

# State modulation of sensorimotor processing

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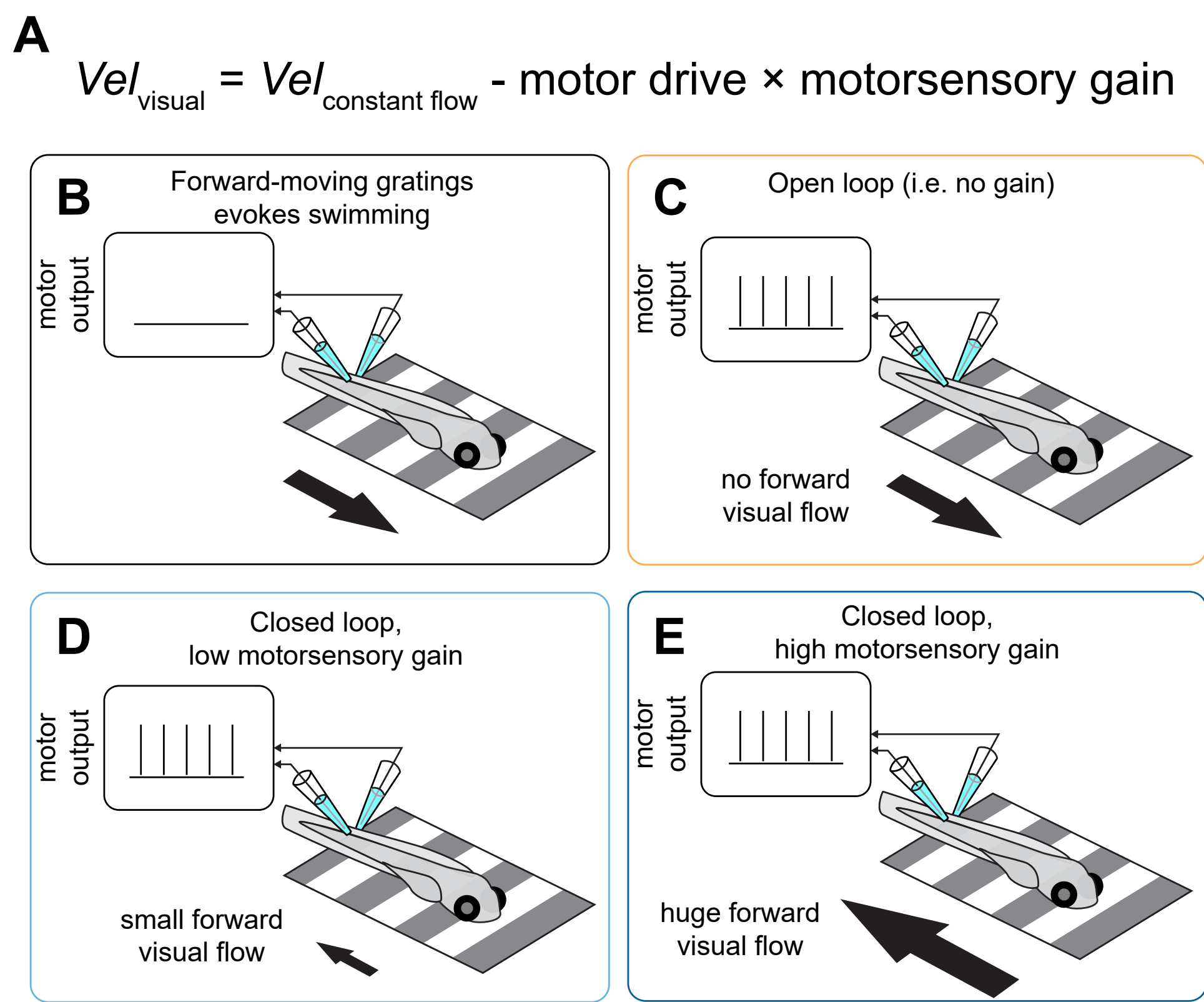
