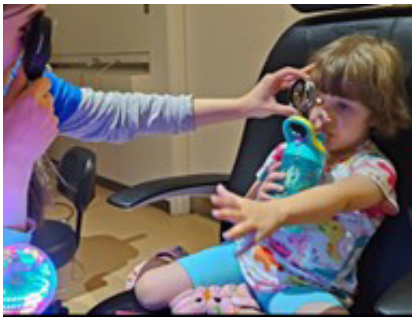
The strabismus evaluation seeks to uncover the "why" behind the deviation and guide tailored interventions. Key goals include:

- Quantify and Classify the Deviation: Type (eso/exo/hyper deviation, horizontal/vertical/diagonal/torsional diplopia), magnitude (prism diopters), laterality (OD/OS/alternating, preferred fixation eye if alternating), constancy (constant vs. intermittent, control level and time unfused if intermittent), comitance (stable vs. varying across gazes).
- Assess Binocularity and Sensory Status: Fusion potential (stereopsis <60 arc sec = good prognosis), suppression depth, adaptations, amblyopia risk (40–50% in constant unilateral strabismus cases).
- Identify Etiology and Rule Out Pathology: Differentiate refractive (70% accommodative esotropia resolve with +Rx), sensory, motor, neurological (CN palsies, 6% tumor in acute acquired), or systemic causes (thyroid in 10–15% adults) via cycloplegia, fundus exam, and red-flag checks.
- Evaluate Functional Impact: Academic/occupational strain, psychosocial effects (stigma in 25% children), motor integration (midline jumps).
- Determine Prognosis and Management Pathway: Integrate data for outcomes; early onset with good stereopsis favors high recovery; deep suppression limits expectations. Consider full options: refractive correction, prisms, vision therapy, partial occlusion, surgery, interdisciplinary care. If ARC is present, strongly consider keeping the ARC intact but optimizing the fusional, vergence, accommodative, and oculomotor function around that ARC instead of attempting to break the brain's sensory adaptation.
- Ensure Patient Education and Compliance: Clear explanations of findings, rationales,

treatment options, and patient participation expectations to foster adherence and long-term success. In rehabilitation, patient participation and effort results in faster and better results. However, in some rare complicated cases, no matter the effort, unrealistic results might be unattainable.

- Facilitate Interdisciplinary Care: Flag referrals for collaborative or emergency management.

Testing must be tailored to age, cooperation, and onset. Infantile cases require rapid amblyopia screening; adult-acquired cases warrant systemic/neurological red-flag checks. The protocol is a multi-tiered process integrating objective and subjective tests to quantify misalignment, assess binocularity, evaluate adaptations, and exclude pathology, all while prioritizing the natural visual state with a least-to-most disruptive sequence.



Monocular Indirect

Overview of Hierarchical Workflow

The evaluation follows a logical progression designed to capture the patient's natural visual state before risking disruption, ensuring that findings reflect real-world function. It begins with a thorough history to uncover onset, symptoms, and contextual factors, which inform the rest of the process. Early stages focus on non-dissociative assessments in free space to gauge baseline binocularity without interference. Subsequent phases introduce mild then full dissociation, quantifying deviations and accommodations while monitoring for sensory adaptations that the brain has made as a response to the strabismus. Advanced instrument-based and auxiliary tests are reserved for specific indications, like suspected muscle weaknesses.

The "Dual-Track" Diagnostic Approach

Effective diagnosis requires the clinician to operate simultaneously on two parallel tracks. Focusing on only one often leads to misdiagnosis or incomplete management plans.

- Track 1: The Structural and Pathological Evaluation (The Classical Model). This track focuses on the "hardware" of the visual system. It asks: Is the strabismus caused by a physical defect, a neurological injury, or systemic disease?
  - Key Questions: Is the deviation comitant or non-comitant? Is there a restriction (Brown syndrome) or a paresis (CN VI palsy)? Are there "Red Flags" like papilledema or sudden onset that require urgent evaluation?
  - The goal is to rule out life-threatening or sight-threatening pathology and to identify mechanical obstacles that might render functional therapy ineffective (fractured orbital floor).
- Track 2: The Functional and Performance Evaluation (The Behavioral Model). This track focuses on the "software"—how the patient uses their visual system to interact with the world. It views strabismus as an adaptation to visual stress rather than a mere mechanical model. Binocularity relies on both mechanical

Pathophysiological Mechanisms of Strabismus

Mechanism	Description	Contributing Factors	Prevalence/Examples
Neural Control Imbalance	Disruptions in brainstem/cortical pathways impairing fusion/vergence	Abnormal development (saccade generator, vergence control); CN palsies (VI esotropia)	40% infantile (brainstem variants); 5-10% acquired palsies
Systemic and Neurological	Underlying diseases affecting EOM/neural network	Thyroid (15% acquired), stroke/MS (10%), hydrocephalus (5-10%); genetic (FRMD7 mutations 20-30%)	DS (30% esotropia, hypotonia); CP (50% amblyopia)
Sensory Deficits	Reduced input leading to misalignment (e.g., amblyopia triggers suppression)	Uncorrected refractive (hyperopia >+3D); macular anomalies (5-10%)	40-50% amblyopia in unilateral constants; ROP sensory eso
Mechanical Restrictions	Physical limitations in EOM movement	Fibrosis (CFEOM), restrictions (thyroid inferior rectus 80%); trauma	10-20% non-comitant; Duane co-contraction
Refractive and Accommodative	Focusing errors driving excess convergence	Hyperopia/high AC/A >6:1 (60% pediatric esotropia)	36% fully accommodative; 40% convergence excess

precision (motor) and neural interpretation (sensory), with interplay explaining why strabismus can persist asymptomatically through adaptations.

Refraction and Optimal Correction Assumptions

A detailed and comprehensive refractive analysis (often with cycloplegic refraction using either 2 drops of 1% tropicamide or 1 drop of 1% cyclopentolate), including near add consideration, is frequently performed prior to the strabismus evaluation. All testing in the strabismus workup should use the updated prescription that provides clear vision and optimizes binocularity at distance and near.

"Thumb Cover Test"

Refraction is pivotal in strabismus evaluation, as uncorrected refractive errors can precipitate or worsen misalignment. For instance, significant hyperopia may cause inward turns via excessive accommodation, while myopia or anisometropia could lead to outward drifts or suppression. Refraction focuses not just on sharp monocular vision but on optimizing binocular clarity, enabling eyes to function as a unit to reduce strain and support fusion. This baseline correction ensures accurate assessments, as uncorrected deviations can mislead diagnosis. Prescription changes can shift alignment; e.g., plus lenses may relax esotropia in accommodative cases. This setup reveals the patient's true functional potential, avoiding artifacts from errors.

Gently hold chin / head to prevent head movement

Lens paddle occludes the other eye in free-space retinoscopy

All strabismus testing should occur with the sharpest and best binocular prescription. If it differs from habitual, update lenses before proceeding. If refraction is revisited during evaluation (e.g., for new symptoms), do it early to minimize impact on later tests. If new refraction varies from habitual, repeat affected key tests through the updated Rx (NPC, stereopsis, cover test, phorias, dynamic retinoscopy, facility testing, etc.).

Differences between habitual and new prescriptions uncover adaptive histories: e.g., improved fusion with updates implies prior errors caused decompensation. Optimal refraction benchmarks performance; stable or enhanced post-change results validate it and refine differentials, separating accommodative from constant strabismus.

Clinical Tips

- Prioritize binocular endpoints during subjective refraction to emphasize binocular function over isolated acuity.
- Consider emmetropization, binocularity, amblyopia risk, and visual needs to finalize the best Rx in pediatric patients.
- For non-verbal patients, use behavioral cues like visual interaction, looking behavior, attention span or head turns to gauge clarity and acceptance.
- Document both pre- and post-correction deviations to track changes accurately.

Initial Patient History and Observation

Gathering a detailed patient history forms the bedrock of strabismus evaluation, yielding the majority of diagnostic insights—typically two-thirds of the information for a complete clinical profile. This step transcends fact-finding: it builds rapport with patients and caregivers, uncovers the condition's timeline and nature, and identifies contributing factors influencing diagnosis and management. In strabismus, history differentiates developmental adaptations (where the visual system copes with misalignment) from acute or pathological causes needing urgent intervention.

