GLM ΔF/F vs. Events Comparison

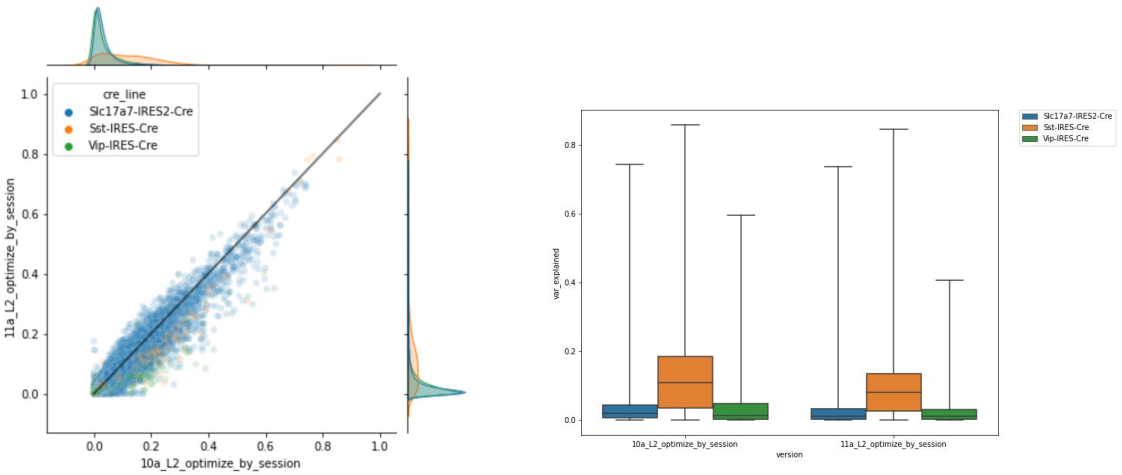
Link to editable version of this document:
https://docs.google.com/document/d/1o91_XCW4-jdazth_YgGCH9D5ECubGXAExC0VnkNB15o/edit?usp=sharing

All versions of the Visual Behavior GLM up to and including version 10 attempted to fit the ΔF/F signal for each neuron, as provided by the AllenSDK. Starting in version 11, we switched to attempting to fit events, after convolving them with a half-gaussian filter.
{DOC DESCRIBING EVENTS AND HALF-GAUSSIAN CONVOLUTION?}

Versions 10a/b/c tested various combinations of image and expectation kernels with ΔF/F. Versions 11a/b/c used the same kernel shapes, but with events substituted for ΔF/F. Comparing these two sets of versions therefore provides a good opportunity to directly measure how events vs. ΔF/F affects model outputs and interpretation.

v10a vs. v11a

Overall variance explained has decreased from v10 to v11:



Left: Scatterplot showing the variance explained for each cell in v10a and v11a. Dots below the diagonal had lower overall variance explained in v11.
Right: Boxplots comparing variance explained for the two models, separated by cre line

