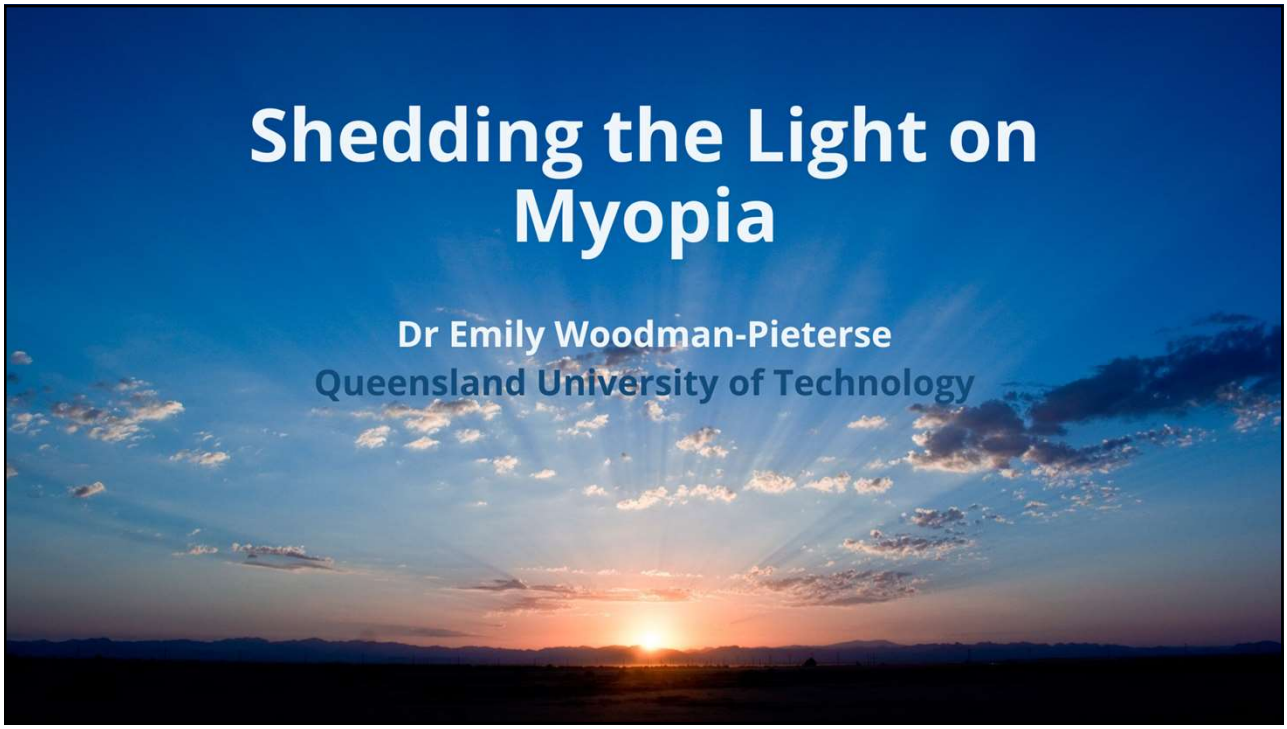
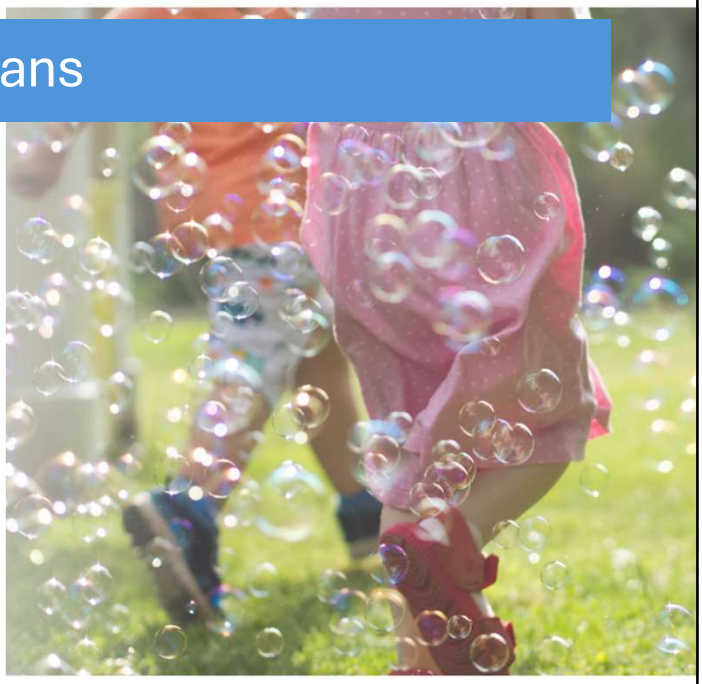