Strabismus often arises during visual maturation, with many infants displaying temporary misalignments that resolve as binocularity develops. Persistent deviations stem from etiologies like refractive errors, neurological issues, or genetic predispositions. A thorough history reveals physical, functional, and emotional impacts—e.g., how misalignment affects daily activities, social interactions, or self-esteem. In children, subtle signs like eye rubbing or task avoidance may signal

A full exam can be done in the stroller or on the floor - go where the patient takes you

Dr. Petrosyan's Refraction Considerations in Pediatrics

(Heavily based on Leat's To Prescribe or Not to Prescribe 2011 publication)

Refractive Error	Age	Recommendation
Hyperopia Amblyogenic >5 D Isometropia >1 D Anisometropia	0-1 years	Consider Rx if VA poorer than 20/400 or if ET
	1-4 years	Consider if above 3.50 D or if ET Under correct by 1 D to allow emmetropization but prevent amblyopia / ET
	4-5 years	Consider if above 2.50 D or if ET, reduced BCVA or stereo Under correct by 1 D to allow emmetropization but prevent amblyopia
	>6	Consider if above 1.50 D Consider visual needs and BCVA, symptoms, NVA and binocular posture Full to near full Rx, Consider NVO specs or bifocals
Myopia Amblyogenic >8 D Isometropia >3 D Anisometropia	0-1 years	Consider if above 5.00 D Under correct by 2-3 D to allow emmetropization but prevent amblyopia
	1-4 years	Consider if above 2.00 D Under correct by 0.50 - 1 D to allow emmetropization but prevent amblyopia (caution in patients that show myopia progression or high risk of progressive myopia as this may aggravate myopic progression)
	4-5 years	Consider if above 1.00 D Full to near full Rx Near esophoria or high lag of accommodation – consider add
	>6	Consider if above 0.75 D Full Rx
Astigmatism Amblyogenic >2.50 D Isometropia >1.50 D Anisometropia	0-1.5 years	Consider if above 2.50 D and REGULAR - Decrease by 50% to allow emmetropization but prevent amblyopia Consider if above 1.00 D and OBLIQUE - Decrease by 1/3 to allow emmetropization but prevent amblyopia
	2-4 years	2 yo: consider if above 2.00 D, decrease by 1 D to allow emmetropization but prevent amblyopia 4 yo: consider if above 1.50 D with full to near full Rx, emmetropization coming to an end for astigmatism
	>6	Consider if above 1.00 D (>0.75 D Oblique) with full cylinder
Anisometropia Amblyogenic >1.00 D Hy >3.00 D My >1.50 D Astig		Correct full anisometropia and astigmatism if amblyopic - Especially if greater than 0.75 D hyperopic, 2.50 D myopic, or 1.00 D astigmatic anisometropia Keep accommodative demand equal between eyes (undercorrect sphere by same amount)

discomfort or suppression; in adults, sudden onset points to systemic concerns or a decompensation of a phoria due to recent illness, stress, head trauma, or age. When a phoria decompensates in an adult, it may appear as a sudden-onset strabismus but evaluates as a long-standing problem (i.e., new onset diagonal diplopia with expanded vertical ranges (>6^ supra/ infra) on testing and longstanding head tilt to the contralateral side on examination showing a decompensated SO weakness). This phase blends objective observations with subjective reports, tailoring subsequent testing. Viewing strabismus neuroadaptively highlights the brain's role in processing, where misalignments may be learned responses rather than fixed defects.

PASS RDS forced preferential looking

Use a structured, flexible framework to collect data, adapting to age, cognition, and culture. For adults/older children, interview directly with simple analogies. In pediatrics, provide pre-visit questionnaires for caregivers to complete over days, with input from multiple observers (parents, teachers, therapists, babysitters) for a well-rounded understanding of the deviation from multiple sources. Observe non-verbal cues like head positioning or eye movements for compensatory clues. Document thoroughly, noting inconsistencies or symptom evolutions for follow-ups. Conclude by summarizing key points to confirm understanding and transition to testing.

Key Components of History-Taking

1. Onset and Progression:
   - Explore first notice and changes: early (first 6 months) often large, steady inward turns with suppression; later ties to refraction/injuries.
   - Inquire on milestones: smooth pursuits to visually interesting targets by 8 weeks, aligned gaze by 4 months; delays signal developmental issues and possible need for other interventions (OT/PT/ST). Persistent exo beyond 6 months may become intermittent exotropia; preschool eso shifts link to accommodation effort.
   - Risks: early birth, low weight, syndromes with muscular/neurological elements elevating misalignment chance.
2. Symptoms and Associations:
   - Visual complaints (overlaps, blur, near strain); non-visual (headaches, dizziness, head postures); triggers (fatigue, near working distances) indicating decompensation.
   - Linked conditions: refractive needs, past treatments, systemic issues (neurological/genetic). Family patterns inform genetic counseling need.
   - Functional impacts: children's play/learning/academics/coordination; adults' driving/reading/occupation/hobbies.
   - Address emotional aspects (bullying/anxiety) for psychosocial burden.
3. Family History and Risk Factors:
   - Relatives with eye conditions/refractive errors/related disorders; parental strabismus significantly raises offspring risk.
   - Environmental/health risks: prenatal exposures, birth complications, chronic illnesses impairing development; screen time/nutrition/trauma exacerbating vulnerabilities.
4. Prior Interventions and Management:
   - Previous evaluations, corrections (glasses/patches), therapies/surgeries; outcomes/adherence. Note non-optometric interventions (speech/occupational/physical therapy, school 504 or Individualized Education Program (IEP)).
   - Current coping (head tilts/eye closure/task avoidance) indicating adaptations. Past successes/failures refine plans and expectations.

Interpret findings by correlating with etiologies: infantile esotropia requires surgical intervention, ideally within 6 months of onset to optimize binocular potential while intermittent later-onset exotropia favors non-surgical management. Strong family history/syndromes imply complexity while isolated accommodative esodeviation predicts favorable lens/therapy responses.

Clinical Tips

- Start with open-ended questions to encourage detailed responses, then narrow to specifics.
- For anxious patients, incorporate breaks or positive reinforcement to maintain engagement. Use visual props, like diagrams of eye alignment, to explain concepts without jargon.

FLORIDAS Mnemonic for Strabismus History-Taking

Component	Description	Clinical Relevance and Examples
F – Frequency	How often does the eye turn occur? (constant vs. intermittent)	Assesses stability; intermittent often decompensates under stress/fatigue, constant increases amblyopia risk
L – Laterality	Which eye is deviating? (right eye, left eye, or alternating between both)	Differentiates unilateral from alternating (if alternating, note whether one eye has a fixation preference over the other)
O – Onset	When did the deviation first start? (congenital/infantile vs. acquired). Sudden onset in adults or older children is a major red flag.	Congenital (0-6 months): large >40$^{\Delta}$, 40-50% amblyopia, linked to prematurity Early-onset (6-36 months): refractive triggers, 70% resolve with correction Later-onset (>36 months): acute often warrants systemic and neurological workup
R – Relief	Does anything make it better? (wearing glasses, looking in a certain direction, resting)	Identifies compensatory mechanisms; e.g., glasses relieve accommodative esotropia fully or partially, head posture for non-comitant deviations, rest for fatigue-induced intermittents

I – Inciting Factors / Injury	What triggers the deviation? (fatigue, illness, near work, stress) Was there a history of trauma/ injury?	Uncovers environmental/systemic triggers; e.g., near work in accommodative types (high AC/A >6:1), stress in decompensated phorias, trauma or other systemic/neurologic signs in acquired palsies (urgent evaluation)
D – Direction	Which way does the eye turn? Which direction is the diplopia?	Guides classification; esotropia, exotropia, vertical, torsional. Horizontal, vertical, diagonal binocular diplopia which resolves when one eye is covered.
A – Association	Are there associated symptoms or conditions?	Links to comorbidities; diplopia, headaches, reduced vision, systemic symptoms or disease, psychosocial, etc
S – Severity / Surgery	How large is the deviation (magnitude)? Has there been previous strabismus surgery or treatment (patching, VT)?	Quantifies in prism diopters (Δ); small <15$^{\Delta}$ better outcomes; large >40$^{\Delta}$ congenital red flag; prior treatments; assess residuals/adaptations

- When starting out, document in a standardized template to ensure no key areas are missed, and flag red flags (e.g., sudden adult onset) for immediate further evaluation/referral.
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Random Dot Stereopsis (RDS) via Lang or Frisby Tests

Assessing random dot stereopsis (RDS) is a critical early step in strabismus evaluation, offering insight into global depth perception without relying on recognizable shapes discernible monocularly. It is often the first test I perform on patients. This assesses the brain's processing of disparate images into a unified 3-D view, reflecting cortical fusion integrity. Stereopsis typically emerges at 3-6 months, aligning with binocular maturation; disruptions from misalignment cause reduced/ absent stereo, often with adaptations like suppression.

Reaching and pointing to stereo targets

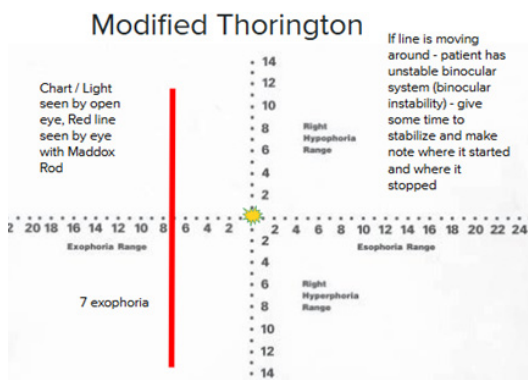
RDS tests are valuable for minimizing monocular cues, ensuring that positive results reflect true binocular cooperation and bifoveal viewing, not guessing or dominance. Lang or Frisby stereotests enable quick free-space administration without glasses, preserving natural environments and avoiding early dissociation that skews findings. In strabismus, absent/coarse stereopsis signals deep adaptations (e.g., in constant deviations ignoring conflicts); partial stereopsis indicates residual binocularity, a positive prognostic sign for fusion-enhancing interventions. This fits the sensory-motor framework: sensory integrity underpins motor stability; poor results guide probing issues like unequal inputs, while strong performance suggests rehabilitation potential.

