

TASMANIA'S LIFESTYLE CONGRESS

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## Solving binocular vision problems



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Acknowledgement of Country

I begin today by acknowledging the Muwinina people of Nipaluna/Hobart, part of the broader Palawa people, Traditional Custodians of lutruwita/Tasmania – the land on which we meet today. I pay my respects to their Elders past and present. I extend that respect to Aboriginal and Torres Strait Islander peoples here today.

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LEARNING OBJECTIVES

By the end of this presentation, you should be able to:

- Apply an evidence-based framework to accommodation-vergence disorders
- Apply an evidence-based framework to strabismus and amblyopia, including use of eye drops in assessment, diagnosis and management

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Session plan

- Interactive case discussion
- Problem-solving framework for assessment, diagnosis and management of binocular vision conditions
- Interactive case discussion/s
- Hands-on workshop of binocular vision tests(?)
- Interactive case discussion/s

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Case 1 – Lucy, aged 10yr 2mth

- PC: headaches and sore eyes when reading
- Initial findings:
  - Cover test maybe small esophoria. Pupils normal. No incomitancy/ nystagmus/ ptosis/ proptosis
  - Unaided vision R=L 6/6
  - Non-cyclo ret R=L +0.75DS. VA (logMAR letters) R=L 6/6+
- Ocular health normal to (good) non-dilated view, stable tear film
- Questions? Further testing?

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Considerations for further testing

- Do we need more detailed accommodation-vergence testing?
- Do we need cyclo refraction and pupil dilation?
- Do we need visual fields?
- Do we need to refer for neurological w/u immediately?

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### Case 1 – Lucy, aged 10yr 2mth

- Headaches and sore eyes when reading; **No nausea/vomiting/clumsiness**
- Small esophoria. Pupils normal. No incomitancy/ nystagmus/ ptosis/ proptosis
- Normal vision improves a little with R=L +0.75DS. Cyclo-ret R=L +1.25DS
- **Accomm: MEM ret +1.50 R=L; AccFac loves +, can't clear -**
- **Verg: D ph ortho; N ph 5pd ep (Prentice card); 15pd ep with -1D OU, ortho with +1D OU; N BO range 45/40, BI range 12/1**
- Ocular health normal (to best available techniques)
- Diagnosis? Prognosis? Management?

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### Breakout discussion of Case 1

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### Case 1 – post-breakout review

- Lucy, 10yo with AI/CE commensurate with headaches and sore eyes; no ocular health concern
- Some data worth knowing:
  - Near add specs significantly improved signs and symptoms of AI, and so did VT (Brautaset et al 2008)
  - Near add specs achieved higher compliance in tx'ing AI than VT (Brautaset et al 2008)
  - Low near add specs (e.g. MEM ret -0.25) probably better than higher near adds (Wahlberg et al 2010)
- My (shared with parents) decision: Rx SVN specs R=L +1.00DS for all N tasks, rev 8/52
  - Expect symptoms to resolve (almost immediately) with specs
  - Acc-verg through specs after 8/52 likely to improve, with potential resolution in 1-5 yrs

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### Problem-solving framework

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### A simple binocular vision decision tree

```

    graph TD
      Q1[Does my patient have a strabismus?] -- Yes --> Q2[Benign?]
      Q1 -- Yes --> Q3[Potentially dangerous?]
      Q1 -- No --> Q4[Normal BV?]
      Q1 -- No --> Q5[Non-strab BV disorder?]
  
```

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### Step 1: Does my patient have a strabismus?

- History
  - Symptoms (cosmesis, diplopia, asthenopia, none)
  - Eye/direction/when, precipitating factor
- Motor aspects via general observation, Hirschberg and cover test
  - Magnitude, constancy, comitancy, laterality, direction
- Monocular sensory aspects (i.e. amblyopia)
  - Vision, fixation, accommodation
- Binocular sensory aspects
  - Suppression, local stereopsis, global stereopsis
- Don't forget
  - Refraction (non-cyclo AND cyclo), health, neurology

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### Critical diagnostic step – differentiating danger

- Most strabismus (75+%) is “benign”. How to pick the 25%?
  - Seek unusual symptoms
    - Nausea and/or vomiting, unusual headaches, clumsiness, general malaise, trauma, recent weight changes, hormonal changes, growth defects
  - Consciously search for unusual signs
    - Nystagmus, torticollis, ptosis, incomitancy, proptosis, pupil abnormalities
  - Do best-practice ocular health exam
- Causes of the 25%
  - CNS abnormalities, sensory strab, paralytic strab