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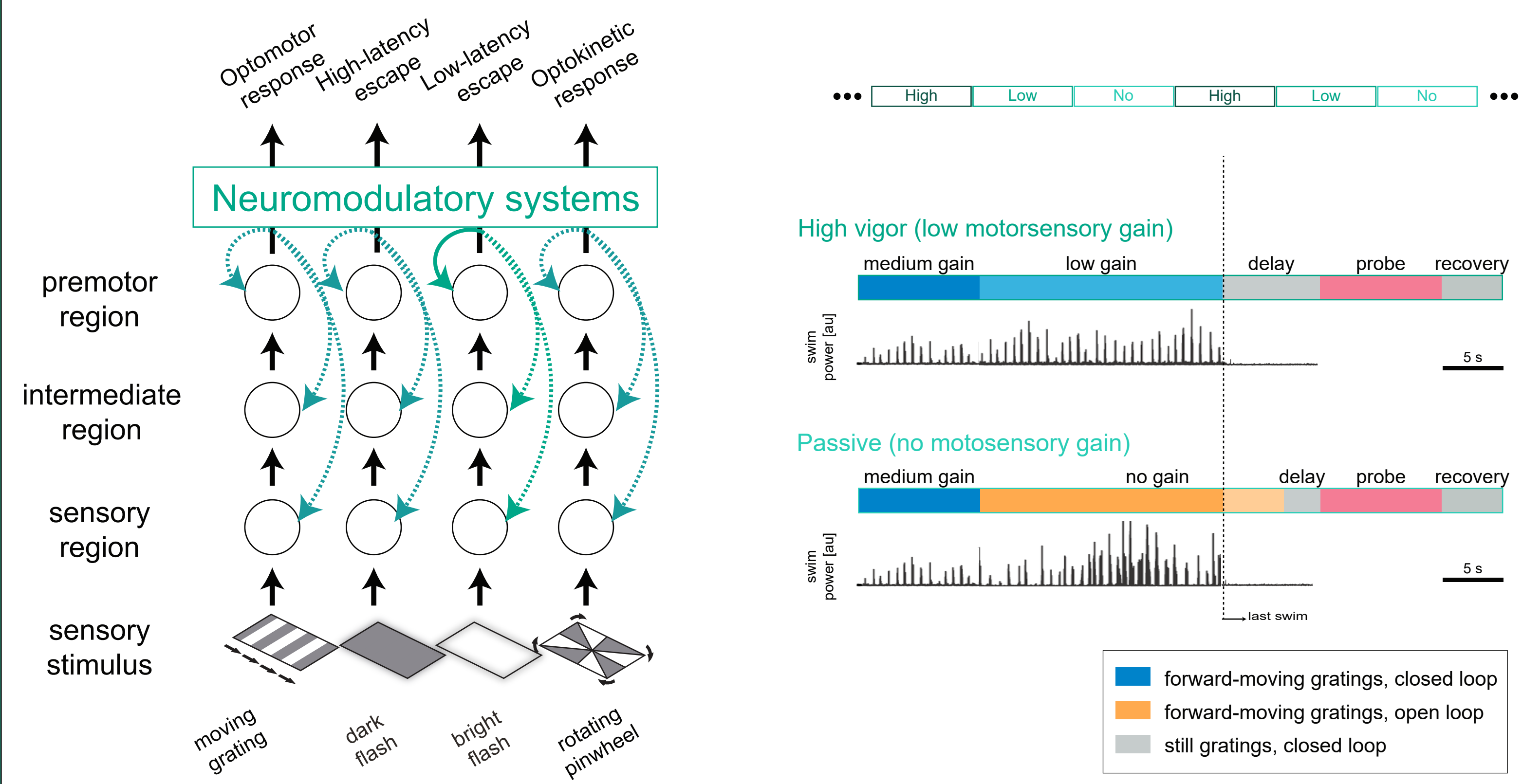
## Introduction

