

A Basic Approach to Convergence Insufficiency

Accommodative Disorders

- 1. Accommodative Insufficiency** – When amplitude of accommodation is less than expected for age.
 - Students complain of blurred near vision, difficulty reading, poor concentration and/or headaches.
 - If occurring after prolonged close work this may be due to *accommodative fatigue*.
 - It shows as reduced NPA when done monocularly, fails minus lenses on flippers & low PRA.*
 - A student with reduced accommodation will perform significantly worse than a pre-presbyopic adult with the same amount of accommodation. This is because the underlying aetiology is different (ie. functional vs end organ). *Functional visual problems* will tend to get worse the greater the effort that is exerted.
 - Treatment may include exercises to help improve accommodative function and/or glasses (single vision or occupational lenses). Students wearing occupational lenses may need to sit closer to the front.
 - Note, in the case of a complete paralysis of accommodation, a medical reason should be sought. If necessary a progressive lens may be prescribed for the affected eye(s).
- 2. Accommodative Infacility** – When the accommodative system is slow in making changes.
 - The student may report transient blurred vision immediately after sustained close work.
 - It shows as failing both plus & minus flippers, and a low PRA & NRA.
 - Consider glasses and/or therapy exercises. Therapy is highly effective.
 - A student with poor facility may not accept too much plus at near.
- 3. Accommodative Lag** – When the accommodative system under responds for close viewing.
 - Typically a high degree of plus (between +0.75D & +2.50D) using MEM ret.
 - The “with” motion is neutralized by a plus lens whilst fixating on a near target (normal is +0.50D).
 - The lens should be held in front of an eye very briefly (less than a second) since accommodation can adjust in less than a second.
 - Consider uncorrected hyperopia, especially if excessively high.
 - If there is a lag in accommodation relative to binocular posture (ie. the eyes are focused *behind* the plane of the page but converge in *front* of the page), the student will often hold a book closer in order to bring these systems together.
- 4. Accommodative Excess** – When accommodation spasms due to an overstimulation of the parasympathetic nervous system.
 - This may be associated with fatigue but can also result from medical causes and be associated with miotic pupils. In many cases the etiology is thought to be psychogenic.
 - It shows as an accommodative lead on MEM, fails plus flippers, low NRA, & mildly myopic.
 - Can cause blurry vision at distance.
 - Lenses alone may not be sufficient to treat. Consider vision therapy or short-term use of cycloplegics.
 - Reinforce the need for a good working distance (eg. Harmon’s distance - knuckles to elbow), lighting and regular rest periods.

**Note: The NPA is referenced to the spectacle plane.*

Non-Functional Causes for Accommodative Insufficiency

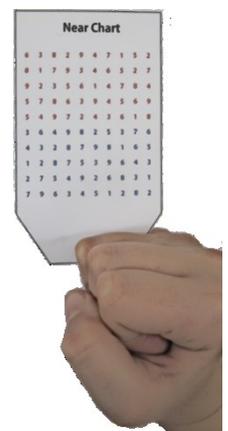
There are a number of non-functional causes of AI including drugs, systemic disease and neuro-ophthalmic conditions which should be considered. This requires taking note of any medications, general health and other relevant symptoms. In particular, AI is associated with closed head injury such as concussion.¹

Therapy for Accommodative Insufficiency

Treatment may include exercises to improve accommodative function and/or glasses.^{2,3} Studies show that treating an accommodative problem with a partial reading lens prescription (eg. +1.00D) provides a therapeutic benefit compared to a full reading lens prescription (eg. +2.00D).³



Unless the student refuses glasses the best approach to treating AI may be a *combination* of therapy and glasses. Even if the problem resolves glasses can continue to be worn for up to 12 to 18 months as *support lenses* for doing sustained near tasks of greater than 5 minutes. As the focusing system and reading becomes more robust glasses may be discontinued. If a patient also has a convergence insufficiency care must be taken not to over prescribe the reading add or the glasses may not be worn or rejected! Plus acceptance may be improved by using occupational progressive lenses which has the added benefit that they can be left on in the classroom.



