Color-blindness of direction-selective units in the zebrafish optic tectum

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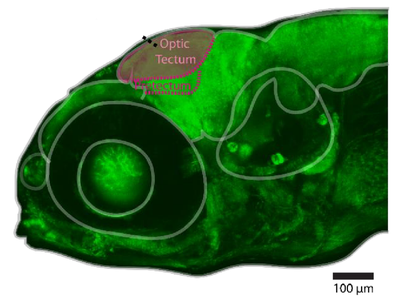
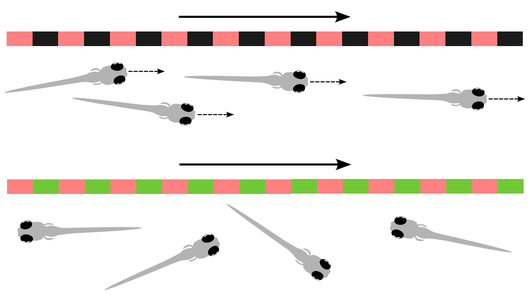


Introduction

Chromaticity has a big influence on motion vision in zebrafish. Orger and Baier (2004) used the opto-motor response to show that combinations of green and red can be used to null the motion perception.

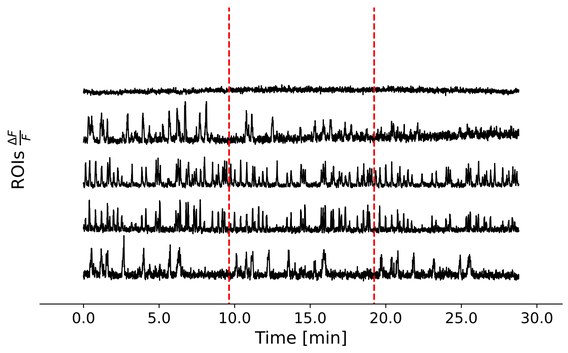


But little is known about the midbrain structures conveing the „color-motion“ perception. We investigated the activity of direction-selective units in the optic tectum of zebrafish in response to gratings of various color contrasts using a combination of two-photon microscopy and calcium imaging.

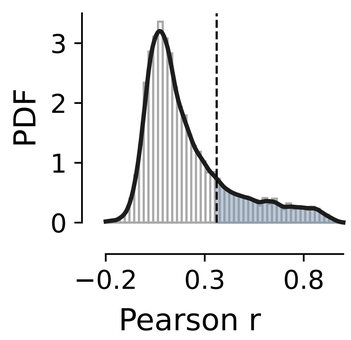
Preprocessing:

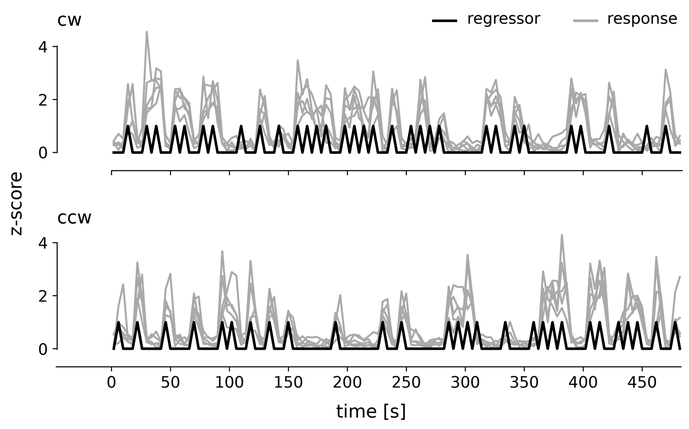
1. Registration and Segmentation

2. Region of Interests (ROI): corresponds to neurons with genetically encoded calcium indicators. The fluorescence F of the calcium imaging is calculated from the change of luminance normalized to the average luminance $F = \frac{\Delta F}{\langle F \rangle}$.