Animals constantly adapt their behavior to changing internal and external conditions. Behavioral adaptations can occur through changes in “brain states”, a functional “re-wiring” of the brain, for example by neuromodulators. Here, we explore how the efficacy of past locomotion changes current behavior by influencing information processing at multiple brain loci.

## Methods



## Experimental Paradigm

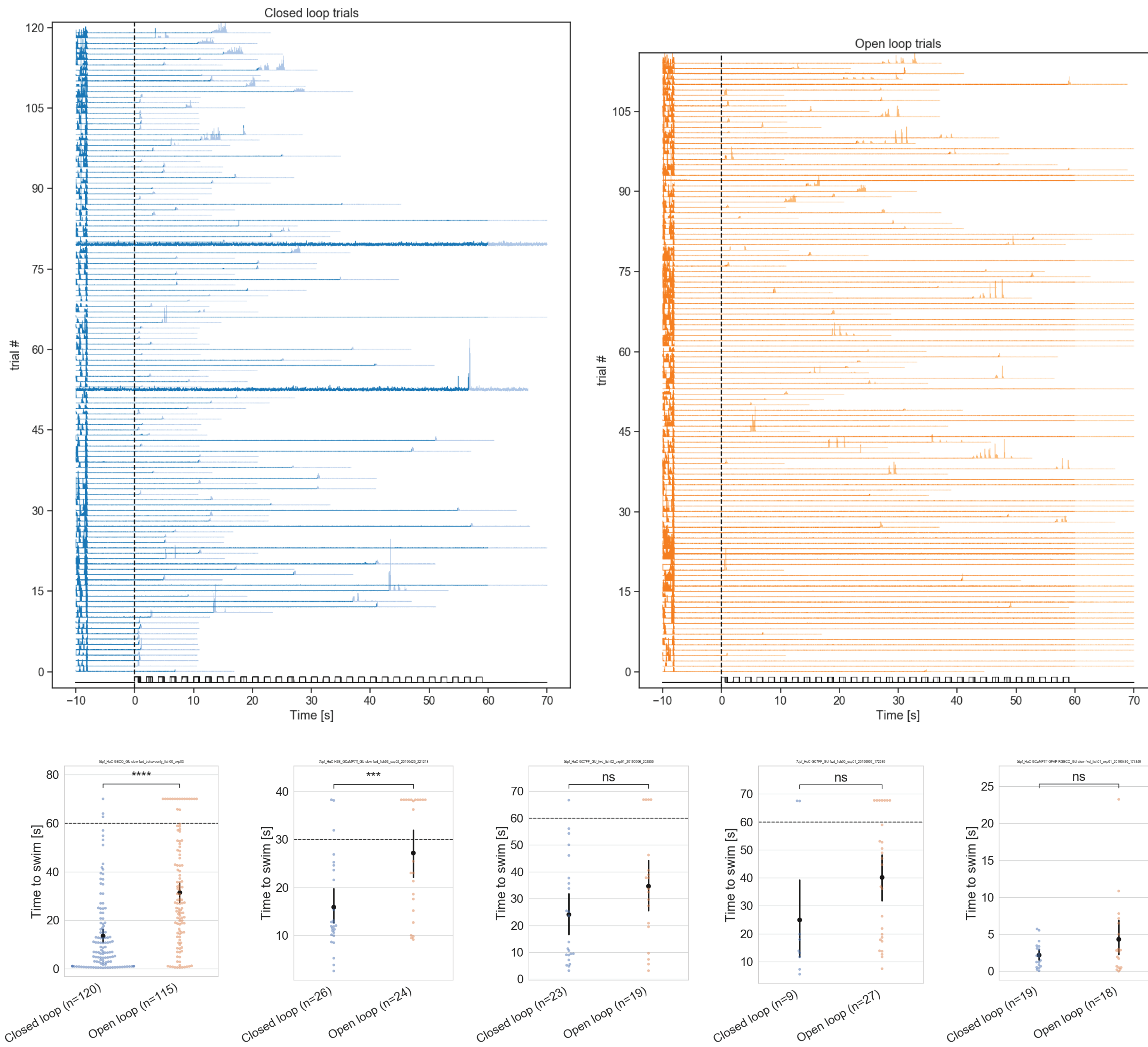


## Summary

- Ineffective swimming evokes a brain state change that results in a reduced responsiveness to pulses of forward-moving grating, a common stimulus used to elicit the optomotor response.
- By probing the animal with different kinds of stimulus, we find that multiple regions of the brain are modulated in this passive state. Both up- and down-regulation are seen.
- Notably, regions associated with visuosensory stimulus and their downstream regions are much less active in the passive state, which suggest a brain-wide modulation of information processing leading to a change in behavior.