An activity called “Near Far” can be found on the VFL website under Resources. The patient is directed to look between a near chart (card held between fingers) and a far chart 3m away. With practice the near chart is slowly brought closer thereby challenging both the “jump” and “ramp” components of the near focusing system. Training can also be undertaken on students who have suffered mild head injury.⁴

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4. Thiagarajan P, Ciuffreda K, Capo-Aponte J, Ludlam D, Kapor N. Oculomotor neurorehabilitation for reading in mild traumatic brain injury (mTBI): an integrative approach. [NeuroRehabilitation 2014, 34\(1\):129-46](#)

EXAM ROOM RESOURCES:

1. Flippers (± 1.50 or ± 2.00)



2. Bernell Near Fixation Target - for measuring NPA (a ruler is also helpful)



3. Near (MEM) Retinoscopy – to measure accommodative posture.



*A spot ret is best for MEM but a streak ret can be used with the sleeve in the down position.

4. Phoropter - for NRA/PRA & to measure the Amplitudes of Accommodation.



Convergence Disorders

1. Convergence Excess (CE) - defined as having a greater esophoria at near, reduced near fusional convergence and a high AC/A ratio. Specifically:

1. At least 3eso more at near compared to distance.
2. Reduced BI fusional reserves (NFC) at near.
3. Typically a high AC/A ratio compared to CI.

- Effectively treated with lenses but larger degrees respond to prism if required.
- **CAUTION:** If a student has a higher ESO at distance than near (ie. divergence excess) this can be a sign of underlying pathology – especially if acquired, gets worse, or is associated with other symptoms (eg. headaches and diplopia).

2. Convergence Insufficiency (CI) - defined as a deficiency of Positive Fusional Convergence (PFC) relative to the demand and/or a deficiency of total convergence, as measured by the Near Point of Convergence (NPC). It requires having *at least 3* of the following:

1. A reduced NPC (double vision or eye turn greater than 7 to 8cm).*
2. More than 4exo at near compared to distance.
3. Reduced BO fusional reserves (PFC) at near.
4. A score of 16 or more on the CI Symptom Survey (CISS).

**Note: The NPC is referenced to the spectacle plane*

- Typically a low AC/A ratio.
- CI may either be *acquired* due to the demands a student places on their eyes or it may be *developmental*, due to a child never having learned to adequately converge. The latter may be observed in a small number of primary school children who have learned to read but have reached a plateau by 7 to 8 years of age.

Non-Functional Causes for Convergence Insufficiency

1. **Medial Rectus Weakness** due to Multiple Sclerosis, Myasthenia Gravis, Previous Strabismus surgery.
2. **Convergence Paralysis** secondary to ischemic infarction, demyelination, viral infection, Parkinson's Disease, & Parinaud's Syndrome.

Interesting Facts about Convergence Insufficiency

- The majority of CI patients have a phoria between *ortho* and *exo*.
- Some patients with a high exophoria at near are asymptomatic and well compensated.
- The majority of CI patients have an underlying AI.
- AI is a *primary source of symptoms* in children diagnosed with CI.¹
- CI patients with AI respond best to *low amounts* of plus (eg. +0.75).
- Excessive plus at near can lead to rejection of glasses due to a fragile binocular system.
- A small number of CI patients are *eso* at near but will still only accept low amounts plus.
- Occupational progressive lenses may help with acceptance of plus at near.
- If higher degrees of hyperopia are present consider a *partial prescription*.
- Increasing fusional ranges alone (eg. computer training) may not resolve symptoms of CI.
- *Push up* exercises should be combined with *jump* or *step* exercises when doing VT.
- Younger patients usually *adapt* to low to moderate amounts of base in prism.²
- Base in prism however may be helpful for *presbyopic* adults with CI.³
- Note that patients who appear positive for tinted lenses (eg. Irlen) may have AI/CI problems.⁴
- Like AI, CI can also be associated with a mild head injury such as concussion from sports.⁵
- More prone to motion sickness & may also be associated with emotional issues or anxiety.
- CI can be treated effectively with a low recurrence rate.^{6,7}