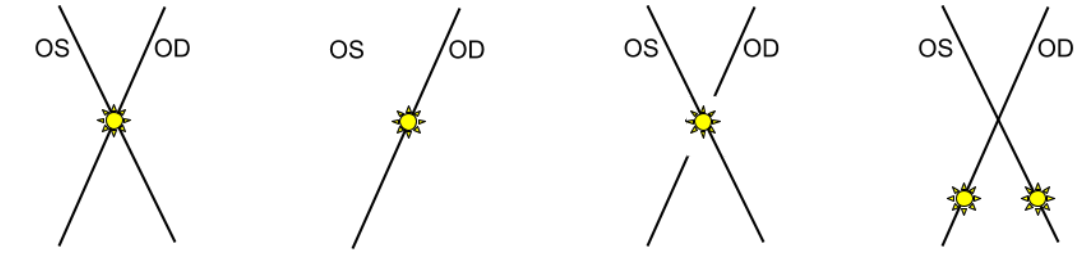
Motor Fusion vs. Sensory Fusion

Motor fusion and sensory fusion form the two interdependent pillars of binocular vision—often likened to the mechanical "hardware" (motor fusion for alignment) and perceptual "software" (sensory fusion for integration). Motor fusion provides the physical alignment needed for sensory input to be processed, while sensory fusion merges those inputs into a unified percept. This distinction is essential: basic vergence emerges at 1 month, with convergence to targets by 2 months, preceding sensory fusion; full stereopsis develops by 24 months. Conversely, sensory fusion "glues" motor alignment, preventing drift.

Poor motor fusion may signal neurological issues (e.g., CN palsy); disrupted sensory fusion points to cortical adaptations (e.g., amblyopia). Strong motor fusion with intact sensory potential is a major green flag for vision therapy success; deficits in both often require multimodal intervention.

Motor fusion is controlled by extraocular muscles and cranial nerves III, IV, VI, mediated by brainstem centers (midbrain for convergence, pontine for





Patient view with No **Subjective** Strabismus. If covert test shows no movement = **NRC**. If Cover Test shows movement = **ARC**.

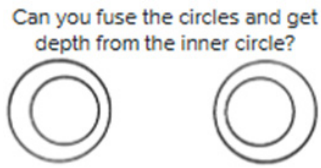
OS Suppression

OD Central Scotoma

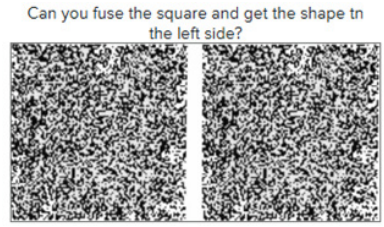
2 lights below X → Exotropia

Bagolini Lens - Patient View

horizontal vergence). Pulse discharges initiate movements; step discharges maintain position against orbital elasticity. In strabismus, deficits appear as tropias/phorias from muscle imbalance, paresis (e.g., CN VI limiting abduction, causing esotropia), or restriction (e.g., thyroid eye disease, 80% inferior rectus). Uncompensated cases cause asthenopia or diplopia, especially in adults with reduced plasticity. Strong, comitant motor function (full versions/ductions with equal magnitude across gazes) is a green flag for therapy; noncomitance (>5$^{\Delta}$ difference) signals red flags like restriction or palsy. Versions grading over/underaction helps differentiate paretic (free forced ductions) from restrictive (resistance) dysfunction, guiding diagnosis and referrals.



Sensory fusion is the neural "software" integrating slightly different images into one with depth in the visual cortex. It is highly plastic and adaptive: motor alignment enables sensory fusion, which in turn stabilizes motor alignment. Processing begins in V1 for disparity detection, with extrastriate areas (V2-V5/MT) computing depth. In strabismus, sensory adaptations compensate motor deficits via suppression (avoids diplopia in 70-80% constant cases) or ARC (30% harmonious pseudo-binocularity); eccentric fixation (non-foveal point used monocularly) occurs in strabismic amblyopia or macular disease; horror



Level	Description	Neurological Basis	Development	In Strabismus	Testing	Details
Simultaneous Perception (First-Degree Fusion)	Basic awareness of images from both eyes without overlap or fusion; prerequisite for higher levels of fusion.	Involves initial cortical recognition in V1 of inputs from corresponding retinal points, allowing simultaneous localization without fusion; absent in suppression where inhibitory interneurons dampen one eye's signal	Emerges by 2-3 months as subcortical reflexes transition to cortical control	Often absent in constants due to chronic misalignment, prompting central suppression - develops as a maladaptive response to binocular conflict (similar images on non-corresponding points causing diplopia, dissimilar images on corresponding points causing rivalry/confusion). Retinal rivalry (alternating suppression of conflicting foveal images) can lead to constant suppression of the non-dominant eye if unresolved.	Use Worth 4-Dot early to detect shallow vs. deep suppression—if 2-3 dots persist despite dimming lights or bringing closer, implies embedded adaptation, guiding anti-suppression VT priority	Indicates potential for binocularity; if absent indicates deep suppression, poor prognosis for fusion therapy, if present indicates shallow suppression, high fusion potential. Intermittent suppression implies high likelihood patient will be therapy-responsive with fusion; deep/constant suppression is harder to reverse, requiring anti-suppression work before motor and fusion work. This is the entry point to binocularity, the brain acknowledges dual inputs without merging them; disruption explains why strabismic patients may not notice deviation until tested.

				Suppression emerges when fusion fails, typically by 2-3 months if vergence delays persist.		Why test for suppression? It explains why a deviation persists (to avoid diplopia) and guides sequencing: perform non-dissociative tests first to detect shallow suppression before occlusion.
Flat Fusion (Second-Degree Fusion)	Superimposition of images with luster/rivalry but no depth; peripheral fusion possible in microstrabismus.	V1 inhibitory interneurons resolve rivalry.	Builds on simultaneous perception by 3-6 months, allowing overlay of images with possible luster (perceived shine from rivalry) but lacking true depth; peripheral retina often supports this in small-angle strabismus.	Enables pseudo-binocularity via ARC, where non-corresponding points remap for harmonious fusion despite deviation; luster/rivalry indicates ongoing cortical competition.	Bagolini glasses detect subtle rivalry (missing line = suppression).	This level adds superimposition to awareness. It's "flat" because disparity processing isn't fully engaged, explaining reduced depth in partial fusions. Presence despite tropia signals harmonious ARC Peripheral flat fusion in microstrabismus (good prognosis) vs. central loss in constants (anti-suppression first, then VT)
Stereopsis (Third-Degree Fusion)	Full 3-D depth from disparity; global (RDS) vs. local (contours).	V1 for disparity detection, V2-V5/MT for depth computation; requires bifoveal fixation (for RDS) and intact vergence.	300 arcsec by 12-18 months; RDS appreciation develops by 5-6 months with stereopsis onset, maturing to adult levels by 24 months.	Absent in constants due to suppression disrupting disparity processing; reduced in intermittents reflects partial fusion reserves. Absent indicates constant tropia; reduced <100 arc seconds indicates intermittent suppression, high VT responsiveness. RDS patterns consist of random dots without monocular contours or lateral disparity clues, requiring correlation of horizontal retinal disparities across a substantial area for form perception— global stereopsis. Signifies bifoveal fusion - no form emerges until disparities are bifoveally fused, contrasting with local/contour tests (Titmus, Wirt Circles) relying on monocularly visible contours for fusion assistance.	RDS (LANG/Frisby, no glasses needed) for global; Titmus for local. Stereopsis quantifies depth perception. Monitors therapy progress; post-surgical improvement >200" predicts stability. Normal: 40" global, 20" local. Red flag: No stereopsis in children <8 years (high amblyopia risk).	This highest level fuses disparities into 3D perception—global (random dots, no monocular cues) tests pure cortical integration, local (contours) allows some monocular aid; development from 300" at 1 year to 40-60" by 2 years. RDS differentiates true bifoveation from peripheral ARC (fails global but passes local in microstrabismus) Why use RDS? It distinguishes true bifoveal fusion from peripheral adaptations. Within the pattern of random dots, specific elements are offset, creating depth and an observable floating image only when both eyes bifoveate. RDS testing should be performed as the first test in the exam sequence, to assess baseline binocularity. If RDS is present, especially if the results are <40 sec arc, it implies bifoveation, intact motor and sensory fusion, relatively good near visual acuity, and relatively equal vision between the two eyes.

fusionis (intractable diplopia post-surgery) arises if adaptations clash with new alignment.

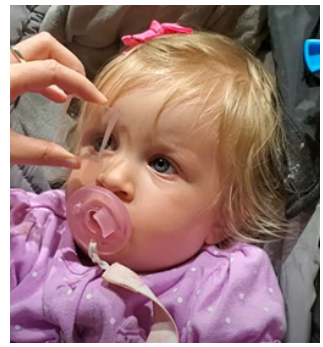
Fusion integrates images from both eyes into a single coherent percept with depth. It occurs hierarchically, often disrupted in strabismus, leading to suppression.