1

Light and myopia in humans

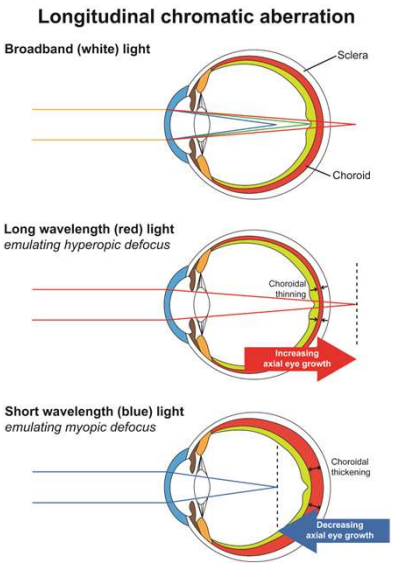
- More time outdoors associated with **lower prevalence** and **reduced risk** of developing myopia in childhood
- Recommendations for outdoor activity:
  - Aim for 2-3 hrs/day or 14-21 hrs/week
  - <40 mins/day assoc. with faster eye growth
- Possible mechanisms of action:
  - Higher illumination
  - Broader spectral distribution



2

What we know from animal studies

- **Illumination**
  - Bright light causes hyperopia or less myopia
  - Dim light causes myopia
  - Disruption of diurnal light-dark cycle interrupts emmetropisation
- **Spectral composition**
  - Blue-violet, cyan (**short**) wavelengths
    ↓ eye growth → hyperopic shift
  - Green (**mid**) & red (**long**) wavelengths
    ↑ eye growth → myopic shift
  - Different responses between animal species



(Woodman-Pieterse and Hughes, 2025)

3

What is light therapy?

- Delivery of a controlled dose of light – can be natural or artificial
- Exposure to a specific wavelength via LEDs
- Commonly used in dermatological and mood and sleep disorders
- Some light therapy already used in ophthalmology
  - e.g. photobiomodulation used in px with dry AMD, dry eye disease, DMO, glaucoma, RP
- Known role of light in myopia development
  → *could light therapy work for myopia control too?*

4

Prophylactic interventions

e.g. myopia prevention

Light-based

- Increased outdoor time
- Classroom lighting
- Red light therapy

Environmental-based

Pharmacological

5

Light-based Interventions

Increased Outdoor Time

- School-based trials show **increased daily outdoor time reduces new myopia**
- Guangzhou Outdoor Activity Longitudinal Study (GOALS)
  - 3-year trial of additional 40 min outdoor class per school day
- Family Incentive Trial Singapore – frequent visual breaks, 11 hrs outdoors every 7 days, family education, structured weekend activities
- Recess Outside Classroom (ROC) Study
  - Locked out of classroom at recess in 'treatment' school vs control school

Clinical trial outcomes

Non-myopic kids: less new myopia, slower eye growth, less refractive change

Already myopic kids: benefits were small and clinically insignificant

6

Light-based Interventions

A note on sun safety

- When promoting outdoor activity **we must simultaneously emphasise sun safety**
- Sight/life-threatening complications of UV exposure equally or more important
- UV skin and eye damage occur primarily in childhood, manifests in adulthood
- Strong sunlight (>10,000 lux) not necessary for effective myopia prevention – use longer time at lower levels (e.g. 1000 -3000 lux for 200 mins/day)
- Light levels still 11-43x higher outdoors than indoors, even with sun protection
- **Emphasise shade, hat, and Australian Standard (category 2, 3 or 4) sunglasses whenever recommending increased outdoor activity**

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Light-based Interventions

Classroom Lighting

- Architectural interventions to alter light exposure indoors
- Typical Chinese classroom illumination vs European:
  - 74 vs 500 lux
- Classrooms **increased luminance** over 12 m:
  - Lower incidence (4% vs 10% in traditional classrooms)
- **Altered spectrum** to mimic outdoor light over 3 yrs
  - Lower incidence of myopia (ANL 21% vs 26% controls)
- Glass walled classrooms – efficacy not reported
- Wallpaper & desk covered with images of outdoor scenes (high SF environments?)