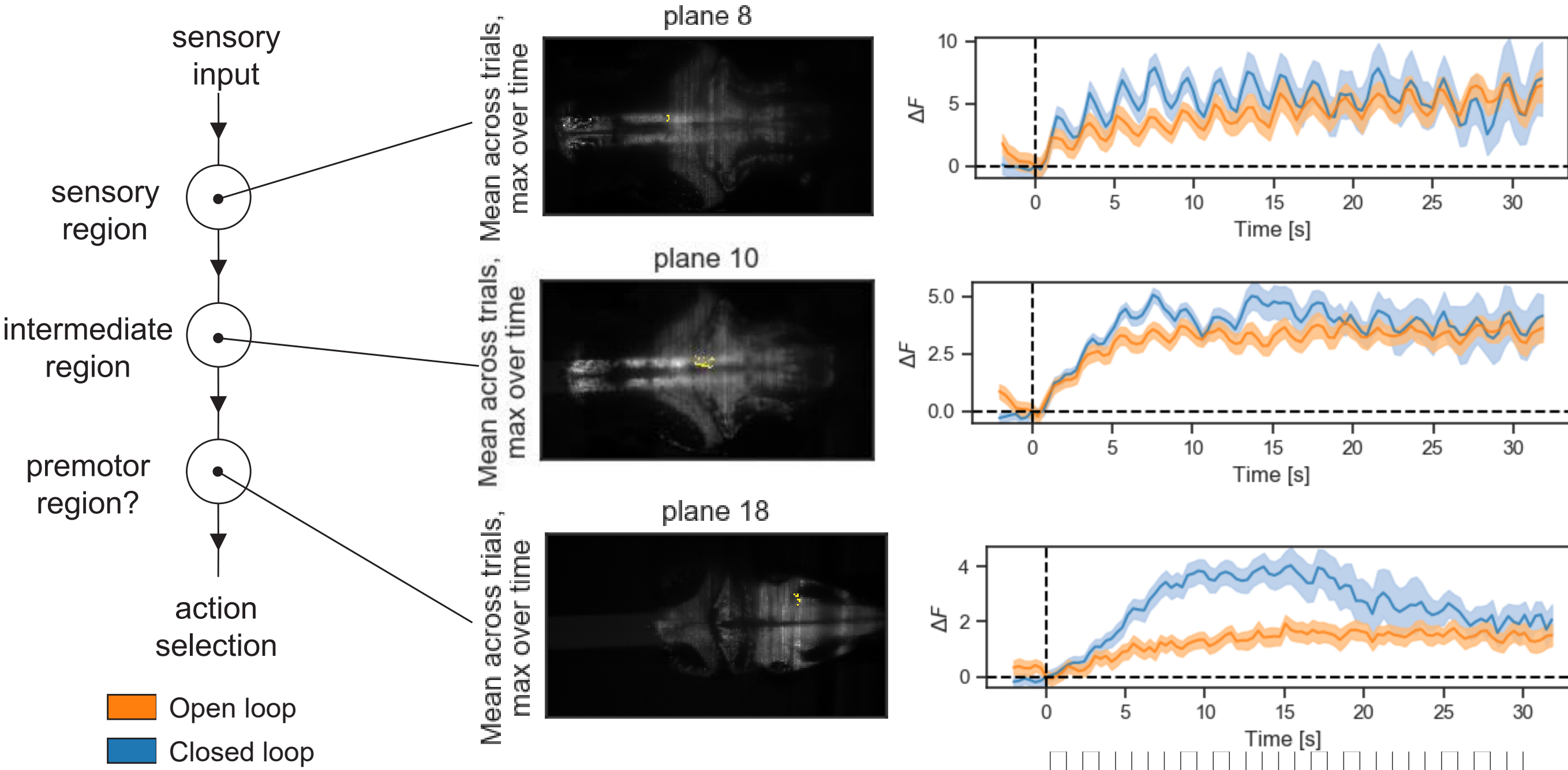
## Ineffective swimming induces futility-induced passivity, causing a weaker optomotor response

Zebrafish need to integration over a larger number of forward-moving grating pulses in the passive state before they start responding.



