

Using Virtual Patients to Predict Perceptual Performance after Optogenetic Sight Recovery

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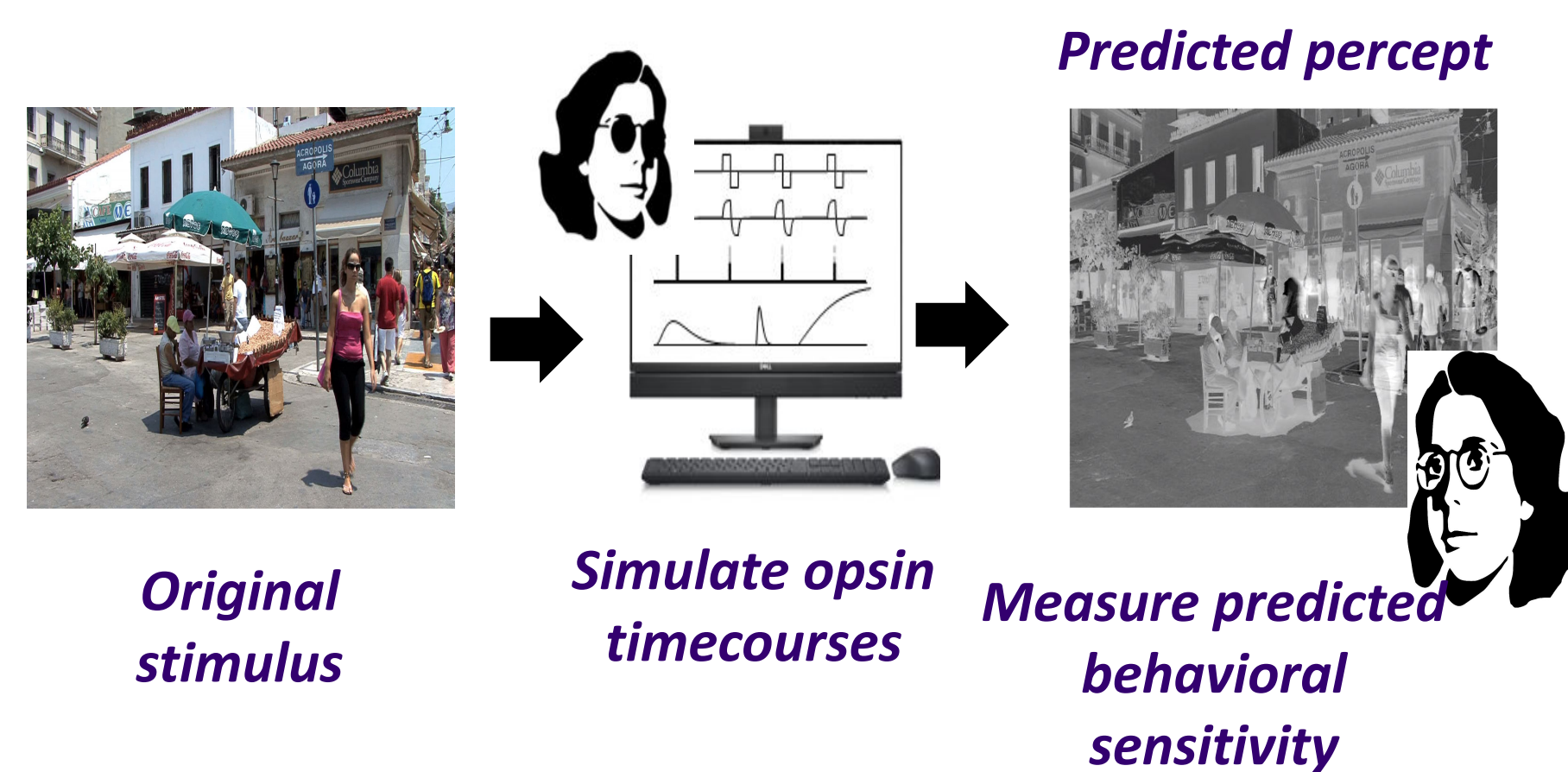
1. The Virtual Patient