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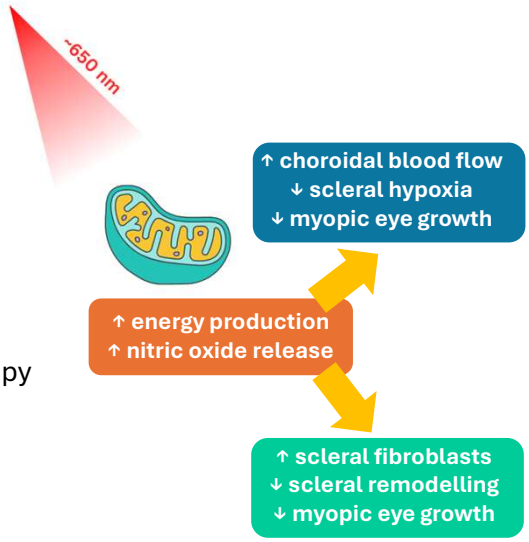
Light-based Interventions

Red Light Therapy

- Light can influence myopia development
- Rhesus monkeys and tree shrews develop hyperopia under red light
  - *Could red light therapy slow eye growth and prevent myopia?*
- RLT an existing amblyopia treatment in China
- Existing devices repurposed for myopia
- Desktop device – use at home or in-office
- Most studied and most effective of light therapy options
- Mechanism of action – photobiomodulation?



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Light-based Interventions

Red Light Therapy – Preventative

- 2 studies on prophylactic RLT in Chinese pre-myopic children
- **Protocol**:
  - Two, 3 min sessions/day
  - 5-7 days/week
  - 12 m
- **Rates of new myopia after 12 m**:
  - RLT 41% vs controls 61% (He et al. 2023)
  - RLT 2.5% vs controls 19% (Liu et al. 2024)
  - Significant ↓ eye length in first few months
  - After initial 3-6 months, changes closer to control group rate

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Adjunctive treatments

e.g. treating existing myopia

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Light-based Interventions

Red Light Therapy - Treatment

- Clinical trials & interventional studies conducted from 4 weeks to 24 months
- Evidence that RLT can:
  - Slow down (and sometimes reverse) eye growth
  - Slow myopic refractive error progression
  - Increase choroidal thickness
- Only one study has looked at efficacy beyond 12 m
  - Some reduction in treatment efficacy in second year
  - Much longer study duration needed
- Moderate rebound on treatment cessation
  - Not enough rebound to completely eliminate benefits of treatment
  - Limits clinical usefulness of treatment

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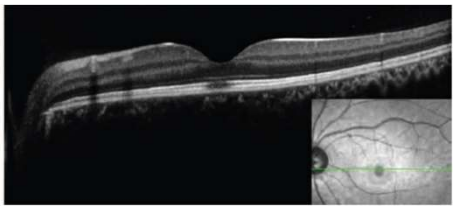
Light-based Interventions

Red Light Therapy – Safety

- Regulatory and safety concerns are beginning to surface
- Concerns from scientific community that RLT may exceed maximum permissible exposure level
- Risk of photochemical and thermal damage to macula?
- Published case report of RLT patient with VA loss and outer retinal damage
- Significant, persistent afterimages common (up to 6 min)
- More safety studies required
  - Trials in primates needed
  - Long-term histopathological assessment
- **Not yet enough safety or efficacy data for widespread adoption of treatment**



(Liu et al., 2023)

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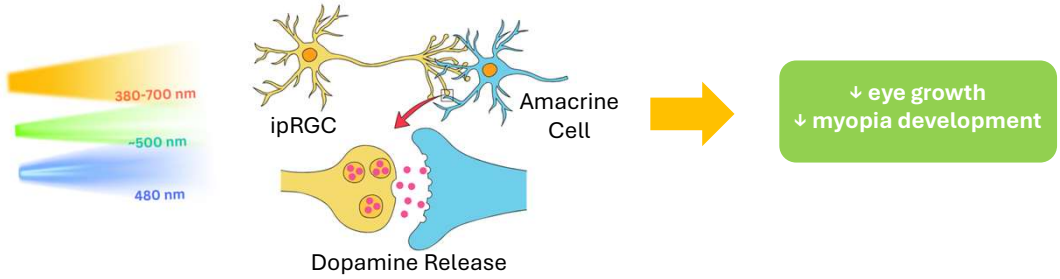
Light-Dopamine Mechanism

- Intrinsically photosensitive retinal ganglion cells (ipRGCs)
  - Subset of RGCs responsible for light-mediated regulation of myopic eye growth
- Blue light (peak λ 480 nm) activates melanopsin photopigment in ipRGCs
- ipRGC stimulation → retinal amacrine cells release dopamine → slow eye growth
- Increased outdoor activity, blue light therapy, cyan light therapy all theoretically mediated by light-dopamine mechanism