Data from tertiary care USA – Mohny (2001), Mohny & Huffaker (2003); Govindan, Mohny et al (2005)

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### Problem-solving pearl – probability pointers

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### “Benign” strabismus pearl

- The cause of an esotropia will tell you what to do
- Describing an exotropia will guide you towards what to do

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### Differential diagnoses of esotropia

1. Infantile ET complex (5%)
2. Accommodative ET (53%)
3. Acquired non-accommodative (11%)
4. Duane's syndrome (2%)
5. CN6- (1%)
6. Neuro and path causes (17%?)
7. Monoc vision loss (7%?)

Data from Mohny (2001)

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### Accommodative esotropia management

- Correct plus
- Treat amblyopia
- Fix all binocular vision issues
  - Residual strabismus? Suppression?
  - Fusion/stereopsis? Accom-vergence?
- Encourage emmetropisation

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### Differential diagnoses of exotropia

1. Infantile XT (3%)
2. Intermittent XT (52%)
3. Convergence insufficiency(16%)
4. Paralytic (3%)
5. Neuro and path causes (13%?)
6. Monoc vision loss (9%?)

Data from Mohny & Huffaker (2003), and Govindan et al (2005)

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### Describing the “benign” XT guides towards what to do, so...

- Measure the size at distance and near
  - Treatment depends on D/N pattern (CI vs DE), and magnitude
- Determine constancy
  - Non-surgical treatments best for intermittent, and prognosis better
- Determine laterality
  - Alternating XT means there will be no or minimal amblyopia
- Measure any vertical deviation
  - Vertical deviations decrease fusion capacity

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### Critical consideration in int XT

- Measure vergence ranges
  - From the fused state, how much prism challenge can you give before blur/break/recovery occur
- Compare them to the size of the deviation – i.e. Sheard’s criterion
  - For sustained fusion and comfort, BO recovery point should be twice the exo-deviation



15pd int alt CI XT, BO range -/25/20

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### Non-strabismic BV disorder

- Too much or too little accommodation?
  - AI responds well to plus lenses (symptomatically, although longer-term outcome less well defined) and/or vision therapy
  - AE... depends on degree and associations
- Too much or too little convergence?
  - CE responds well to plus lenses (depending on AC/A ratio)
  - CI responds well to vision therapy

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### Horwood and Toor 2014

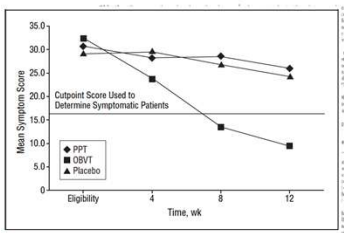
**Clinical test responses to different orthoptic exercise regimes in typical young adults**

- Accommodation vergence signs and symptoms improve most when:
  - Exercising vergence independent of accommodation or proximity
  - Exercising accommodation independent of vergence or proximity
  - Includes ‘cross-over’ benefits
- Changing vergence, accommodation and proximity all at once doesn’t work
- Participant effort effected outcome
- Participant effort depended on instructor effort

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### The clearest quantification of CI VT success

- CITT (2005a, b and c; 2008, 2009, 2011, 2012...)
  - Randomised, masked, multicentre clinical trials
  - Clear assessment, diagnosis, interventions and reviews




**Figure 4.** Mean convergence insufficiency symptom score after 4, 8, and 12 weeks of treatment. PPT indicates pencil push-ups therapy; OBVT, office-based vision therapy.

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### Implications of acc-vergence tx evidence

- Do NOT prescribe pencil push-ups
- Consider glasses with a near add for AI
  - +1.00, or MEM ret-0.25D? But NOT +2.00D
- Consider prescribing VT for AI and/or CI:
  - Motivate your patients
  - Isolate accommodation/vergence, from each other & from proximity, i.e. use loose prisms, tranalygths, loose lenses, flippers, computer-based therapy
  - Aim to satisfy Sheard’s Criterion
  - VT for CI provides a long-term treatment effect
  - Accommodative therapy helps vergence problems and vice versa
  - Higher intensity of VT probably achieves greater improvements

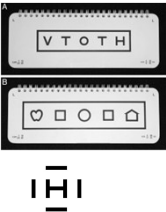




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### Case 2 – Flora, aged 3yr 2mth