The Convergence Insufficiency Treatment Trial

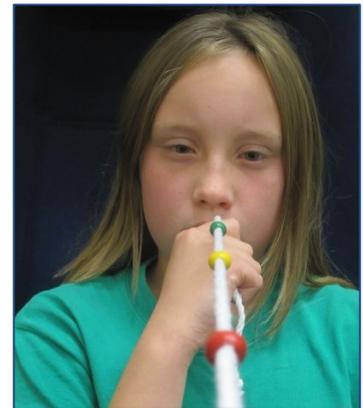
The CITT study is the biggest study on convergence insufficiency.⁶ It found CI therapy was effective for in-office therapy (compared to placebo) but not for pencil push-up or computer based therapy when prescribed as home therapy. This has led some authors to conclude that ONLY office based therapy is an effective intervention but this is not necessarily the case. The study shows that when used alone, pencil push-ups or computer based therapy does not provide an adequate home based therapy solution.

It should be noted that 50 to 60% of students in the CITT study also had AI. If this is managed with appropriate support lenses along with home-based accommodative therapy that targets both the *jump* and *ramp* systems and combined with real space convergence training (eg. Brock String) that also targets the jump *and* ramp systems, then the outcome is more likely to be effective as a low cost home therapy solution.

Basic Therapy for CI

Therapy for CI is usually a combination of accommodative and convergence therapy. Example:

1. Prescribe low plus reading lenses if AI is present - to be worn when reading for more than 5 minutes. This provides some immediate benefit to the patient but can also be continued for 12 to 18 months as “support lenses” - even if the *symptoms* have resolved.
2. Accommodative Therapy (10min daily) - done *monocularly* over a period of 3 weeks using a Near Far Chart and should challenge both the jump and ramp components of accommodation (also helpful for supporting the development of *voluntary saccades*).
3. Brock String (10min daily) – is done *binocularly* following AI training over a period of 3 weeks. The therapy should challenge both the jump and ramp components of convergence (also helpful for supporting the development of *binocular fixation stability*).
4. Review in 6 weeks. Compliance for home therapy is usually best up to 6 weeks!
5. Additional therapy, continuing training or a maintenance programme may be recommended as indicated.



Helpful Hints

- Convergence training teaches the brain *where* to point the eyes in space.
- The crossing of the strings tells the brain where the eyes are pointing.
- If the patient can't make the strings cross at the bead try using your finger or the tip of a pen to guide them to the bead. Remove your finger or pen and ask them to try and hold that position.
- Therapy should generally be done standing rather than sitting.
- If a string disappears due to *suppression* you can try 1) twanging the string 2) increasing the weighting on one foot 3) getting them to look at a bead further away 4) increasing the lighting.
- Note that training may initially cause sore eyes or headaches!
- Emphasize *holding* the eyes converged for at least 5 seconds or more.
- Training can also be helpful for students with a history of mild head injury.⁴

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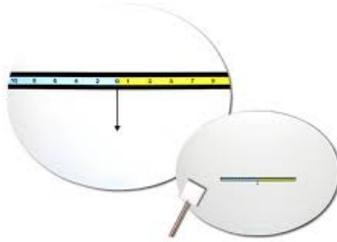
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5. Szymanowicz D, Ciuffreda K, Thiagarajan P, Ludlam D, Green W, Kapoor N. Vergence in mild traumatic brain injury: a pilot study. [J Rehabil Res Dev 2012, 49\(7\):1083-100](#)
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EXAM ROOM RESOURCES:

1. Wolf Wand:



2. **Phorias:** The best way to measure phorias in real space is with a Howell Phoria Card (one for distance and one for near). These are available from Cyclopean Design in Australia.



3. **Vergences:** The best way to measure vergence ranges is with a prism bar (a shorter bar is easier) and a Bernell fixation target.



4. **Questionnaire:** The Convergence Insufficiency Symptom Survey (CISS) can be *very helpful* to gauge the impact of the CI especially for *teenage* students. In some cases the score may be low and the patient may decide against treatment. A score of 16 or more is considered to be significant. It is not uncommon to get scores in the 30's. Scores in the 40's & 50's are severe.

A copy of the CISS can be found on the iCept website.