1. Simultaneous perception (both images seen without overlap)
2. Flat fusion (superimposition without depth, often with luster/rivalry)
3. Stereopsis (third-degree fusion providing 3-D depth)

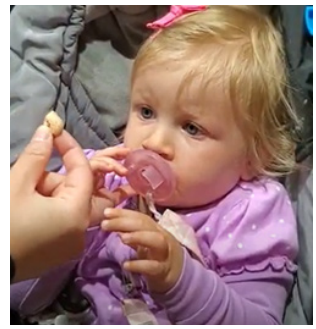
Select the Lang stereotest (plates with embedded figures visible only binocularly) or Frisby stereotest (transparent plates with varying thicknesses for depth disparities). Position the patient at near distance (30-40 cm) in good lighting, with optimal correction. For Lang, show plates sequentially; ask to identify/point to hidden shapes (e.g., star/car) without head tilt or eye closure. For Frisby, hold plates perpendicular, rotate to show protruding circle, and ask if it "pops out." Lang I: 550–1200 arc sec, Lang II: 600-200 arc sec, Frisby: 600–150 arc sec

Begin with coarser disparities, advancing to finer if successful. Record the finest consistent level (arc seconds). For young/non-verbal patients, observe reaching or preferential looking. Note monocular attempts/head movements if no stereopsis. Perform as the first test to preserve undissociated binocularity; repeat for fatigue/inattention.

Positive RDS (finer than 100 arc sec) indicates robust global stereopsis, active integration, functional binocularity, and favorable therapy outlook. Coarser/absent (e.g., >550 arc sec) correlates with suppression/constant misalignment, implying adaptations needing intensive interventions; guarded prognosis, especially with other deficits. Present RDS (especially <40 arc sec) implies bifoveation, intact motor/sensory fusion, relatively good near acuity, and relatively equal vision. Initial RDS with later constant strabismus on cover test suggests intermittency, as constant cases cannot achieve RDS.



10^ test



NPC with Cheerios

Developmental Phases of Binocular Vision

Phase	Description	Milestones	Disruptions	Additional Details
Neonatal Phase (Birth-2 Months)	High tonic vergence leads to exotropia in most newborns, resolves by 6 months as sensory-motor system matures and cortical fusion emerges. Subcortical mechanisms like vestibulo-ocular reflex (VOR) with perfect gain stabilize images during head movement. Asymmetric optokinetic nystagmus (OKN) is temporal-nasal dominant. ~6 months, most infants achieve stable binocular function, including depth perception - highlights that alignment is largely acquired through experience rather than being innate.	Conjugate gaze by 2 months; proximal vergence from birth contributing to near vergence demand; basic convergence and divergence abilities emerge by 1 month, allowing initial vergence movements; convergence to both moving and stationary targets by 2 months.	Persistent exotropia due to low fusional reserves; those with early deviations may struggle with VOR gain adjustment; asymmetric OKN reflects temporal-nasal bias resolving as binocular pathways mature. Disruptions may prolong exotropia, increasing susceptibility to amblyopia if not monitored.	Transient divergence misalignment rapidly decreases between 2 and 6 months of age; at 6 months, binocular sensory function, including stereopsis, becomes well established. Persistent neonatal exotropia beyond 6 months is a red flag for concern. Infantile esotropia usually appears between 2-4 months, becoming the more prevalent form.

Infantile Phase (2-6 Months)	Emergence of convergence/divergence; stereopsis by 4 months via tactile-visual pairing; OKN symmetric by 3-5 months. Esotropia becomes prevalent by 2-4 months. This progression relies on midbrain supraoculomotor areas for vergence control and medial rectus motoneurons for horizontal vergence, receiving input from pretectal nuclei for the near triad (convergence, miosis, accommodation). Pulse neural discharges move the eyes, while step discharges maintain position.	Proper convergence without delay by 3 months, marking the onset of coordinated vergence; fusion develops by 5-6 months, with stereopsis present; accommodative vergence begins integrating with fusional vergence.	Disruptions like high tonic vergence leading to persistent exotropia or low fusional reserves can result in strabismus; asymmetric OKN persistence indicates delayed cortical fusion and higher amblyopia risk.	Esotropia onset at 2-4 months signals potential refractive triggers (hyperopia). This phase illustrates the rapid maturation from subcortical to cortical control, with stereopsis emerging through multisensory integration (visual-tactile). By 2 months, conjugate gaze emerges, allowing basic tracking, but true convergence/divergence develops by 3 months, enabling fixation on near objects without delay. Stereopsis at 4 months arises from pairing visual input with tactile feedback, fostering depth perception essential for hand-eye coordination. OKN symmetry by 3-5 months reflects maturing cortical pathways in V1 and MT areas.
Toddler Phase (6-24 Months)	Full stereopsis (40-60 arcsec by 24 months); integration of tonic, proximal, fusional, and accommodative vergence. Retained primitive reflexes, lack of body midline awareness, and postural imbalances, such as gait abnormalities or sway, are common in deviations.	Fusion improves by 6-7 months, with central fusion strengthening; stereoacuity reaches 300 arc seconds by 12-18 months (cortical level); approaching adult-like stereoacuity (40-60 arc seconds) by 24 months, with full integration of tonic, proximal, fusional, and accommodative vergence.	Deviations linked to retained reflexes warrant interdisciplinary referral (PT/chiropractic); persistent reflexes prompt neurodevelopmental assessment.	This phase emphasizes how gross motor milestones (e.g., crawling by 10 months) foster bilateral body control essential for binocular teaming, with retained reflexes causing postural imbalances that exacerbate deviations.

Clinical Tips

- Use verbal encouragement for children, framing the test as a "magic picture" game to boost engagement.
- Avoid leading questions; let patients describe what they see to prevent false positives or let them match by pointing.
- Reduce glare, which can interfere with disparity detection.
- Keep the patient where they are comfortable and do the full exam there: in the stroller, on mom's lap, on the floor, etc.

Binocular Visual Acuity and Non-Dissociative Motor Evaluation

This phase of the strabismus evaluation assesses visual acuity and eye movement coordination while maintaining natural binocular interaction, without separating the eyes' visual inputs. Prioritizing non-dissociative methods allows observation of the patient's habitual binocularity and real-world eye teaming. This is essential because many strabismus patients maintain fragile fusion reliant on peripheral cues and spatial orientation; premature disruption can produce artificial results, such as exaggerated deviations or suppressed responses.

Binocular acuity tests determine whether combined eye use yields superior performance, indicating synergistic cortical processing. Motor assessments (tracking, alignment) reveal teaming efficiency without occlusion, highlighting developmental progress or anomalies. In early childhood, smooth coordinated movements emerge as the system integrates sensory inputs, with deviations often reflecting adaptive learning rather than fixed defects. Tools like reflex alignments and pursuit tasks minimize interference, detecting subtle

Test Name	Indication / What It Assesses	How to Perform	Normal Results	Abnormal Result	Pitfalls / Tips	Patient Age / Adaptations	Prognostic Indicators / Red Flags
Binocular Distance Acuity	Baseline for binocular synergy: assesses binocular summation: Do two eyes see better together than either alone? Establishes binocular boost due to coordinated cortical processing — key prognostic clue for functional binocularity potential.	20 ft Snellen / HOTV / LEA symbols / tumbling E chart • Optimal correction (from prior refraction) • Both eyes open • Read smallest line possible • Observe head posture, squinting, fatigue, or avoidance	OU ≥ better monocular eye (20/20 or age-norm) = binocular boost »» excellent cortical integration & fusion; strong sensory status	OU < best monocular eye (e.g., 20/30 OU vs 20/25 monocular) = suppression, amblyopia or fragile binocularity	Free space, not in phoropter — breaks fusion • Kids: use matching games or pointing • Record exact line, optotype, + any head turn/torticollis. • Crowding bars in single optotypes	• **3-5 months:** Lea Paddles forced preferential looking 1-2 cpd or Fix & Follow • **6 months:** 2-4 cpd or Fix and Follow • **6–12 months:** 20/200–20/60 (Lea Paddles / Cardiff Cards) • **1–3 years:** 20/60–20/40 (Cardiff Cards / LEA Pictures / HOTV) • **3–5 years:** 20/40–20/25 • **5–6 years:** 20/25–20/20 • **≥6 years:** 20/20 expected	Binocular > monocular = strong positive prognostic clue for functional binocularity & VT success **Red Flag:** Poorer binocular acuity »» suspicion of suppression or amblyopia
Binocular Near Acuity	Near symptoms (reading blur, asthenopia, headaches); suspected high AC/A esotropia or convergence insufficiency. Assesses near binocular clarity & accom/vergence synergy at working distance.	• 40 cm reduced Snellen / LEA symbols chart • Best Rx • Both eyes open • Read smallest line • Note blur, fatigue, head lean, or avoidance	20/20 equivalent at near (or age-norm); no symptoms = good near fusion & balanced accom-vergence link; stable near binocularity	Reduced (e.g., 20/40+ equivalent), blur, asthenopia, diplopia after brief near work = near decompensation (CI, high AC/A eso, or suppression at near)	• Use string/ruler for exact 40 cm • Watch for leaning forward (accom spasm) or rubbing eyes • Kids: use pictures / symbols / HOTV	• **<3 years:** testability depends on child maturity; use picture matching • **3–5 years:** 20/40–20/30 expected • **5–6 years:** 20/30–20/20 • **≥6 years:** 20/20 equivalent at near •	Free-space near testing provides better prognostic insight than phoropter-based methods Normal = good near reserves **Red Flag:** Receded or symptomatic »» NPC with accommodative target & +1.00 D lenses
Hirschberg Test	Quick gross alignment screen; infants/uncooperative/initial observation. Assesses manifest tropia direction & rough magnitude (1 mm displacement ≈ 22Δ). Non-dissociative baseline alignment in natural environment.	• Penlight at 33-50 cm • Patient fixates light (toy attachment for kids) • Observe reflex vs pupil center • Estimate in mm	Centered reflexes in both pupils = orthotropia or well-controlled phoria; no manifest deviation	Displaced (temporal = eso, nasal = exo); asymmetry = manifest tropia; estimate angle (e.g., 3 mm nasal = ~66$^{\Delta}$ exo)	• Estimate in mm first, then convert to Δ • Can take photo for records • Beware angle kappa (pseudo-deviation)	• All ages (especially infants & uncooperative patients) • Quick & non-invasive • No age-specific norms — alignment should be centered at any age	Provides immediate alignment clue in free space; constant unilateral deviation = higher amblyopia risk **Red Flag:** Abnormal »» quantify with prism bar later in testing hierarchy; constant large angle »» suspect deep suppression