Predicting the Perceptual Experience of Optogenetic Vision

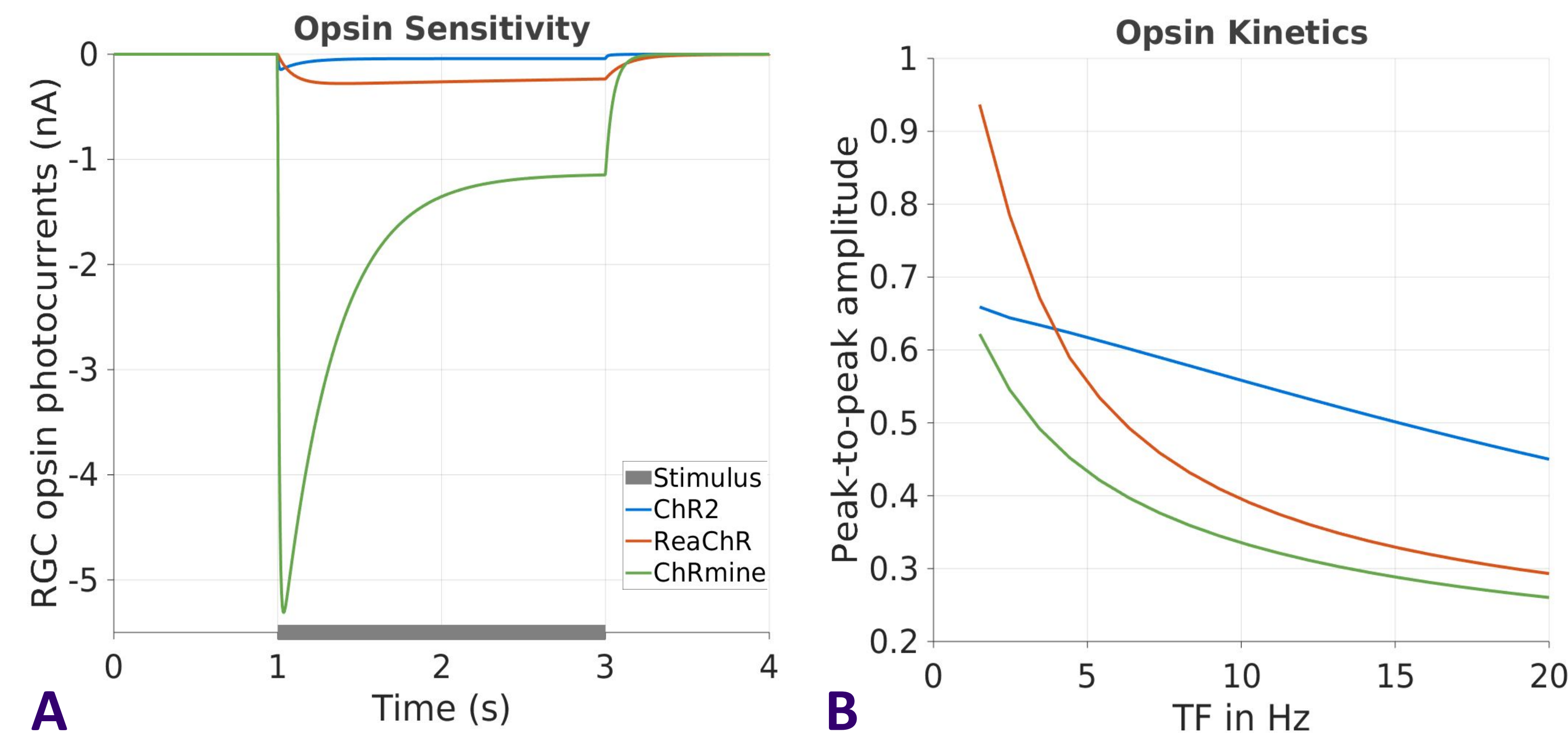
Optogenetic sight recovery uses retinaldehyde-binding proteins to elicit light sensitivity in remaining healthy retinal cells (bipolar and/or ganglion cells) of patients with inherited retinal disorders.

Can we predict functional vision from cell responsiveness?

