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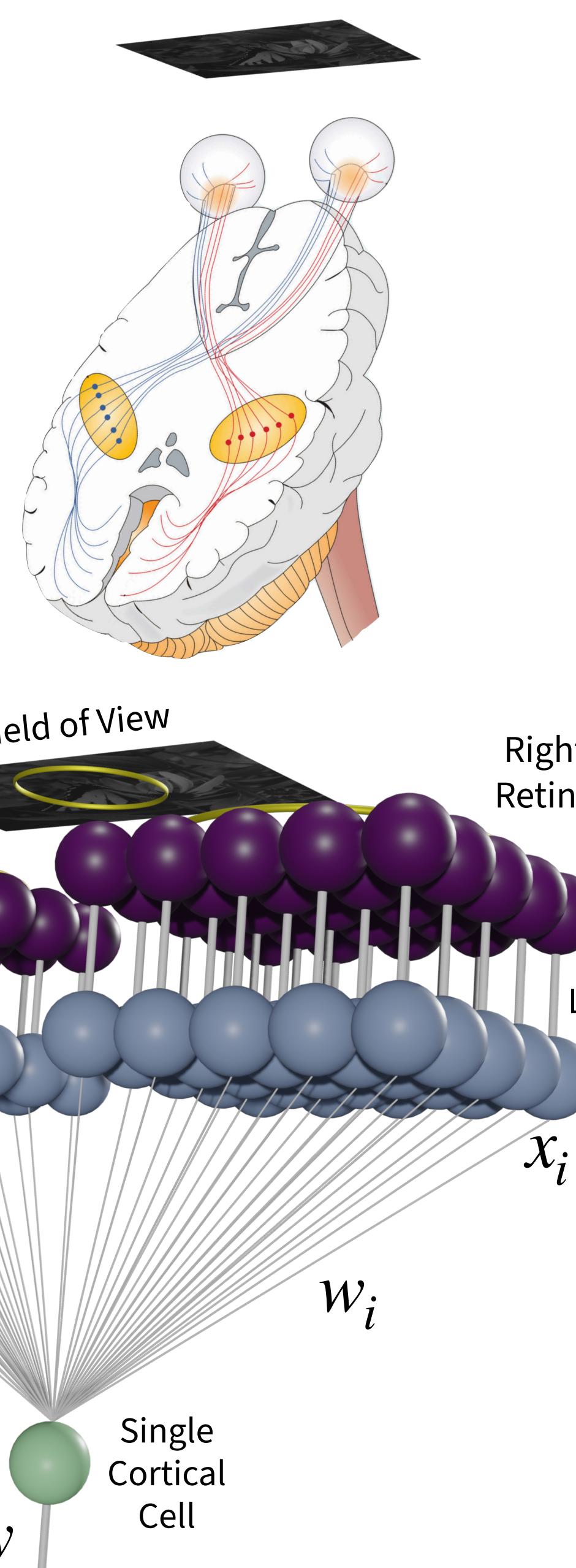
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Purpose

Amblyopia is a common cause of visual impairment that results from unequal visual inputs during development, known to manifest through synaptic alterations in the visual cortex. What is not known is the detailed mechanisms of these synaptic changes and how these mechanisms impact the dynamics of recovery. Here we use a computational model of neural plasticity to compare multiple treatment strategies.

Methods

- Bienenstock, Cooper, and Munro (BCM) model of activity-dependent neural plasticity
- Compare the dynamics of amblyopia recovery at the neuronal level
- Treatment protocols:
 - optical correction
 - patching
 - atropine penalization
 - binocular therapies.
- Multiple sources for amblyogenesis
 - refractive error
 - strabismus