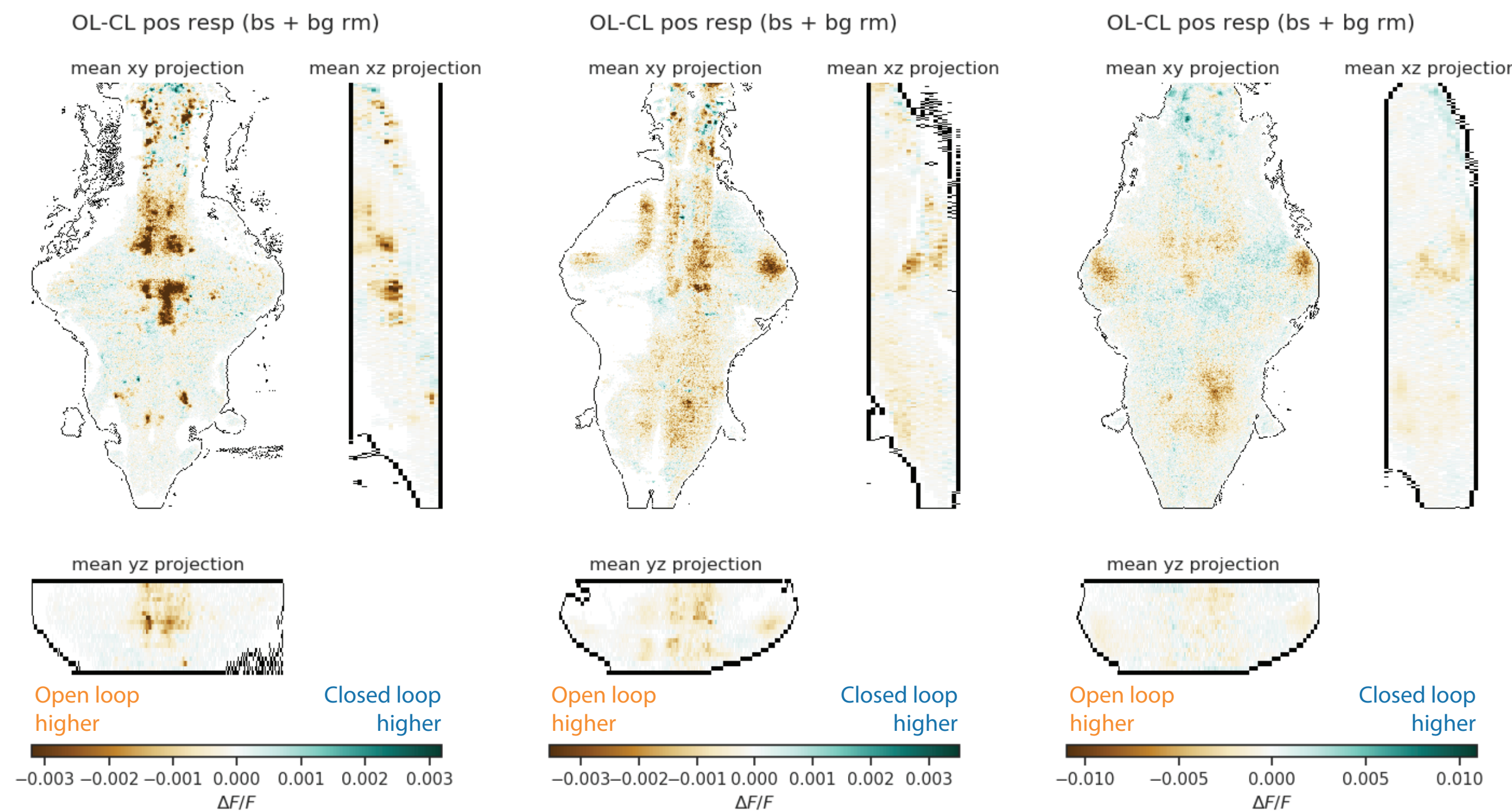
While the effect is common amongst fish, a clear bimodal distribution of time to swim is not seen. This suggests that many factors, in addition to brain states, influence motor responsiveness in fish.