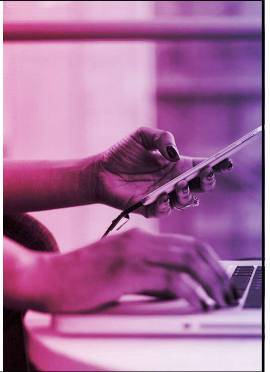


- PC: Parents think her eyes look funny – probably LE, maybe turns inwards, getting worse (bigger turn, more frequent). No FOH other than specs
- Initial findings:
  - Hirschberg mod L ET. Cover test constant L 40pd ET with some V-pattern and elevation on adduction @ N. Objects (strongly) to R cover. -MG pupil
  - Unaided vision R 6/24, L 6/75
  - Non-cyclo ret R=L +4.00DS. VA (LH SS with CI bars) R 6/15, L 6/60. VA (LH SS without CI bars) R 6/15, L 6/48-
  - Ocular health normal to an okay non-dilated view
- Questions? Further testing?


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### Breakout discussion of Case 2




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### Considerations for further testing




- Do we have an explanation for the PC:
  - Sort of – “esotropia”! But are we comfortable with the differentials?
    - Infantile ET complex; Accommodative ET; Acquired non-accommodative ET; Duane’s syndrome; “Neurological/pathological causes” inc CN6-
  - Differentiating danger?
    - Ask about nausea, vomiting, unusual headaches, clumsiness, general malaise, trauma, recent weight changes, hormonal changes, growth defects
    - Look for nystagmus, torticollis, ptosis, incomitancy, proptosis, pupil abnormalities
    - Positively diagnose a benign ET
    - Do best-practice ocular health exam
  - Differentiating the more benign causes?

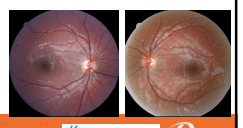



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### Case 2 – Flora, aged 3yr 2mth

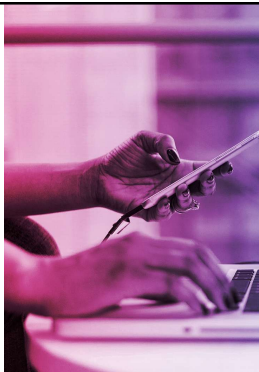


- PC: Parents think her eyes look funny – probably LE, maybe turns inwards, getting worse (bigger turn, more frequent). No FOH other than specs. **No nausea, vomiting, headaches, clumsiness, malaise, trauma, weight/hormonal/growth change**
- Initial findings:
  - Hirschberg mod L ET. Cover test constant L 40pd ET with some V-pattern and elevation on adduction @ N: **720pd ET @ D?**  
**No LN/MNTSPA/DVD. Objects (strongly) to R cover. -MG pupil. No nystagmus, torticollis, ptosis, proptosis/retraction**
  - Unaided vision R 6/24, L 6/75
  - Non-cyclo ret R=L +4.00DS. VA (LH SS with CI bars) R 6/15, L 6/60. VA (LH SS without CI bars) R 6/15, L 6/48-
  - **Cover test with R=L +4D = constant 20pd ET**
  - **Cyclo ret R +5.00DS, L +5.50DS**
  - Ocular health normal to BIO with 15D lens after diln, although LE extorted?
- Diagnosis? Management? Prognosis?


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### Breakout discussion of Case 2




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### Case 2 – post-breakout review



- Flora, 3yr old with accomm ET with mild oblique muscle adaptations and amblyopia. No other ocular/neurological problems apparent
- Data worth knowing about accET: (from Mohnney 2001, Berk et al 2004, Ludwig et al Inc Parks 2005, de Pagano & Pagano 2012)
  - 53% of childhood ET presenting to tertiary ophthalmology (far higher at ACO)
- Prescribe the glasses that get eyes as straight as possible ASAP
  - Correction on the good eye controls the deviation
  - Correction on bad eye allows you to treat the amblyopia
  - If compliance issues, consider CLs, atropine OR pilo (I), or refractive sx
- My (shared with parents) initial management:
  - SV specs with R +5, L+5.5 for FT wear, review 3/52 to check alignment and VA



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### “Case 3” – Flora, aged 3 - 7yrs

- With SV specs R +5 L +5.5, FT wear. “Eyes straight with specs”, worse without specs
  - D ortho, N 10pd constant L ET; Vision (LH SS with CI bars) with specs R 6/12, L 6/48; R 6/9, L 6/38 (LH SS without CI bars). No stereopsis.
  - Near ET decreases to 5pd with +2D over SV specs
  - No other changes
- Continued steady with 3/52 reviews until VA stopped improving
  - About 4 cycles later, stabilized at R 6/7, L 6/18 (with CI), L 6/24 (without CI)
  - No other changes