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Light-based Interventions

Blue-light Stimulation of Blindspot

Dopavision MyopiaX - blue-light stimulation of ONH

Background:

- Axons of ipRGC converge at optic disc
- ONH should be predominantly sensitive to blue light (highest density of melanopsin)
- Blue light exposure mediates effect of outdoor light on eye growth regulation → myopia control via dopamine modulation

Protocol:

- ~460 nm flickering circle, 10 min daily via Dopavision software
- Multicentre clinical trials underway, 12 m data soon
- No safety concerns

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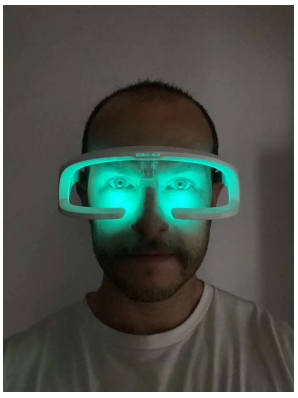
Light-based Interventions

Cyan Light

- Cyan light (peak λ ~507 nm) falls within spectral sensitivity of melanopsin
  - *Could cyan light exposure reduce myopic eye growth via melanopsin-ipRGC signalling pathway?*
- Effect of short-term cyan light exposure investigated using low powered LEDs:
  - Re-timer glasses (marketed for insomnia, jetlag, SAD) → 30 mins each morning for 1 week
  - Custom built frame with LEDs → single 2 hr session
- Results showed cyan light could cause temporary choroidal thickening and axial eye shortening
- Not enough evidence to be used for myopia control



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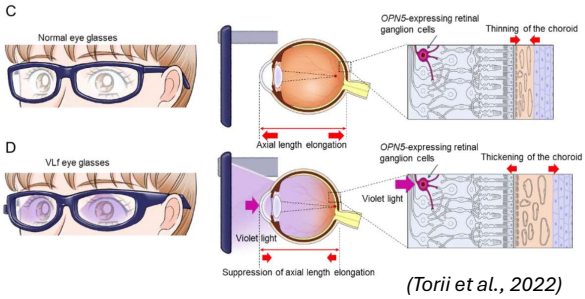
Light-based Interventions

Violet Light

- Violet light (λ 360-400 nm) abundant outdoors, absent indoors
- Evidence that myopic children wearing UV blocking specs/CL have faster eye growth
- Clinical trial: custom-built frames with LEDs emit violet light 3hrs/day (11am to 2pm) over 6/12 trialled in myopic children
  - Children 8-10 y.o. had less eye growth and myopic refractive change at 6 m
- Limited evidence:
  - Very few studies
  - Small sample sizes
  - Small effect sizes
- Long-term risk of UV light exposure?



(Torii et al., 2022)

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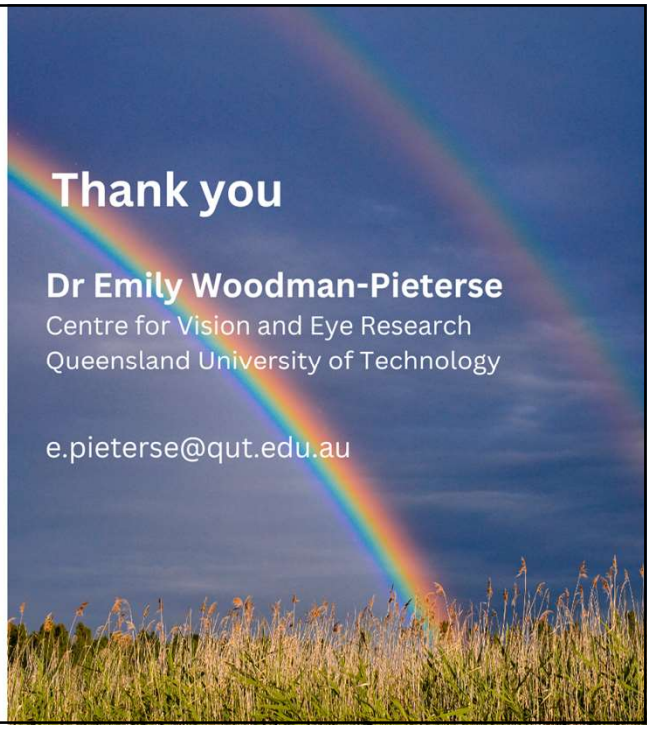
Summary

Rapidly expanding field - more research needed before widespread adoption

Include outdoor time recommendations in all premyopic and myopic children

Emphasise sun safety



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