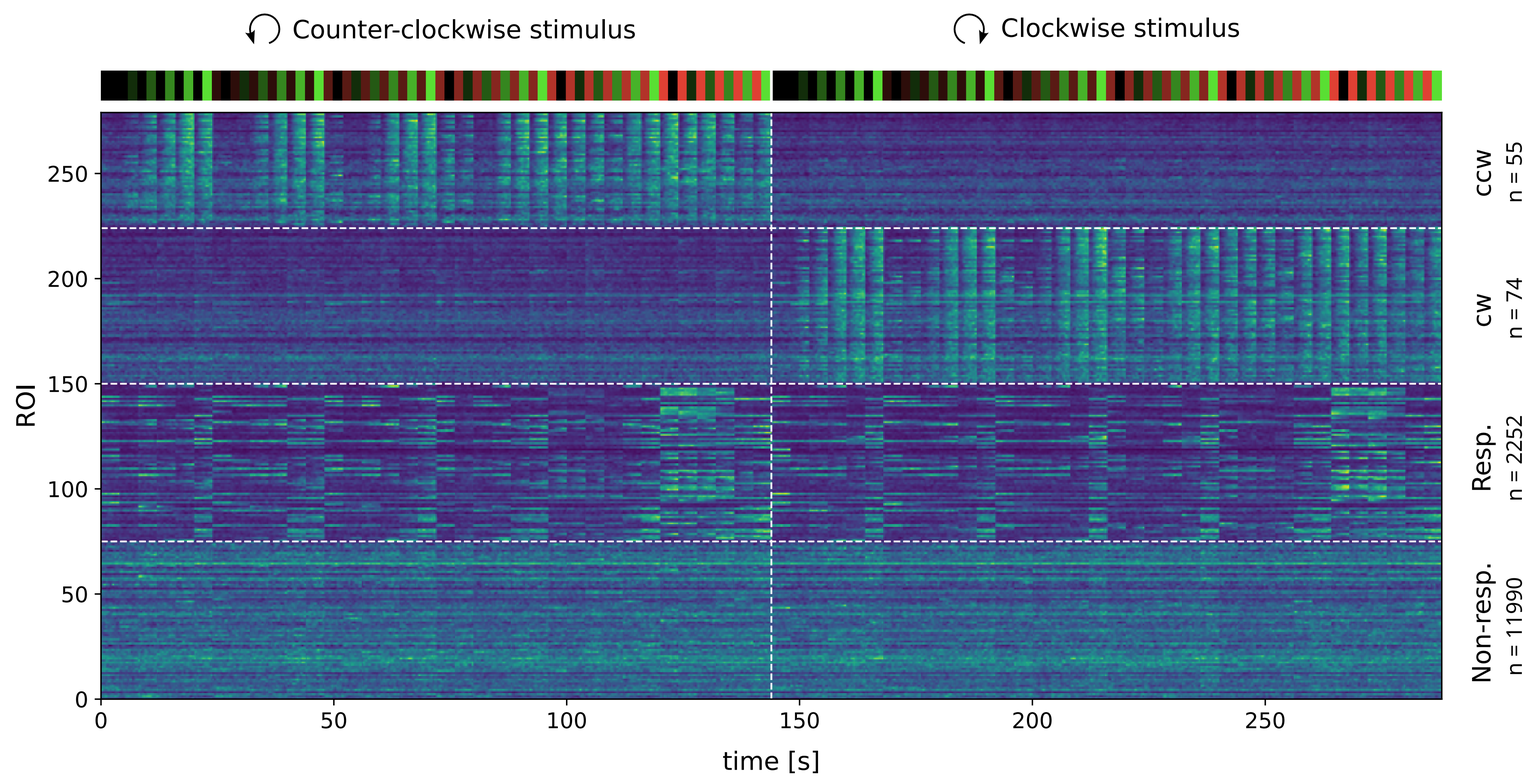


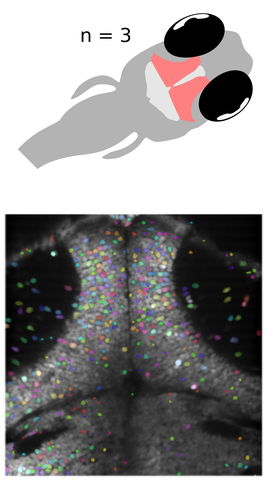
3. Active and direction-selective ROIs: Strongly autocorrelated ROIs across stimulus repeats are „responding“, and ROIs that correlated with a direction regressor (clockwise (CW) or counterclockwise (CCW)) are direction selective.