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### Considerations

- What should we do to promote normalization of sensory binocularity?
  - Amblyopia vision therapy via
    - Continuing with specs alone?
    - Adding opaque patching?
    - Adding atropine penalization?
    - Alternatives?
  - Anti-suppression/pro-fusion vision therapy
- What should we do to promote motor binocularity?
  - More plus? E.g. change to bifocals for improved alignment at near?
  - Seek surgical opinion for improved alignment at near?
  - Start divergence vision therapy?
  - Alternatives?



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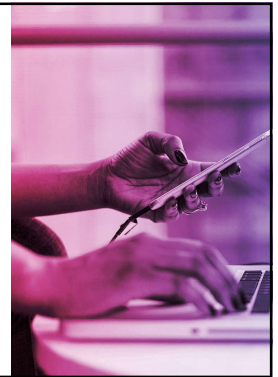
### Case “3” – Flora, aged 3 - 7yrs

- Did well with a combination of:
  - 35mm D seg BFs with R +5, L +5.5, +2D near add (FT wear, ongoing)
  - RE PT opaque occlusion patching for next 3 cycles
  - RE 2x/week 1% atropine penalization for subsequent 3 cycles
  - Then specs-only until 6.5yrs old in grade 1
    - Good VA in both eyes, with periodic regression of up to 2 lines in LE
    - Low grade fusion, no stereopsis, effectively a L microET
- What are your amblyopia tx pearls? (Methods? Achieving compliance?)
- What would you have done differently for Flora?



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### Breakout discussion of “Case 3”



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### “Case 3” – post-breakout review

- Flora, aged 3 – 7yo with accom ET, hyperopia, amblyopia
  - Some data worth knowing (from MOTAS 2004, PEDIG 2006, PEDIG 2007, MOTAS 2009, MOTAS 2011, PEDIG 2002, PEDIG 2005, PEDIG 2008 and PEDIG 2003, MOTAS 2004, PEDIG 2013, PEDIG 2004, PEDIG 2008, PEDIG 2011):
    - 75% of children with amblyopia (aniso or strab) will have  $\geq 2$  lines VA improvement over 3/12 with specs alone
    - Patching (FT and PT) and atropine (2x/week) both work – individualise to your pt
    - Optometrist effort (listening; providing information, stories, rewards framework) helps compliance
  - At 7 years of age, Flora has no significant amblyopia, cosmetic alignment, has not needed surgery
  - But, she is reliant on “unflattering” specs, has zero stereopsis, only low-grade fusion, periodically regresses to shallow amblyopia



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### “Case 4” – Flora, aged 7 - 15yrs

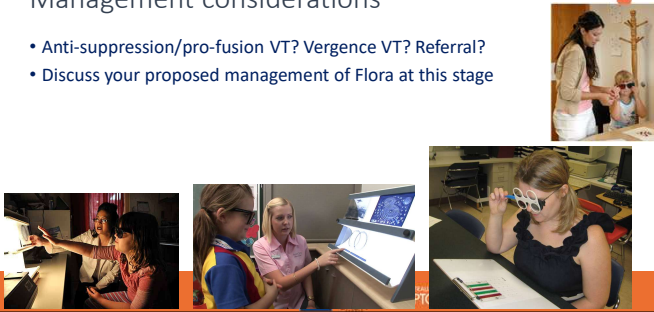
- Flora and mum would like to decrease reliance on specs without going esotropic, and prevent amblyopia regressions
- Options discussed
  1. CLs, refractive surgery
  2. Strab surgery
  3. Vision therapy aiming to improve fusion, followed by spectacle “weaning”



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## Management considerations

- Anti-suppression/pro-fusion VT? Vergence VT? Referral?
- Discuss your proposed management of Flora at this stage



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## Breakout discussion of "Case 4"



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## "Case 4" – post-breakout review