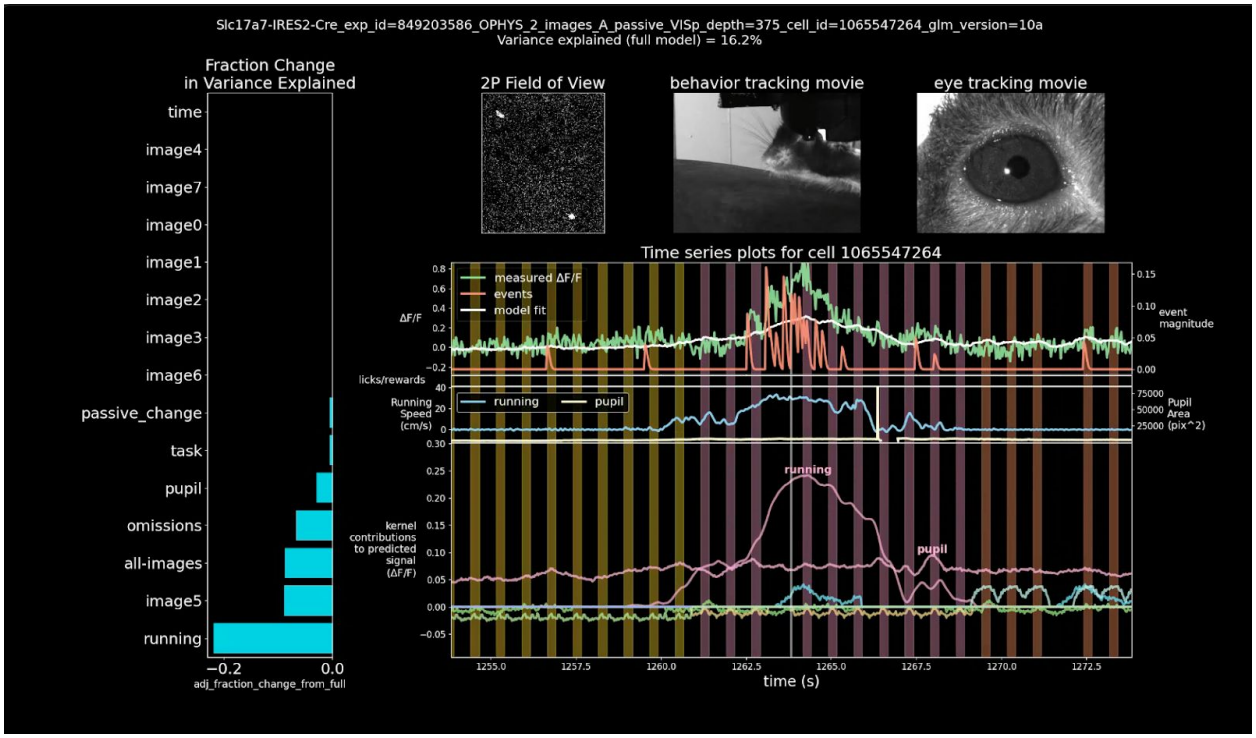
What is driving the decrease in variance explained?

To get a better understanding of what might be driving this decrease in variance explained, we generated GLM movies for both v10a and v11a for a sampling of cells with large variance explained decreases.

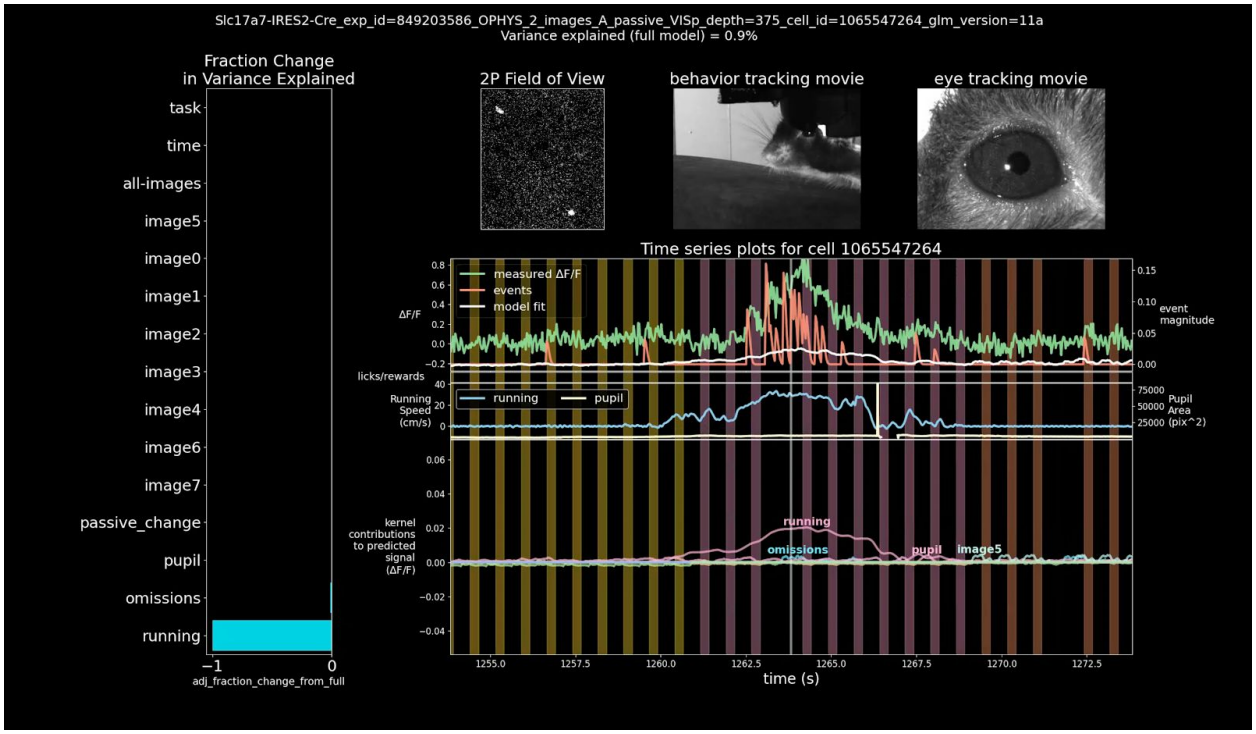
The full movies can be found here:
/allen/programs/braintv/workgroups/nc-ophys/visual_behavior/ophys_glm/events_dff_comparison_videos