BCM equations for Synaptic Plasticity

$$y = \sigma \left(\sum_i x_i w_i \right)$$

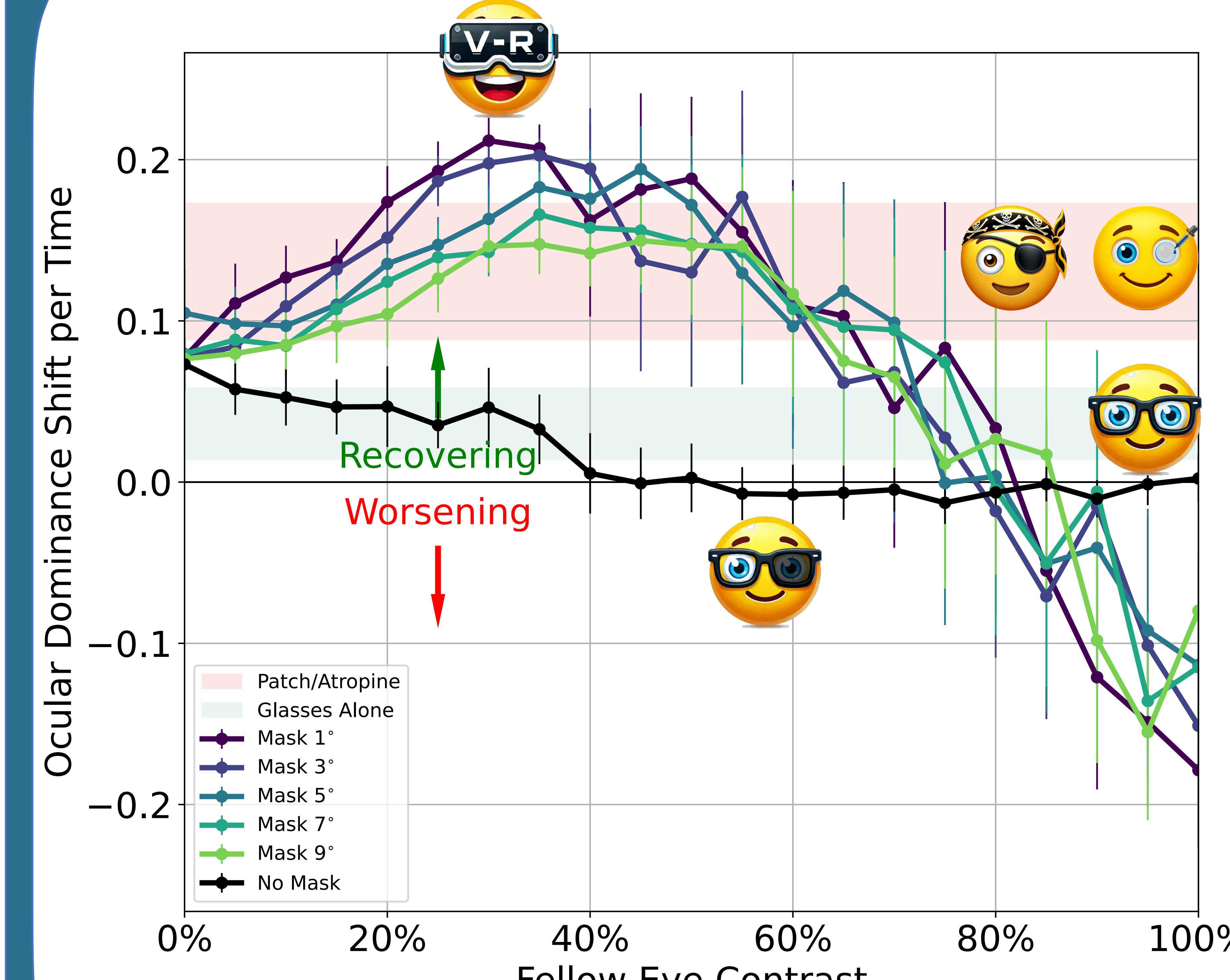
$$\frac{dw_i}{dt} = \eta y (y - \theta_M) x_i$$