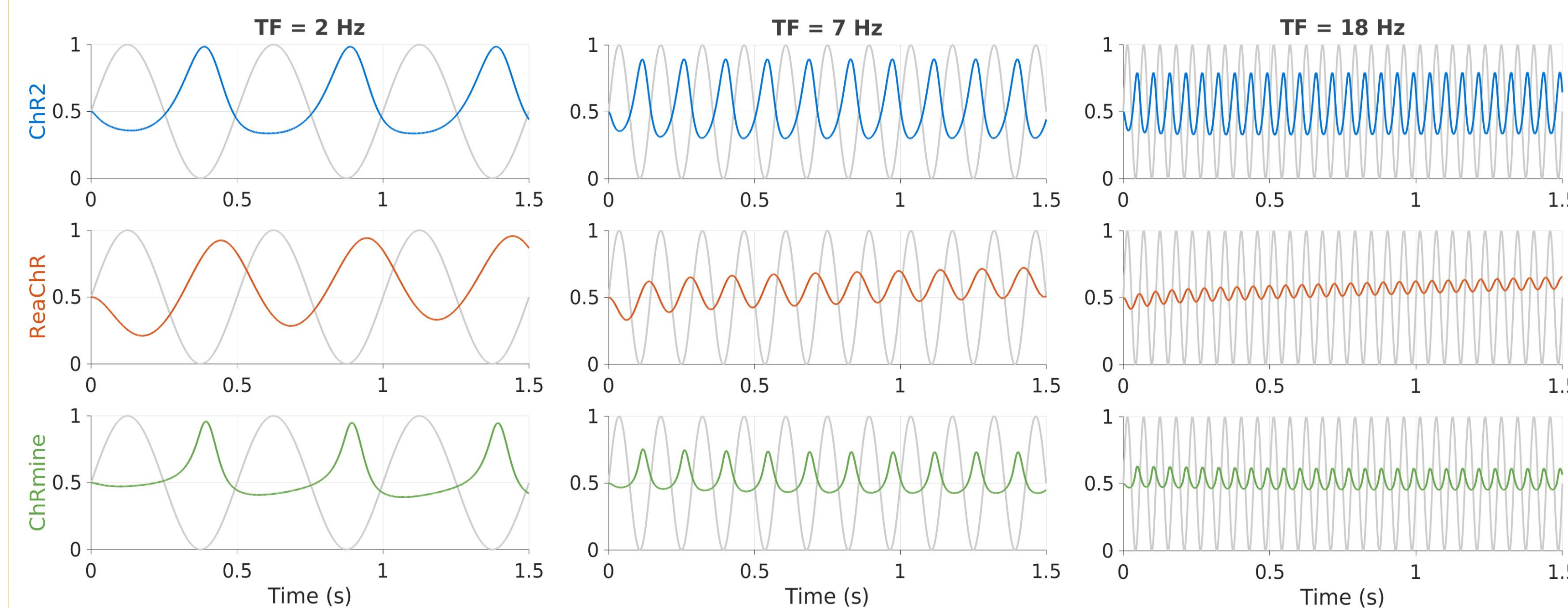
Opsins vary in sensitivity and speed which cause perceptual distortions. Here, we show how a 'virtual patient' can be used to predict the perceptual performance of optogenetic vision [1].