Versions	Observe non-comitancy, A/V pattern, diplopia in eccentric gaze. Assesses yoked EOM function in 9 cardinal gazes; under/overaction; comitant vs non-comitant. Test both eyes together first; critical for identifying A/V patterns that can cause surgical failure if missed.	• Target (transilluminator/bead) in H-pattern • Smooth pursuit, head fixed • Grade -4 to +4 (0=normal) • Watch speed, amplitude, symmetry	Full, symmetric excursions; grade 0 all gazes = balanced EOM function; likely comitant (sensory) strabismus	Underaction (-1 to -4), overaction (+1 to +4), A/V pattern (>10–15$^{\Delta}$ change). > 5$^{\Delta}$ difference = non-comitant strabismus; palsy / restriction / oblique dysfunction	• Watch lids, pain, head movement • Observe for nystagmus, EOM overshoot/undershoot, DVD. • Gently hold chin/ head to prevent movement. • Video record deviations if possible	• **Birth–3 months:** Limited excursions normal (immature) • **3–6 months:** Full versions expected • **≥6 months:** Full, symmetric, grade 0 • Use engaging toys/beads for infants/toddlers	Missing A/V = surgical failure risk Incomitant »» neuro referral if new **Red Flag:** Abnormal »» do saccades and ductions »» forced ductions if restriction suspected
Saccades	Helps differentiate neural (palsy) from mechanical (restriction) causes. Assesses rapid eye movement velocity & accuracy in restricted fields.	• Two targets at extremes • "Look quickly from here to there only when I say" • Observe: floating (slow drift) vs ballistic (abrupt stop)	Fast, precise saccades reaching target fully, slight under/overshoot ok. No drift or abrupt stop = intact neural drive & muscle mechanics	Floating saccade (slow drift to target) »» reduced innervation / palsy. Ballistic (abrupt halt mid-way to target) »» mechanical restriction.	• Vary time between jumps to avoid anticipatory saccades • Ensure head stability	• **<6 months:** Saccades immature (slower, less accurate) • **≥6 months:** Fast, accurate saccades expected • Use bright, engaging targets for young kids	Neural issues = variable recovery; restriction = surgical candidate **Red Flag:** Abnormal »» ductions to confirm; if restriction »» forced ductions
RDS and Local Stereopsis Quantification	Quantify global & local stereopsis. Assesses cortical fusion & disparity detection. Best early prognostic indicator: preserved stereo = excellent VT/ sensory recovery potential; nil stereo = poorer prognosis.	• Randot Polarized RDS and Wirt Circles or Animals 40 cm • Quantify in arc seconds	• Global stereo present = strong cortical binocularity & fusion potential	Reduced (>200 arc sec) or absent stereo = suppression / ARC / constant tropia, microtropia	• No dissociation — BEST prognostic test • Make it a game for kids • For infants can use red/ green Stereo Tranaglyph like Basic Binocular; observe for reaching and grasping	• **Birth–3 months:** No reliable stereo • **3–6 months:** Gross stereo emerging (1200–550 arc sec) • **6–12 months:** 550–300 arc sec • **2–3 years:** 200–120 arc sec • **≥4 years:** 60–20 arc sec	Preserved global stereo = excellent VT/sensory recovery potential Nil stereo = poor prognosis **Red Flag:** Absent »» try Worth 4 Dot for gross fusion vs. suppression
NPC with Accommodative Target	Assesses convergence break, recovery, release, and regrasp; accom-vergence linkage and fusional control. Identifies near decompensation; assesses quality of convergence control — critical for fusional reserve and prognosis.	• Small detailed letter/bead at 40 cm »» move slowly toward nose tip • Patient reports first blur/diplopia (break) or watch for fusion break • Move away until recovery (clear single vision or reuptake of fusion visible) • Instruct voluntary relaxation (release by looking away) • Then re-fixate and re-acquire target (regrasp point)	Break ~5 cm Recovery ~7 cm Smooth release Quick regrasp; clear & single throughout = robust near convergence, strong fusional reserves, good control and re-acquisition of fusion	Break >10 cm, poor/no recovery, delayed/ poor release, delayed/absent regrasp. CI / near exotropia / poor fusional control / suppression / ARC	• Move slowly (2 cm/sec) to nose tip • Watch for one eye drifting out / in • Ask specifically about diplopia at each phase • Use very engaging target for kids	• **<2 years:** Testability depends on child maturity, use large visually stimulating target • **3–5 years:** Break 8–12 cm typical • **5–12 years:** Break 6–10 cm, recovery 8–12 cm • **≥12 years / adults:** Break 6-10 cm, recovery 8-12 cm • Use very engaging targets (beads, stickers) for young kids	Normal break/recovery/release/regrasp = good near binocularity and fusional control Receded or poor regrasp = VT/ prism candidate; poor control flags fragile binocularity **Red Flag:** Receded break/ recovery or poor release/regrasp »» NPC with red lens then +1.00 D lenses to assess motor control and differentiate accommodative vs non-accommodative component

compensations (e.g., head postures, asymmetries). Prognostically, strong binocular performance suggests neuroplastic potential for interventions, while weaknesses indicate entrenched adaptations needing targeted therapy. The accompanying tables show a general progression of the hierarchical testing.

Synthesize results to gauge binocularity depth: consistent strong performance across the above sequence of tests (e.g., fine acuity, smooth movements, fusion signs) suggests robust teaming with excellent prognosis; fragmented findings indicate adaptations like peripheral reliance, guiding toward gradual interventions. Disparities between free-space and later controlled tests highlight environmental aids, positive for real-world function.

Clinical Tips

- For pediatrics, gamify the test/instructions to sustain interest.
- Repeat inconsistent results to rule out worsening function with fatigue, especially when initial performance on testing is significantly better than the reported symptoms.

Unilateral Visual Acuity, Alignment, Motility, Accommodation, and Facility

Transitioning to this stage introduces controlled dissociation to one eye at a time, allowing providers to quantify deviations, assess individual eye performance, and evaluate accommodative influences. This partial dissociation builds on prior non-dissociative findings, revealing how the visual system handles mild and full disruptions. In strabismus, unilateral tests are vital for distinguishing between latent (phoric) and manifest (tropic) misalignments, as well as identifying asymmetries that could indicate reduced vision in one eye or motor imbalances.

Always evaluate monocular ductions if binocular versions are abnormal

From a developmental viewpoint, these assessments probe the brain's learned responses to misalignment: for example, chronic deviations may lead to neural rewiring, where one eye's input is prioritized, affecting acuity and teaming efficiency. Tools here, such as occlusion-based alignment checks or lens-induced accommodative tests, help differentiate accommodative components—common in childhood esotropia—from pure motor or sensory issues. This section's hierarchical placement ensures that fragile fusion isn't overly compromised early on, preserving the ability to compare associated and dissociated states for prognostic insights. Strong unilateral performance with minimal shifts suggests adaptive potential, while large deviations or asymmetries point to entrenched issues requiring more complex intervention.

Integrate findings to classify strabismus: small comitant deviations with strong acuities and ranges suggest functional potential; large incomitant ones with asymmetries indicate neurological or restrictive causes. Accommodative influences (high AC/A, facility issues) favor non-invasive management; sensory

IXT Control Score

Step 1 - Observe for 30 seconds at distance
Constant XT: Score 5
Spontaneous tropia >50%: Score 4
Spontaneous tropia <50%: Score 3

Step 2 - Observe for 30 seconds at near
If no spontaneous tropia observed at distance, observe for 30 seconds at near before occluding for distance

Step 3 - Observe OD for 10 seconds, observe recovery
If no tropia is observed without occlusion, score will be less than three

The the worse the level of control observed following the 3, 10-second periods of occlusion is recorded.