## Multiple brain loci are down-regulated, which could explain the weaker optomotor response

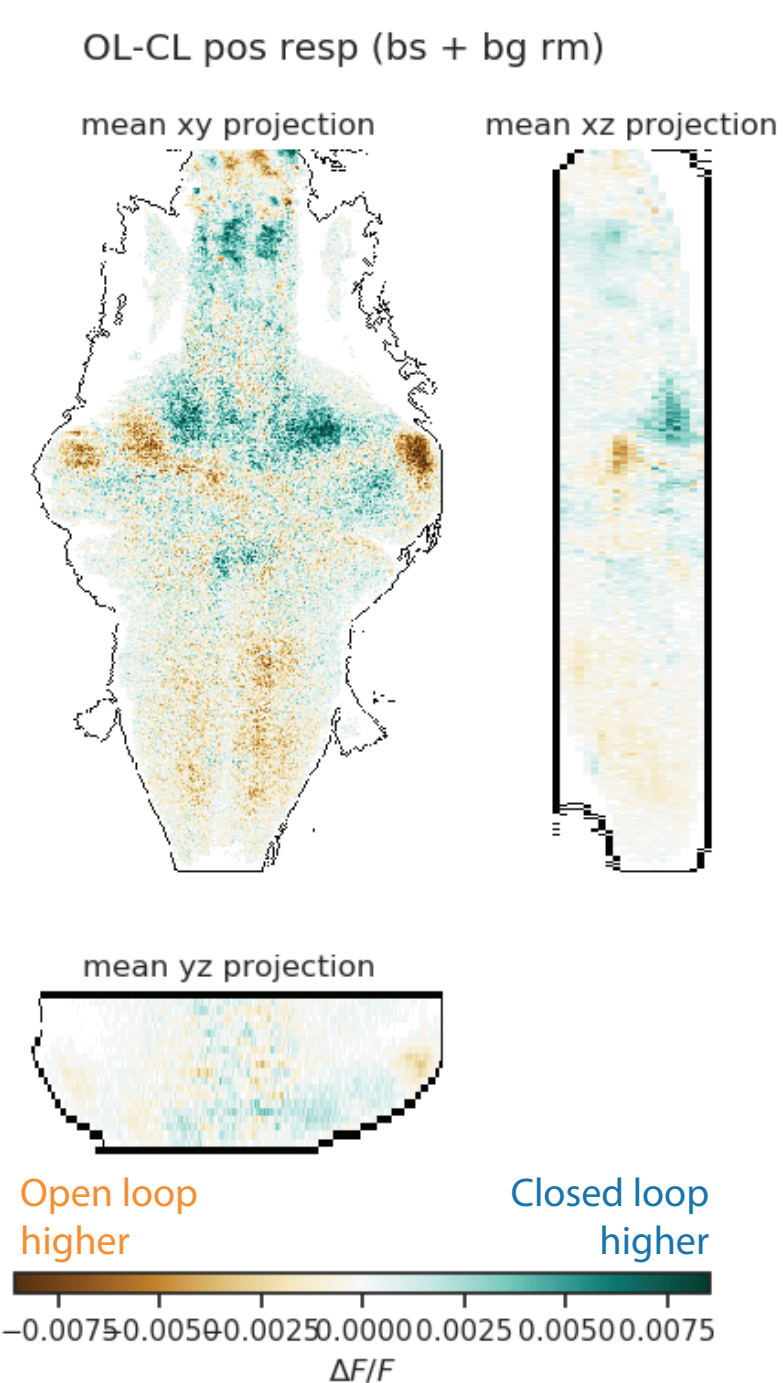


## Sensory and intermediate brain loci are less sensitive to visual stimuli of multiple types

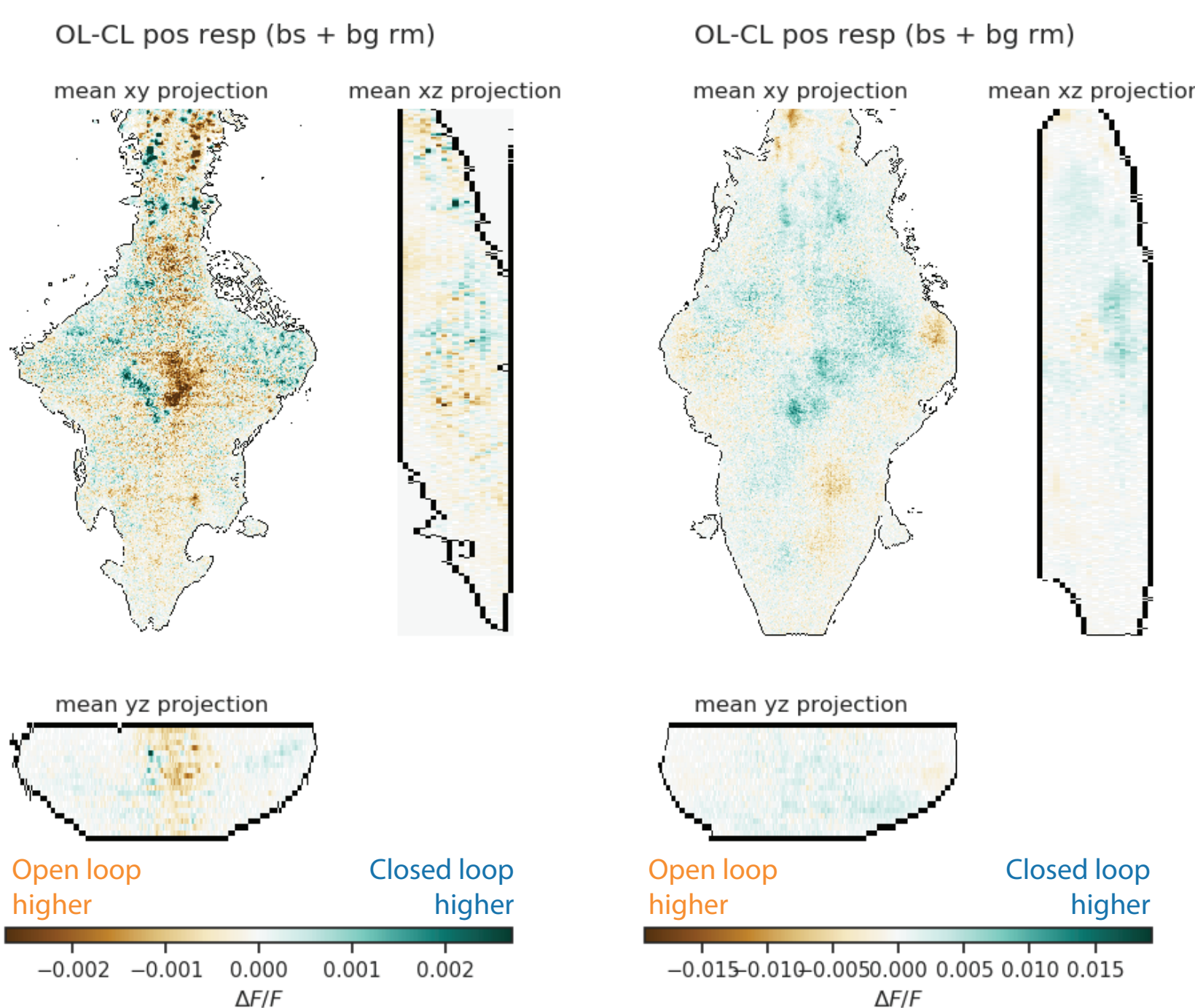