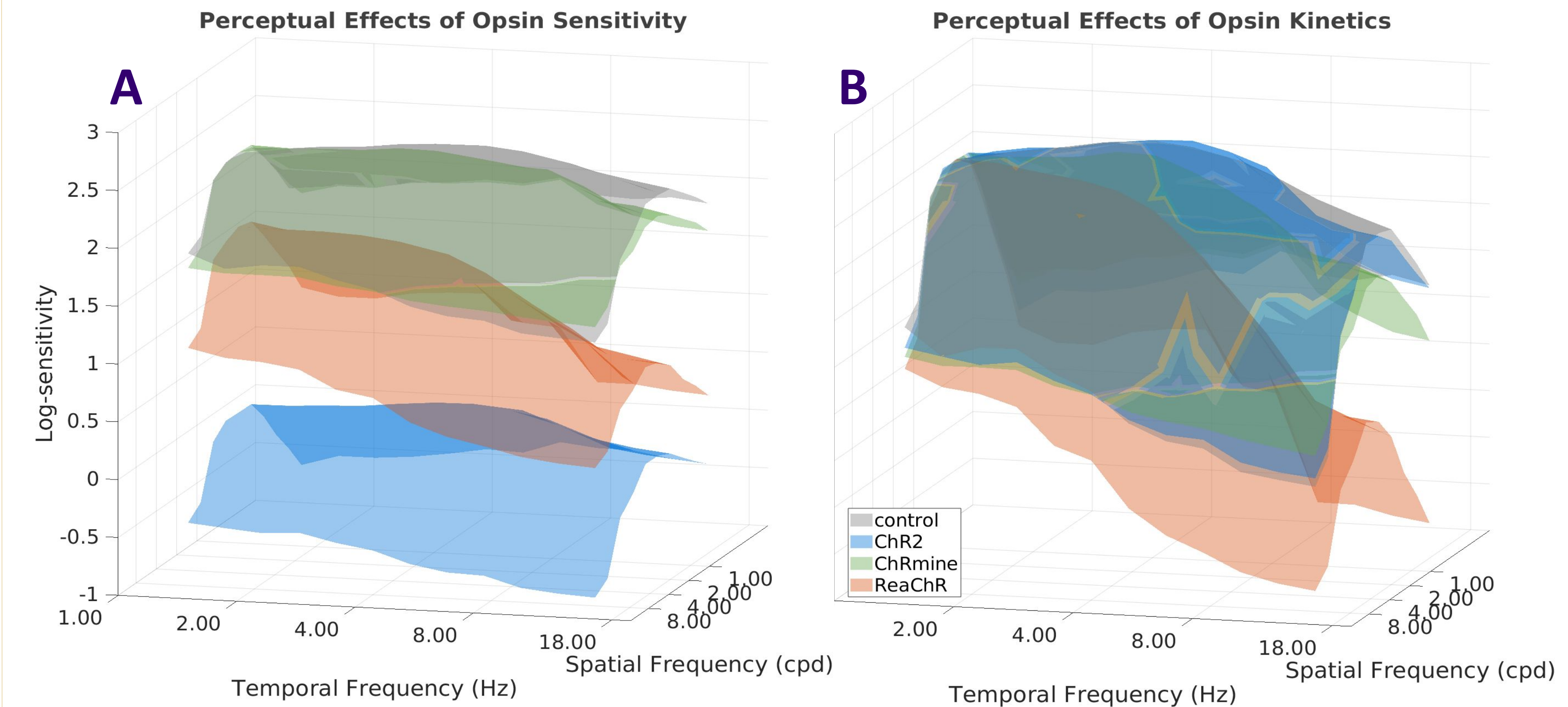
2. Modeling Photocurrents for Three Opsins



3. Simulated Optogenetic Timecourses



4. TCSF Detection Thresholds



5. Discussion

Both Speed and Sensitivity matter!

- Our framework can be used to predict perceptual performance of any opsin.
- ChR2:** Fastest opsin - matches neurotypical attenuation of higher TFs most closely, reducing temporal distortions. However **its low sensitivity leads to a ~100x loss of visual acuity.**
- ReaChR:** More sensitive than ChR2: ~30x improvement in visual acuity at the lowest TF. However, it has steep drop-off in sensitivity above 5 Hz (corresponds to a 10x loss in sensitivity between 5 Hz and 16 Hz) **rendering fast moving objects invisible. Losses are likely to be more severe in the presence of eye-movements.**
- ChRmine:** Most sensitive of the three opsins. Attenuates higher TFs at ~2x more than neurotypical vision leading to more suppression of fast moving objects. **Could potentially preserve spike fidelity when used with light-amplifying goggles.**

REFERENCES

- [1] Fine, Boynton 2015. Pulse trains to percepts: The challenge of creating a perceptually intelligible world with sight recovery technologies. Philosophical Transactions of The Royal Society B Biological Sciences. (DOI: 10.1098/rstb.2014.0208)
- [2] 1. Bansal, H., Gupta, N. & Roy, S. Theoretical analysis of optogenetic spiking with ChRmine, bReaChES and CsChrimson-expressing neurons for retinal prostheses. J. Neural Eng. 18, 0460b8 (2021).

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