$$\frac{d\theta_M}{dt} = (y^2 - \theta_M)/\tau$$

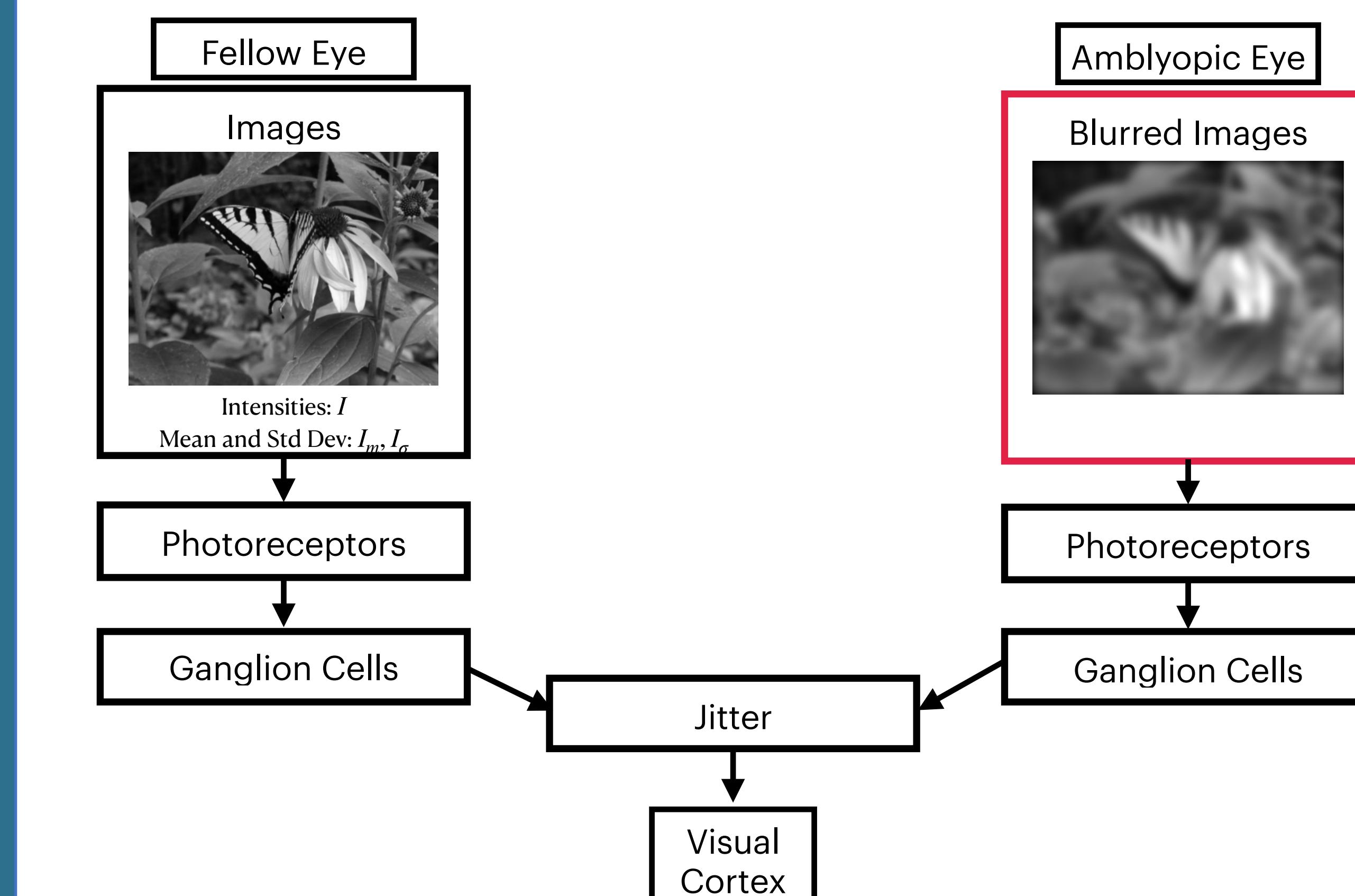
Results

- Recapitulated anisometropic amblyopia
- Ocular dominance remained stable even when simulating large angle strabismus
- Recovery achieved with dichoptic masks combined with an interocular contrast disparity exceeded that of patch and atropine treatments
- Patch and atropine treatment models produced faster recovery compared to a contrast disparity alone
- The rate of recovery depended on experimentally accessible treatment features
 - size of the dichoptic masks
 - magnitude of the contrast disparity
- The model suggests optimal values for these modifications
- Eye jitter and offset made very little if any difference on treatment response
- BCM theory of synaptic plasticity is sufficient to model anisometropic but not all of strabismic amblyopia
- Modeling can thus serve as a useful tool to compare therapeutic approaches and make specific clinical predictions