### Forward-moving gratings



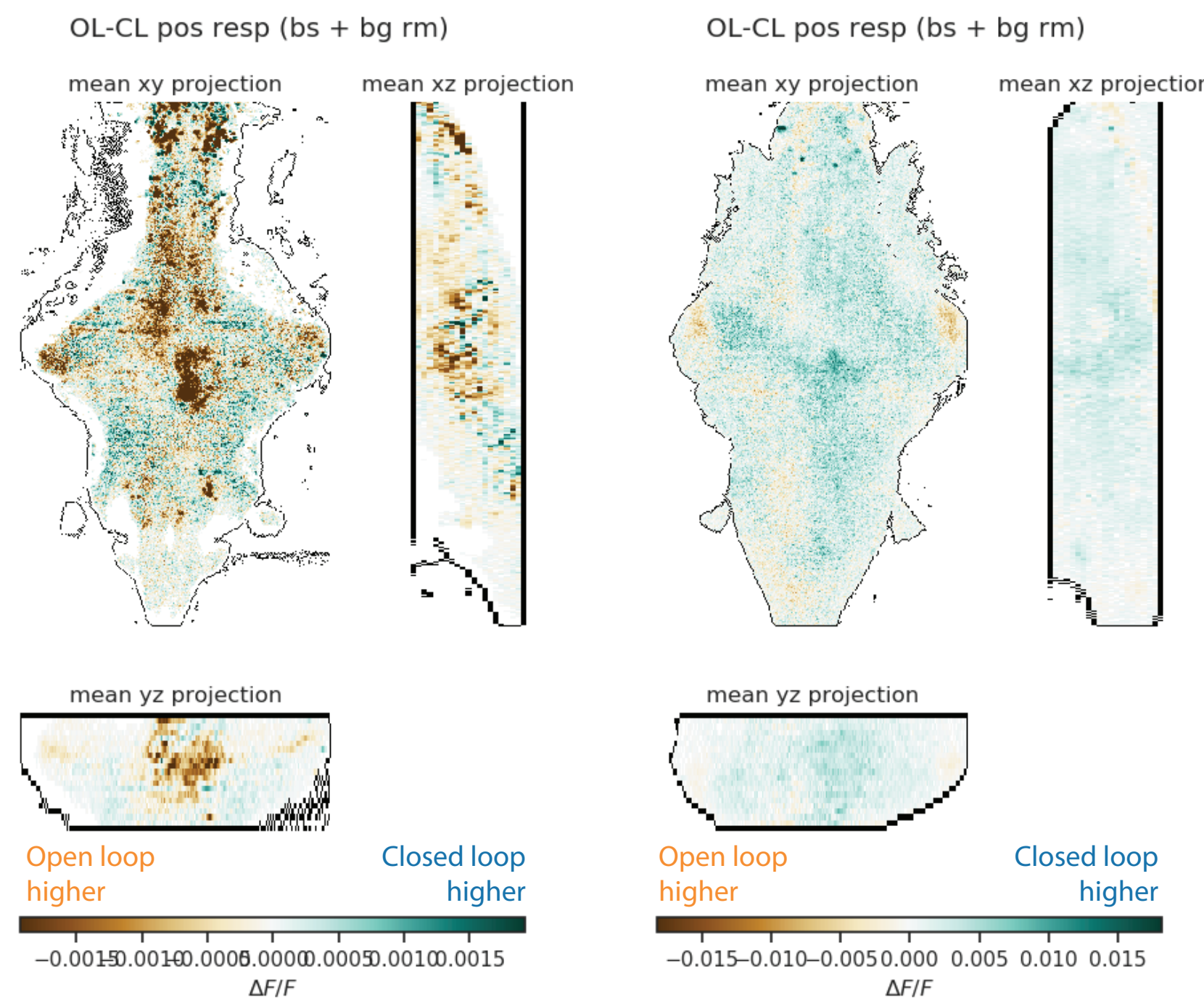
### Dark flash



### Bright flash



### Rotating pinwheel



Kawashima, T., Zwart, M.F., Yang, C.T., Mensh, B.D., and Ahrens, M.B. (2016). The Serotonergic System Tracks the Outcomes of Actions to Mediate Short-Term Motor Learning. *Cell* 167, 933-946.e20.

Mu, Y., Bennett, D. V., Rubinov, M., Narayan, S., Yang, C., Tanimoto, M., Mensh, B.D., Looger, L.L., and Ahrens, M.B. (2019). Glia Accumulate Evidence that Actions Are Futile and Suppress Unsuccessful Behavior. *Cell*.