	Control Score	Description
Tropic	5	Constant XT during a 30-second observation period (before dissociation)
	4	XT>50% of time during a 30-second observation period (before dissociation)
	3	XT<50% of time during a 30-second observation period (before dissociation)
Phoric	2	No XT unless dissociated (10 seconds) recovery in >5 seconds
	1	No XT unless dissociated (10 seconds) recovery in 1-5 seconds
	0	Pure phoria <1 second recovery after 10-second dissociation

Test Name	Indication / What It Assesses	How to Perform	Normal Result	Abnormal Result	Common Pitfalls & Tips	Prognostic Indicators and Red Flags
Unilateral Cover Test (Distance and Near)	Detects manifest tropia (tropic component only). Critical for distinguishing tropia from phoria and assessing control in intermittent cases.	• At distance (6m) and near (40 cm) • Cover one eye to dissociate (2–3 sec) with opaque occluder • Uncover and observe that eye for refixation movement • Repeat for other eye • Note direction and magnitude	No refixation movement = orthotropia or well-compensated phoria; stable fusion holding alignment	Inward shift = exotropia; outward = esotropia; vertical shift = hypertropia/ hypotropia Manifest tropia present.	• Use proper distance and near targets. • Don't uncover too quickly, dissociate for a full 2-3 seconds. • Kids: use engaging target to maintain fixation • Can use your thumb to occlude pupil and central field in infants / anxious patients instead of full visual occlusion • Error: Poor occlusion (patient peeks) — use opaque paddle and watch closely • Error: Rushing	Smaller than alternating cover = latent component hidden by fusion »» better prognosis Large constant unilateral tropia = poor control »» higher amblyopia risk **Red Flag:** Large manifest tropia »» suspect suppression »» do W4D if stereo absent
Alternating Cover Test (Distance and Near)	Reveals full deviation (tropia + latent phoria); measures total misalignment and fusional vergence strength. Gold standard for quantifying strabismus angle.	• Occlude 1-2 sec then alternate occluder rapidly to other eye. • Observe recovery movements • Neutralize with prism bar if needed • Test in primary gaze first, then cardinal gazes if non-comitancy suspected	Small exo phoria (1–4$^{\Delta}$ distance, 3–6$^{\Delta}$ near) = compensated latency; strong motor fusion	Large deviation (e.g., >10$^{\Delta}$ eso), non-comitant, or increasing with alternation = decompensated phoria/tropia; poor fusional reserves	• Alternate rapidly to prevent fusion re • Record exact $^{\Delta}$ with prism • Error: Slow alternation — allows fusion recovery »» artifactual small deviation — alternate quickly • Error: Not testing both distances — always do distance & near	Difference from unilateral = fusional vergence strength; larger deviation = poorer control »» guarded prognosis **Red Flag:** Very large or unstable »» suspect ARC/ suppression »» prism neutralization
Neutralize / Measure Deviation with Prism Bar	Quantifies exact deviation magnitude when cover test shows tropia/ phoria.	• Hold prism bar over deviated eye • Increase prism until no shift seen on cover test • Record horizontal/vertical $^{\Delta}$ at distance & near	0$^{\Delta}$ or small compensated phoria = aligned or minimal latency	Unstable neutralization = significant strabismus, instability suggests ARC or variable control	• Hold bar over deviated eye; watch endpoint stability • Test distance/near & cardinal gazes	Sizes deviation for Rx; unstable = anomalous adaptation **Red Flag:** Unstable neutralization »» suspect ARC »» red lens with prism cover test or Bagolini for ARC eval
Unilateral Distance Acuity	Compares individual eye performance to binocular; detects amblyopia or asymmetry.	• Observe for asymmetric resistance to occlusion / discomfort	20/20 each eye = equal to binocular; no unilateral deficit	Reduced in one eye (e.g., 20/50) = amblyopia, eccentric fixation, microstrabismus, or pathology in deviated eye	• Dense occlusion can cause upset — use translucent / frosted / high plus fogging instead	**Red Flag:** Significant difference »» screen for amblyopia / eccentric fixation / ocular disease
Unilateral Near Acuity	Assesses near vision per eye.	• Occlude one eye • Test at 40 cm with near chart	Equal to binocular near acuity = balanced accommodation monocularly	Poorer in one eye = near amblyopia or accommodative issue	• Use age-appropriate and engaging optotypes	**Red Flag:** Asymmetry »» accommodative testing
NPC with Red Lens	Evaluates motor control and suppression when converging.	• Place red lens over one eye (usually OD) and perform NPC with penlight • Note break/recovery/release/regrasp and presence of diplopia	• Break ~7cm, Recovery ~10cm; diplopia at break = no suppression	Further receded (poor motor control) or diplopia absent (suppression in deviated eye)	• Red lens dissociates input to eyes minimally • OD sees red light, OS sees white light - Easier to identify / report diplopia and suppression	Suppression indicates sensory adaptation. Receded indicates poor motor control. »» both mean poorer prognosis **Red Flag:** Absent diplopia when motor fusion breaks »» deeper suppression

Range of Clear, Comfortable, and Binocular Vision	Evaluates sustained clarity and binocularity across near / intermediate distances; assesses accommodation-vergence flexibility.	• Use a 20/30 near target 40 cm away - move away until blurry or double then closer until blurry or double - note endpoints	Clear & single vision from 20 cm to 60 cm = flexible system	Limited range (e.g., diplopia at 30 cm) = accommodative or vergence insufficiency	• Move target slowly towards nose tip • Record exact distances • Error: Not noting subjective symptoms — always ask about blur/ diplopia/ asthenopia/ HA	Defines functional zones of clear, comfortable, binocular vision **Red Flag:** Very limited »» accommodative/vergence deficit »»amplitude & facility tests
Phoria via Modified Thorington in 9 Positions (Distance and Near)	Measures latent deviation in cardinal gazes; detects non-comitancy or A/V patterns.	• Maddox rod horizontally/vertically • Patient reports streak position on Thorington card in 9 gazes	Small, comitant phoria across gazes = uniform alignment control	Variable (e.g., increasing exo in down gaze) = non-comitant strabismus or pattern	• Test distance & near • Error: Moving too extreme in lateral gazes so patient looses binocular view. • A 'Maddox Phoria Testor' tool (free space maddox rod attached to Risley Prism) is my preferred free space tool for quick and easy phoria and ranges.	Detects gaze-dependent deviations; critical for differential dx **Red Flag:** Significant pattern »» evaluate cause
Vergence Ranges via Prism Bar (Distance and Near; BI/BO)	Quantifies fusional vergence reserves; divergence/convergence amplitudes.	• Ramp prism bar (BI then BO) at distance & near • Record blur/ break/recovery points	Near BO Children Break 23 +/- 8 Recovery 16 +/- 6 Dist BO Adult Break 11 +/- 7 Recovery 7 +/- 2 Near BO Adult Break 19 +/- 9 Recovery 14 +/- 7	Near BI Children Break 12 +/- 5 Recovery 7 +/- 4 Dist BI Adult Break 7 +/- 3 Recovery 4 +/- 2 Near BI Adult Break 13 +/- 6 Recovery 10 +/- 5	• Note blur/break/recovery separately • Test BI first • Error: Ramping too fast — allow time for adaptation • Error: not identifying suppression (visible loss of fusion or patient says target is moving right / left) • Error: not paying attention to the recovery point	Motor fusion strength; low ranges indicate decompensation risk **Red Flag:** Suppression, receded ranges, receded recovery
Accommodation Amplitude	Assesses amplitude of accommodation; accommodative contribution to deviation.	• Pull-away method: Move detailed target away from eye until able to identify • Calculate D = 100 / cm distance	15 – (0.25 × age) D = adequate focusing reserve	Reduced (<10 D in young adult) = accommodative insufficiency	• OD / OS • Error: letting patient see target before starting test • Error: not using a ruler to measure distance from canthus	Links accommodation to strabismus (high in eso, low in exo) **Red Flag:** Low amplitude »» accommodative insufficiency »» evaluate facility
Accommodative Convergence to Accommodation (AC/A) Ratio	Determines tightness of accommodative-convergence link and accommodative convergence contribution strabismus; high ratio often links to accommodative esotropia.	• Gradient method: Measure phoria at near then remeasure with +1.00 D lenses • Ratio = Δ change / D change	4:1 to 6:1 = normal linkage; no excess convergence	High (>6:1) = accommodative esotropia; low (<3:1) = divergence excess tendency	• Can also use heterophoria measurement method. $AC/A = IPD(\text{cm}) + \frac{N - D}{d}$ IPD = interpupillary distance d = 2.5 for 40cm, 3.0 for 30cm working distance of near phoria measurement	Differentiates accommodative vs non-accommodative strabismus **Red Flag:** High AC/A »» trial plus lenses or bifocals
Monocular Estimation Method (MEM)	Dynamic retinoscopy; assesses accommodative response lag/lead to near demand.	Retinoscope and reading material at near target (40 cm) • Both eyes open. Neutralize reflex with lenses while patient keeps target clear.	+0.25 to +0.50 D lag = accurate accommodative response	High lag (>+0.75 D) = under-accommodation; lead (- to neutralize) = spasm	• Quick neutralization, do not leave lenses in front of eye • Error: Not binocular, name is misleading	Identifies accommodative contribution to deviation **Red Flag:** High lag »» accommodative insufficiency »» measure amp, facility, +1.00 if NPC receded, and range of clear binocular vision; may benefit from add/ VT

Accommodative Facility	Tests accommodative flexibility and differentiate accommodative from vergence facility dysfunction.	• ±2.00 D flippers at near • Count clear cycles/min (monocular & binocular)	10–15 cpm monocular, 8–12 cpm binocular = efficient accommodation and accommodative/vergence shifts. Norms decline with age.	Reduced (<5 cpm) = infacility; linked to near esotropia symptoms	• Ensure clear vision each flip • Error: Not performing for full 60 seconds to observe decomposition. • Error: Not noting difficulty between + and - and OD/OS vs OU performance	Evaluates accommodative role in strabismus symptoms **Red Flag:** Low facility overall, depleting function with time, or fail OU but normal OD/OS
Vergence Facility	Measures vergence speed/flexibility; complements accommodative facility.	• 3^{Δ} BI / 12^{Δ} BO prism flippers • Count cycles/min (clear single vision each flip)	15 cpm or better = flexible vergence system. Norms decline with age.	Low (<10 cpm) = sluggish vergence	• Error: Not checking for suppression (target jumping right/left) • Error: Not performing for full 60 seconds to observe decomposition/fatigue.	Assesses motor adaptability in strabismus **Red Flag:** Suppression »» evaluate W4D for suppression

Prism bar fusion ranges

MEM Retinoscopy

adaptations (ARC, suppression) require targeted therapy.