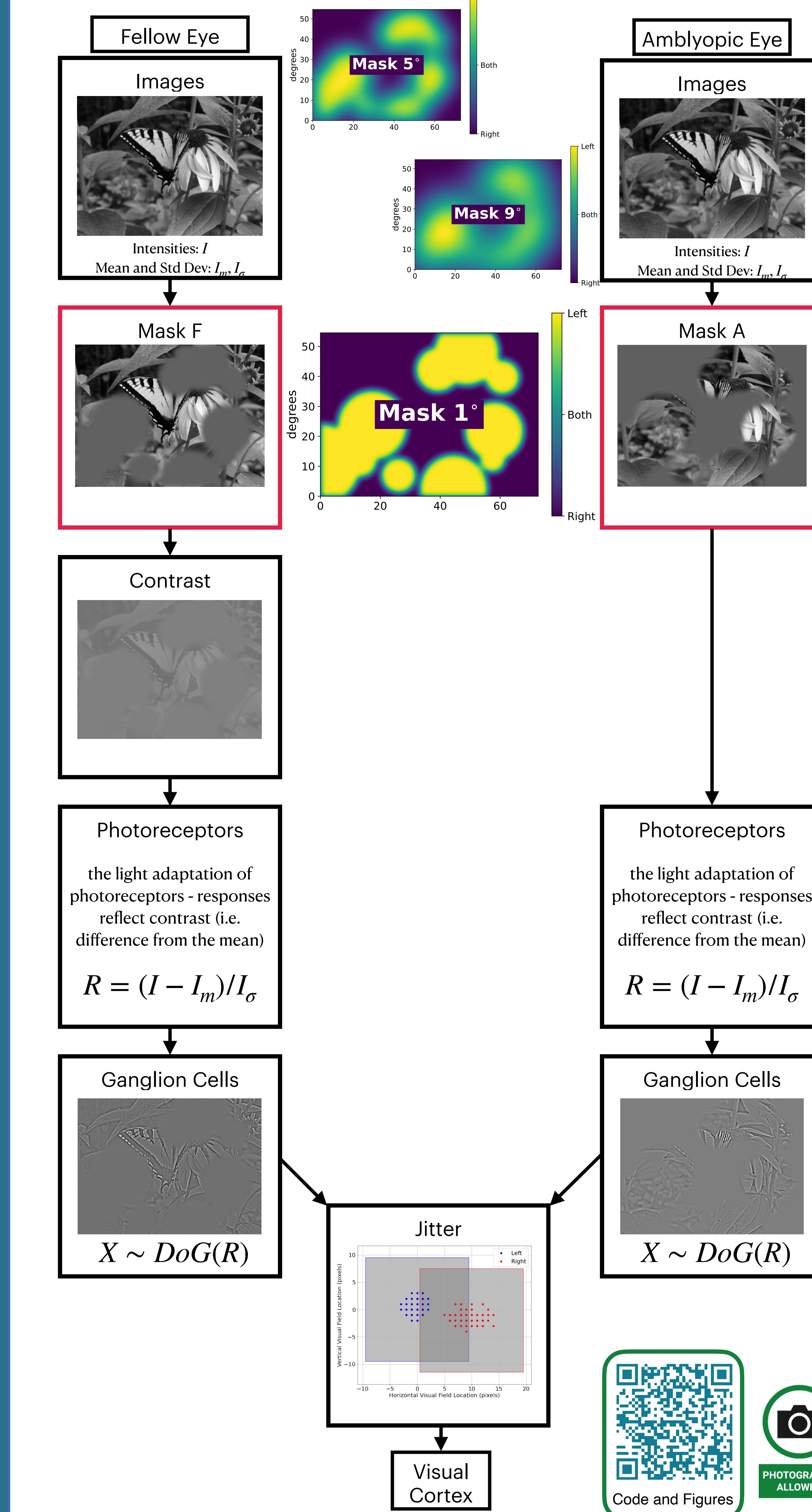
Synaptic plasticity models predict that (with small masks and moderate contrast disparity) binocular treatments for amblyopia can outperform monocular treatments



Deficit Model



Treatment Model



PHOTOGRAPHY ALLOWED

Code and Figures