5. **Brock String:** Made from 6mm Crafters Choice Macrame Cord & 12mm Arbee round wooden beads (eg. Spotlight Store, or find on internet). Cord length should be around 2.0m or longer.



Convergence Insufficiency Symptom Survey (CISS)

Name _____ Date ___/___/___

Instructions: Read the following patient instructions and then each item exactly as written. If patient responds with "yes" – please qualify with frequency choices. Do not give examples.

Patient instructions: Please answer the following questions about how your eyes feel when reading or doing close work.

	Never	(Not very often) Infrequently	Sometimes	Fairly Often	Always
1. Do your eyes feel tired when reading or doing close work?					
2. Do your eyes feel uncomfortable when reading or doing close work?					
3. Do you have headaches when reading or doing close work?					
4. Do you feel sleepy when reading or doing close work?					
5. Do you lose concentration when reading or doing close work?					
6. Do you have trouble remembering what you have read?					
7. Do you have double vision when reading or doing close work?					
8. Do you see the words move, jump, swim or appear to float on the page when reading or doing close work?					
9. Do you feel like you read slowly?					
10. Do your eyes ever hurt when reading or doing close work?					
11. Do your eyes ever feel sore when reading or doing close work?					
12. Do you feel a "pulling" feeling around your eyes when reading or doing close work?					
13. Do you notice the words blurring or coming in and out of focus when reading or doing close work?					
14. Do you lose your place while reading or doing close work?					
15. Do you have to re-read the same line of words when reading?					
	___x0	___x1	___x2	___x3	___x4

TOTAL SCORE _____

6. **Near Far Card:** Use 300g white card. Print from iCept website under "Resources".

Tinted Lenses

Students that report a positive effect with tinted lenses may actually have an accommodative-convergence problem so this should be ruled-out first.^{1,2} If accommodation and convergence is normal but the student still reports seeing words move on the page, this is referred to as “visual stress” but the underlying mechanism is uncertain.³

A key reported symptom of visual stress is words “jumping or moving” on the page. This is a highly disruptive symptom and therefore likely to affect reading or limit eye movement or perceptual training. In such cases a tinted lens can be helpful.⁴ The blue and yellow tinted lenses recommended by VFL are based on the Kodak Wratten filters used by the Dyslexia Research Trust in placebo controlled trials.³ Their findings indicate that blue and yellow filters (Kodak 47B & 15) are as effective as selecting from a range of tint options in terms of *educational outcomes*. VFL also offer the option of a pink tint which is sometimes preferred.



In cases where a student has an accommodative-convergence problem AND reports that words moving on the page this can be checked by adding plus power with one eye covered to see if the symptoms are eliminated. If adding a tinted lens is still helpful this can be incorporated into the prescription at the initial visit or else the lenses can be ordered as “tintable” and added at the 6 week review if necessary.

If there is uncertainty, try comparing with and without the tint while the student reads age appropriate text and or the DEM (Developmental Eye Movement Test). Time with a stopwatch and note any differences.

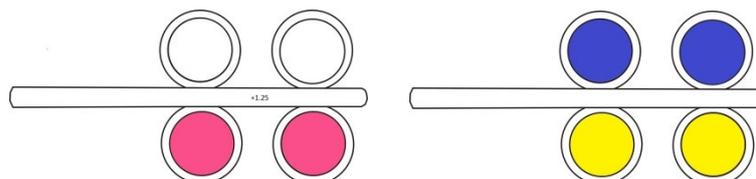
1. VFL Kodak Wratten 47B Blue 80% (screening kit) & 50% (optometrist kit only)
2. VFL Kodak Wratten 15 Yellow 35% (screening kit) & 20% (optometrists kit only)
3. VFL Pink 60% (screening kit)

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4. Hall R, Ray N, Harries P, Stein J. A comparison of two coloured filter systems for treating visual reading difficulties. [Disabil Rehabil 2013, 35\(26\):2221-2226.](#)

EXAM ROOM RESOURCES:

1. Tinted Lenses



These can either be purchased from VFL as part of the *3 Point Check Test* (includes lighter tints) or separately from Universal Lens Company in Auckland, NZ.

NOTE: We are currently looking for labs outside of NZ to supply the tinted lenses.