Clinical Tips

- Use translucent occluders or fogging to reduce full dissociation when doing testing such as monocular visual acuity.
- For children, incorporate rewards like a sticker after each set of testing to encourage cooperation.

Instrument Testing

Instrument-based testing represents an advanced phase in strabismus evaluation, using specialized optical devices to explore sensory-motor integration and binocularity under controlled conditions. These tools introduce greater dissociation than prior steps, enabling simulation and assessment of fusion capabilities, retinal correspondence, and convergence skills in a structured setting. Placed after unilateral assessments, this stage builds on established findings, ensuring that fragile binocularity is documented naturally before applying more demanding stimuli.

Pull Away Accom Amps

These tests are not mandatory but help uncover brain adaptations to misalignment—such as altered perceptual mapping or suppression zones—that may be subtle in free-space evaluations. Vectograms, cheiroscopic tracings, and Brock string are among the more widely used tests, selected for their precision in quantifying subtle anomalies while offering therapeutic potential, as many transition into training tools. Poor performance confirms deep-seated issues; success indicates residual capacity for improvement. Overall, these tests refine the diagnostic picture, linking sensory deficits to motor outcomes and enhancing prognostic accuracy.

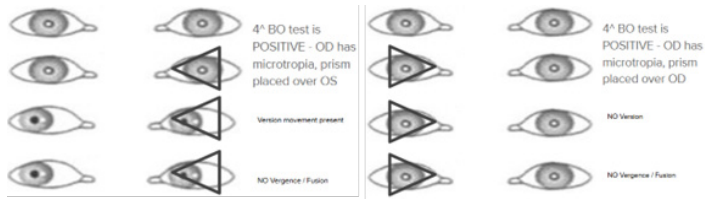
Instrument results assess binocular sophistication. Consistent fusion across tools (e.g., wide vectogram ranges, accurate tracings, stable physiologic diplopia perceptions) indicates advanced sensory-motor integration, predicting high success with rehabilitative therapies; discrepancies highlight specific deficits like near-point stress. These findings validate earlier tests with poor overall results, signaling deep adaptations.

Auxiliary Tests

Auxiliary tests serve as targeted extensions in the strabismus evaluation, employed selectively when preliminary findings raise specific suspicions about underlying mechanisms, such as mechanical restrictions, neurological deficits, or subtle sensory adaptations. These assessments are conditional,

4^ Base Out Test

triggered by anomalies detected in earlier stages like versions or alignment checks. These tools are reserved for refining differentials without routinely applying them to all cases.



Test Name	Indication	How to Perform	Normal Result	Abnormal Result	Pitfalls & Tips	Prognostic Indicators and Red Flags
Fix and Follow	Used when VA is unattainable (infants/non-verbal); assesses basic fixation ability, stability and smooth pursuit. Screens gross visual/binocular motor function and oculomotor integrity. Note size and viewing distance of target.	• Use engaging lighted/noisy toy or target with no noise • Move slowly, horizontally & vertically • Observe both eyes fixate & follow smoothly • Note if conjugate and sustained	Smooth, sustained, conjugate pursuit = intact basic visual ability and oculomotor control; no gross motility defect	Jerky pursuit, nystagmus, poor hold, asymmetry = nystagmus, CN palsy, developmental delay, or neuro issue	• Use very engaging, visual-only targets • Short trials — kids fatigue quickly • Error: Use a target that makes noise - don't know if looking at auditory or visual stimulus	• Birth–6 months: Expected to fix & follow by 2–3 months • 6–12 months: Smooth conjugate pursuit. Early visual and motility screen; abnormal »» suspect neuro/developmental issue »» neuro consult **Red Flag:** Absent or asymmetric »» possible nystagmus or palsy »» ocular health/systemic neuro evaluation
10^{Δ} Vertical Prism Dissociation Test	Used when VA unattainable; assesses gross equality of vision between the eyes by inducing vertical diplopia and looking for vertical fixation/saccade. Screens gross visual inequality.	• Place 10^{Δ} prism base down over one eye while fixating on interesting target • If vision is within 2-3 lines, patient performs a very fast vertical saccade	If performs a very quick vertical saccade, indicates both targets seen and vision is relatively equal between eyes.	If no vertical saccade, indicates either inattention or that one eye is significantly blurrier than the other, so either too blurred to see or eye is suppressed	• Use large prism (10^{Δ}) for clear effect • Error: Not observing both eyes very closely/carefully. • Error: expecting a profound saccade - will very very small and very quick	Basic binocularity screen in uncooperative patients **Red Flag:** No realignment »» suppression »» proceed to Worth 4 Dot or Bagolini
Asymmetry in Resistance to Occlusion	Used when VA unattainable; assesses behavioral preference during occlusion (amblyopia/suppression clue).	• Occlude each eye briefly • Note resistance, upset, or preference (stronger resistance = better eye)	No asymmetry = equal eye preference; no amblyopia	Strong resistance to one eye's occlusion = amblyopia or suppression in occluded eye	• Occlude gently — avoid upset • Error: Too long occlusion — keep brief (2–3 sec) • Tip: Observe facial expression, head turn	Functional preference in strabismus **Red Flag:** Strong resistance to one eye »» asymmetry = amblyopia / suppression risk
OKN Drum	Used when VA/Fix & Follow unattainable; objective motility and vision estimate. Elicits involuntary reflexive optokinetic nystagmus to screen visual pathway integrity.	• Rotate striped drum slowly (2–3°/sec) • Observe slow pursuit in direction of spin + fast saccade reset • Test both directions & both eyes separately	Symmetric, brisk OKN both directions = functional vision + intact motility pathways	Absent, asymmetric, or reverse OKN = severe acuity loss, cortical visual impairment, or motility defect	• Before 3-5 months OKN is asymmetric; temporal-nasal dominant. • Error: Slow rotation is key — too fast = smearing on retina = no response	Objective proxy for vision pathway in uncooperative patients **Red Flag:** Absent OKN = poor prognosis for functional vision »» electrodiagnostic and neuroimaging

Bruckner Test	Screens media opacities, strabismus, refractive asymmetry in uncooperative/infants/young children. Assesses red reflex symmetry & brightness.	• Direct ophthalmoscope at 1 m to nose bridge • View both pupils simultaneously • Compare glow color and brightness	Equal, bright red reflexes = clear media, symmetric refraction, no significant deviation	One reflex dimmer, brighter, or crescent-shaped = strabismus , amblyopia, cataract, anisometropia, retinoblastoma (deviated or higher Rx brighter)	• Dim room lights essential • Error: Not comparing OU simultaneously side-by-side — always view both pupils	Brighter in deviated eye = classic strab sign **Red Flag:** Abnormal »» evaluate refractive/ocular health etiology
Worth 4-Dot	Used when no stereo on RDS/Frisby; assesses gross peripheral & central fusion vs suppression/diplopia.	• Red-green glasses (red OD, green OS) • View 4 lights at distance & near • "How many lights & colors?"	4 lights in diamond pattern = peripheral + central fusion Luster (shimmering) or retinal rivalry (switching between red/green) present on the white light.	2 or 3 lights (suppression), 5 lights (diplopia). Can use prism bar to neutralize diplopia.	• Blink eyes, flash room lights, turn off room light to try breaking suppression; still suppressing = deep seated • Move closer to make target larger and gauge size of suppression; closer and still suppressing = large suppression scotoma size • Error: Glasses ensure proper fit	4 lights = good fusion prognosis 2 lights = poor sensory status »» cautious prognosis **Red Flag:** Suppression without breaking »» consider Bagolini next
NPC with +1.00 Lenses	Performed if standard NPC is receded; differentiates accommodative vs non-accommodative convergence insufficiency.	• Repeat accommodative NPC with +1.00 D lenses OU • Compare to standard NPC • Note break/recovery	Similar NPC break/recovery = no accommodative dysfunction contributing to convergence insufficiency	Improvement on NPC = accommodative dysfunction holding back convergence (poor accommodative convergence)	• Error: not using the same accommodative target for comparison	**Red Flag:** Improvement »» accommodative dysfunction is contributing / holding back vergence function
IXT Control Score	Used if exotropia present; rates control over deviation (poor control = progression risk).	• Observe frequency, recovery, and control • Score 0–5 (0 = excellent control, 5 = constant with poor control) • Use Newcastle score	Score 0–1 = good control; stable phoria or intermittent exo	Score 3–5 = intermittent with poor control or constant	• Error: Not observing or dissociating the recommended amount. • Error: Not testing at distance and near	**Red Flag:** High score (3–5) »» poorer control »» poorer VT prognostic factors
Ductions	Performed if versions abnormal; assesses monocular movements to isolate muscle/nerve defects.	• Occlude one eye • Test full range in cardinal gazes • Grade -4 to +4	Full range = no isolated limitation	Reduced range = muscle/nerve issue (palsy/restriction)	• Error: Not comparing to versions — always do if versions abnormal	Differentiates from versions in incomitant strabismus **Red Flag:** Reduced ductions »» proceed to forced ductions
Forced Ductions	Performed if ductions abnormal; assesses passive movement to differentiate mechanical restriction from palsy.	• Anesthetize conjunctiva (topical) • Grasp globe with forceps or push with Q-tip • Rotate eye passively into field of limitation	Free movement = no mechanical block so innervation issue	Resistance = restriction (e.g., fibrosis, entrapment)	• Error: Not anesthetizing — causes pain/reflex • Tip: Only perform if ductions abnormal	Distinguishes mechanical from neural causes **Red Flag:** Resistance »» surgical release may be indicated
Krimsky Test	Performed if Hirschberg abnormal and deviation cannot be measured via cover test/prism bar (uncooperative patients).	• Align Hirshberg corneal reflexes with prisms over one eye • Record prism power needed for alignment	0^{Δ} = aligned	Prism needed = deviation magnitude	• Very gross measurement • Error: Not aligning reflexes — ensure symmetry as precise as possible	Objective measure for uncooperative patients **Red Flag:** Large angle »»high amblyopia risk