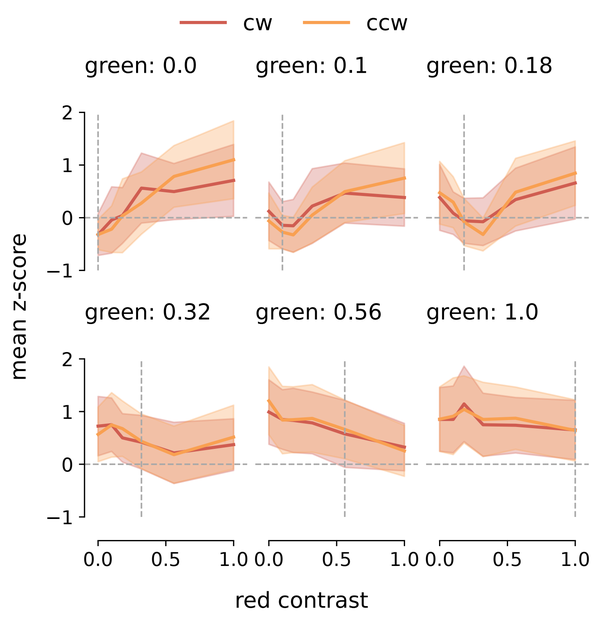


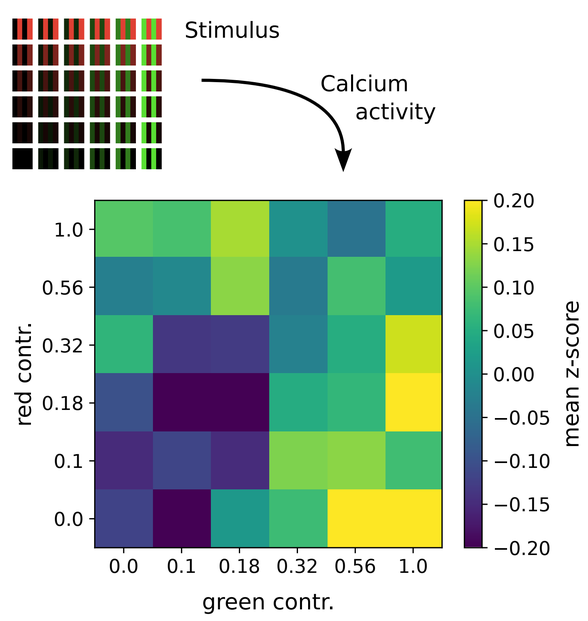
2-photon calcium imaging





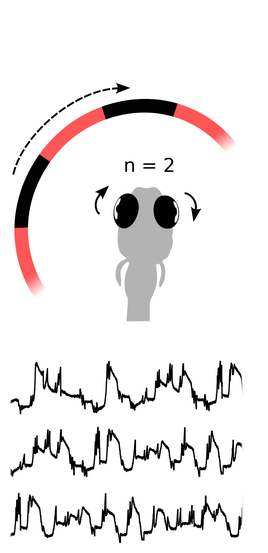
ROIs on optic tectum

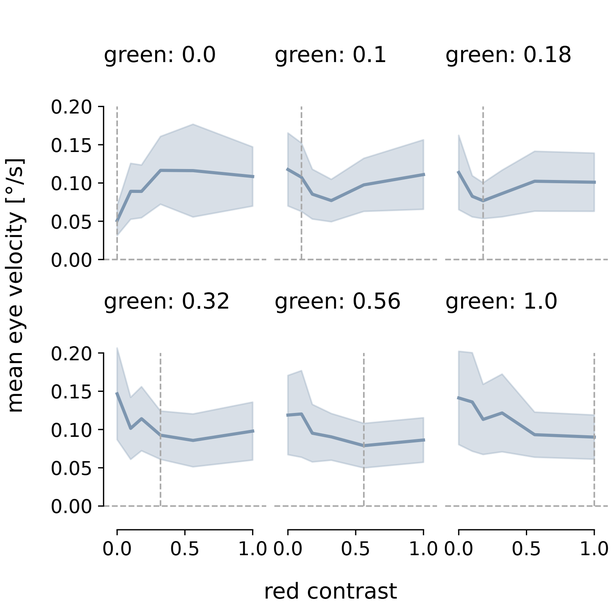


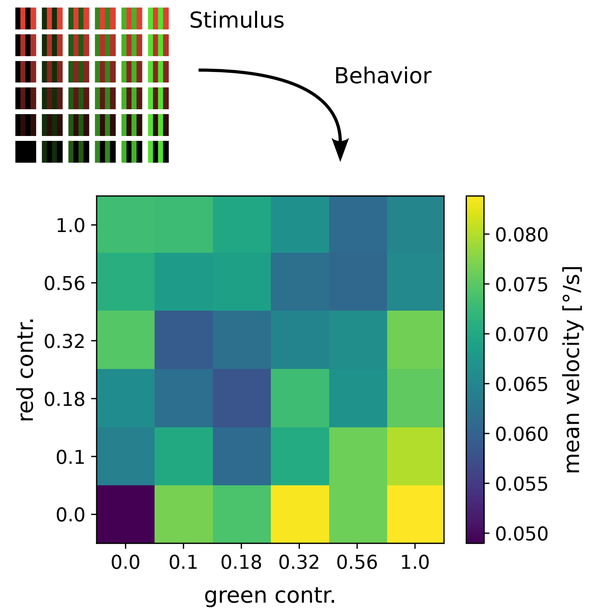


- ROIs responded to moving gratings of red and green
- Both directions CW and CCW responded equally
- If both red and green had the same contrast the response was supressed indicating color blindness
- A slight shift in the troughs of activity could be explained by a higher intensity of green compared to red.

Behavior







- The behavioral response (OKR) reflect the pattern shown in calcium activity.

Conclusion

- We observed that the optic tectum lack the response to red-green merged out-of-phase stimuli and is therefore color-blind