- Flora, 7 – 15yo with accET and hyperopia, wanting to decrease reliance on specs and cease amblyopia regressions
  - Things worth knowing (from Birch et al 2004, Fawcett & Birch 2003, Hutcheson et al 2003, Lambert et al 2003, Lambert & Lynn 2006, Somer et al 2006, Ludwig et al 2005, Portela-Camino et al 2018):
    - VT can overcome suppression, facilitate/establish fusion, facilitate/establish stereopsis, improve vergence control
    - Spec weaning standard = 0.5D per 6/12. Accuracy of accom (i.e. MEM ret) is best way to predict readiness. 20-60% of children with accET able to discontinue specs (for strab) 10yrs post-dx
  - Flora overcame central suppression, improved fusion, "established" stereopsis (good contour, "blobby" random dot). Amblyopia regressions have ceased.
  - Able to transition out of bifocals and decrease SV specs to R=L +2.50, which she can remove while remaining straight. Also has CLs, which are helpful




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## Clinical pearls for accommodative ET

- Keep eyes on both the short game and the long game
- Be aware of the evidence. Critically:
  - Urgent specs to get eyes as straight as possible ASAP avoided strab sx
    - Well-chosen plus, progressing to BFs, were critical at the right times
  - Hold the patch (note VA improvement with "spectacle adaptation")
  - Part-time opaque patching works on amblyopia
  - Atropine penalisation works on amblyopia
  - Vision therapy can overcome suppression, "establish" fusion/stereopsis, and contribute to improved vergence control (even divergence)
  - Spectacle weaning can be helpful (at the appropriate time)

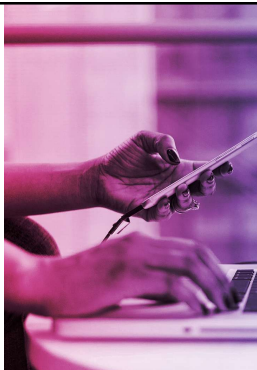


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## Hands-on workshop of binocular vision tests(?)


- Is this viable???



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## Case 5 – Lukesh, aged 7yr 10mth

- PC: Optom referral for CI (okay in am, but in pm has tired eyes/ sore eyes/ words move and go double, feels sleepy when reading)
  - NPC 20cm, N ph 20xp
  - Occupational spec lenses with R +1.00/-0.25x80 L +1.25Ds at near that Lukesh doesn't like
  - Pencil push-up VT that didn't seem to help
- Confirmed:
  - Hyperopia (R +2.25, L +2.75), healthy and neurologically normal
  - CI with NPC 12/15cm, D Ph 4xp, N Ph 18xp (sometimes breaking to int XT), N BO range 4/1, N BI range 25/20, AC/A ratio 1.5pd/D (+ = -)
  - Accommodation varies (prefers minus to acc fac, but MEM ret sometimes lead sometimes lag)
- Management questions?





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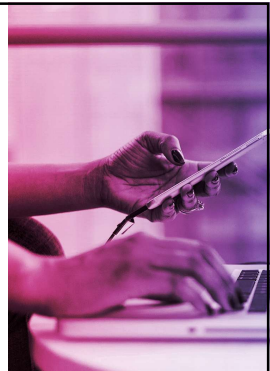


## Management considerations

- We discussed evidence that VT would help CI. Are there any other options in Lukesh's case (CI combined with hyperopia and variable accom)?
  - Is there evidence:
    - Glasses would help (distance and/or near add)?
    - Prism glasses would help?
    - Surgery (strab or refractive) would help?
- Discuss your proposed management of Lukesh?

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## Breakout discussion of Case 5

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## Case 5 – post-breakout review



- Lukesh, 7yo with hyperopia and CI
  - Things worth knowing:
    - Compliance maximized when instructions are clear, enthusiastic & relevant; rewards gamified
    - If patient has amblyopia or suppression, start by treating those (Lukesh doesn't, so...)
    - Decide whether to treat hyperopia, CI or both
      - Noting that Lukesh didn't like previous + specs, elected for VT
  - Activities broadly consistent with Horwood & Toor (2014), CITT (2005) and Huston and Hoover (2015) = 15 mins/day, ≥5 days/week, tablet only used during VT
    - 10 mins loose prism – loaned 4pd to start BO (5 mins) and 20 pd to start BI (5 mins)
    - 5 mins +/- lens flippers concentrating on trying to make tablet single and clear through +
    - Rev 1/12

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## Clinical pearls for accomm-vert VT



- Be aware of the evidence. Critically:
  - VT evidence clearest for CI ( $\pm$  accom problems)
  - Near add specs clearest for AI ( $\pm$  CE)
  - If using VT for CI
    - Vary vergence demands independently of proximity and accommodation (e.g. with loose prisms)
    - Vary accommodation demands independently of proximity and vergence (e.g. with lens flippers)
- Consider interactions of acc-vert with refractive correction

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