Red Lens and Prism Bar Cover Test for ARC	Detects anomalous retinal correspondence (ARC); performed when ARC suspected (unstable neutralization).	• Red lens over right eye looking at penlight • Subjectively sees 2 lights (red/white). Add compensating prism until says lights are aligned (subjectively thinks/sees that they are aligned). Perform cover test. If movement still present then objectively/anatomically they are not aligned and have ARC. Add more prism until movement on CT stops.	Normal neutralization = harmonious correspondence. Subjective perception of alignment is same as objective anatomical alignment.	Subjectively notes alignment but still get movement on cover test = ARC present Patient might start suppressing the deviated eye instead of getting fusion.	• Difference in prism power between subjective and objective alignment is amount of ARC • Error: Not using prism bar — always neutralize	Identifies adaptations affecting prognosis **Red Flag:** ARC »» guarded surgical prognosis. Depending on patient goals / commitment, consider keeping ARC embedded and optimizing skills around the ARC
Bagolini Striated Glasses	Partial dissociation; assesses suppression/ ARC with minimal disruption. Tests fragile binocularity before full dissociation.	• Wear Bagolini glasses (45° & 135° striations) • View small light at 33 cm & 6 m • "Where do the lines cross?"	Symmetrical X (crossed streaks) through light; no scotoma = peripheral fusion intact; if CT is ortho then NRC present	Symmetrical X through light but movement on CT = ARC. Missing one streak, two lights, or scotoma = suppression/ strabismus/ARC/ deep amblyopia	• Less dissociative than red lens test • Error: Not checking glasses — ensure proper fit	Crossed lines = good peripheral fusion. Missing line = suppression »» more guarded prognosis **Red Flag:** Suppression »» more guarded prognosis, requires anti-suppression VT
Parks 3-Step	Performed if superior oblique palsy suspected; isolates cyclovertical muscle weakness (CN IV).	• Use cover test or Modified Thorrington to assess 1: Hyperopia worse in which eye on primary gaze? 2: hypertropia worse on R or L gaze? 3: hypertropia worsens on R or L head tilt?	No hypertropia or pattern matching = no SO palsy	Pattern matching SO palsy = CN IV involvement Right SO will be RLR 1. R hyper. 2. Worse on L gaze. 3. Worse on R head tilt. Left SO is LRL: 1. L 2. R 3. L	• Follow exact 3 steps • Error: Not doing head tilt — always include	**Red Flag:** Positive Parks 3-Step »» superior oblique palsy »» identify etiology
4^{Δ} Base Out	Performed if microstrabismus suspected (no RDS, slight monocular VA reduction, EF); detects small-angle deviations or scotomas.	• Place 4^{Δ} base-out prism over one eye • Observe movement or compensation	Small version + vergence movement when placed OD and OS = no microtropia	Small version but no vergence when placed in non-strab eye. No movement when placed in strab eye = microstrabismus	• Use 4^{Δ} BO prism • Error: Not observing refixation — watch closely, movements are quick and small	Identifies subtle strabismus **Red Flag:** No movement »» scotoma »» more guarded prognosis/needs antisuppression VT
Visuoscopy	Performed if eccentric fixation (EF) suspected in unilateral strabismic amblyopia; locates fixation point on retina when monocular.	• Patient fixates star/bullseye target through visuoscope monocularly • Observe fovea position relative to target	Foveal fixation = central fixation	Unstable or off-center = eccentric fixation	• Use visuoscope in dark room, do non-strab eye first • Error: Not shining target on your hand first so patient knows what to expect and where to look • Error: performing binocularly	Confirms EF **Red Flag:** Eccentric fixation »» more guarded prognosis / needs antisuppression VT

Discussion of Testing Results, Interpretation, and Implications

The culmination of a strabismus evaluation involves thoughtfully synthesizing all collected data into a cohesive clinical narrative that informs diagnosis, prognosis, and management. This phase integrates case history, sensory, motor, and adaptive findings from the hierarchical testing sequence, recognizing strabismus as a dynamic interplay of neurovisual development and compensation rather than a static anomaly and predicting functional potential. Considerations: age of onset, current patient age, patient health, developmental level, motivation and anticipated compliance with intervention/therapy, concerns of patient/parents, signs and symptoms, visual demand, activities of daily living, deviation etiology, deviation comitance, deviation size and frequency, presence of fusion, presence of amblyopia, presence of sensory adaptations, previous treatments.

The principal objective is identifying the etiology (and need for further evaluation) and then the patient's realistic goals and potential for functional binocularity. Whether cosmetic or functional, long-lasting resolution is most likely when functional gains maintain tandem eye use. Create visualized or actual deviation maps that put all the information together, evaluate binocularity, and identify adaptations for refined classification and intervention options/goals.

Infantile strabismus (infantile, non-accommodative esotropia) often requires surgical alignment within 6 months of diagnosis to optimize binocularity retention/potential. Large exo/eso deviations or mechanical strabismus frequently require surgical intervention for alignment, ideally with vision therapy (preferably before and after surgery) to optimize sensory fusion and lock in fusion/binocularity, reducing re-surgery requirement. Constant strabismus with sensory adaptations, such as eccentric fixation, suppression, and ARC, have a more guarded/difficult treatment prognosis with the need for a more involved and complicated treatment plan, focusing on antisuppression therapy and patient commitment. Intermittent deviations with intact stereopsis have a much better potential prognosis for full rehabilitation. Accommodative components like accommodative esotropia prioritize lenses to resolve strabismus. Age factors: treatment efficacy declines after the critical period, though effective into geriatric years. Consider the full treatment arsenal: refractive correction, prisms, partial occlusion, filters, tints, vision rehabilitation, computer-based therapy, photobiomodulation, penalization, surgery, botox, interdisciplinary management.

Norms in Binocular Vision Testing

Test	Expected Findings	Standard Deviation
Distance cover test	1 exophoria	+/- 2$^{\Delta}$
Near cover test	3 exophoria	+/- 3$^{\Delta}$
Accommodative NPC	5/7 cm	+/- 2.5/3 cm
Non-accommodative or red lens NPC	7/10 cm	+/- 4/5 cm
Jump convergence	30 cpm	+/- 10 cpm
Distance lateral phoria (pre-presbyopes)	1 esophoria	+/- 1$^{\Delta}$

Norms in Step Vergence Testing (adults) (break/recovery)

Test	Expected Findings	Standard Deviation
Distance BO	11/7$^{\Delta}$	+/- 7/2$^{\Delta}$
Distance BI	7/4$^{\Delta}$	+/- 3/2$^{\Delta}$
Near BO	19/14$^{\Delta}$	+/- 9/7$^{\Delta}$
Near BI	13/10$^{\Delta}$	+/- 6/5$^{\Delta}$

Norms in Smooth Vergence Testing (blur/break/recovery)

Test	Expected Findings	Standard Deviation
Distance BO	9/19/10$^{\Delta}$	+/- 4/8/4$^{\Delta}$
Distance BI	x/7/4$^{\Delta}$	+/- x/3/2$^{\Delta}$
Near BO	17/21/11$^{\Delta}$	+/- 5/6/7$^{\Delta}$
Near BI	13/21/13$^{\Delta}$	+/- 4/4/5$^{\Delta}$

Norms in Accommodative Amplitude

Test	Expected Findings	
Hofstetter Formula	15-(0.25 x age)	
Donders' Expected	10 years --- 14 D	30 years --- 7 D
	20 years --- 10 D	40 years --- 4.5 D

Norms in Accomm Facility Below 30 yo with +/-2 D flippers

Test	Expected Findings
Monocular	11 cpm
Binocular	8 cpm

Norms in Accomm Facility Below 30 yo with +/-1.50 D flippers

Test	Expected Findings
Monocular	10 cpm
Binocular	8 cpm

Norms in Near Vergence Facilty Testing

Test	Expected Findings	Standard Deviation
12 BO/3 BI	15 cpm	+/- 3 cpm

Correspondence should be emailed to Tamara Petrosyan, OD at tvpetrosyan@gmail.com. Petrosyan TS. An approach to strabismus diagnosis (part 2 – clinical testing and evaluation. Optom Vis Perf 2026;14(1):87-107.