What follows are static images from a selection of movies at the above path:

Example 1:
Here's an Slc cell that seems to be active when the animal is running. Maybe running-modulated visual responses? The dff model does a decent job of capturing the relativel slow change in dff that tracks running (16% var explained):

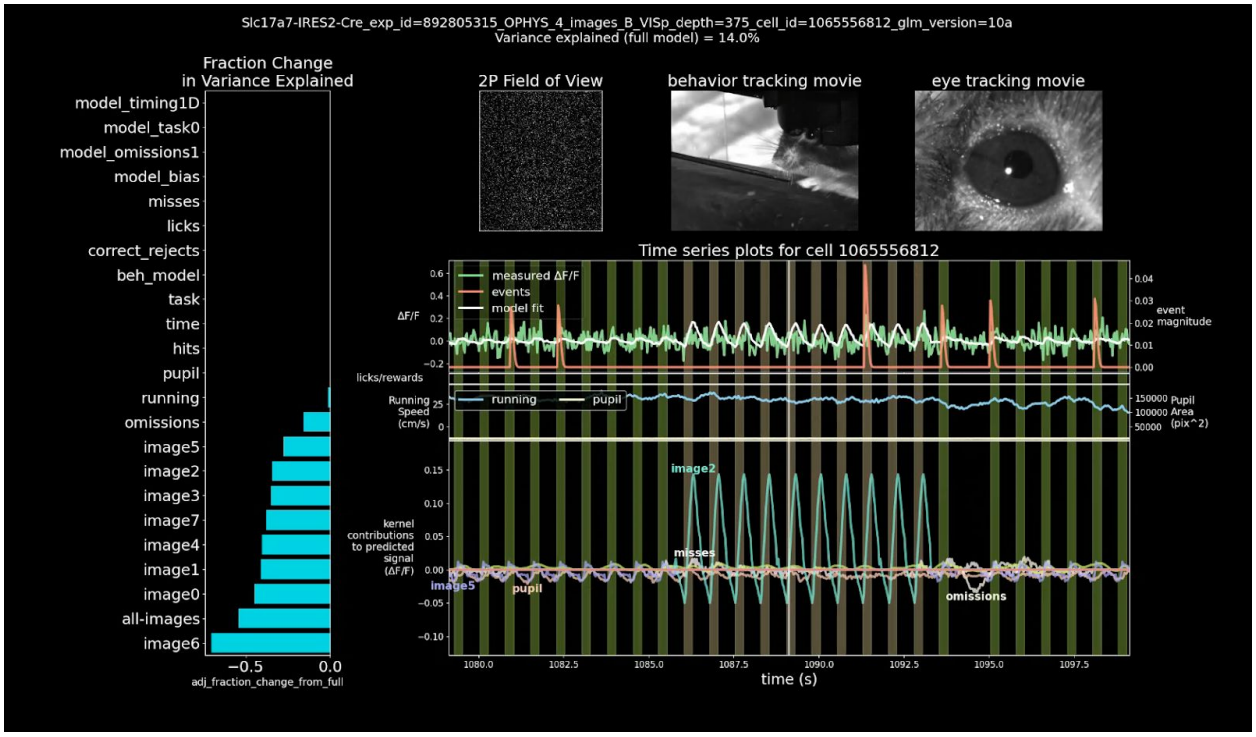


And the same point in time for the events model. Since the events are quick transients, as opposed to a slowly changing signal that mirrors running, the model can't find a linear mapping between running speed and the events. So it misses most of the variance, and overall var explained falls to 0.9%.

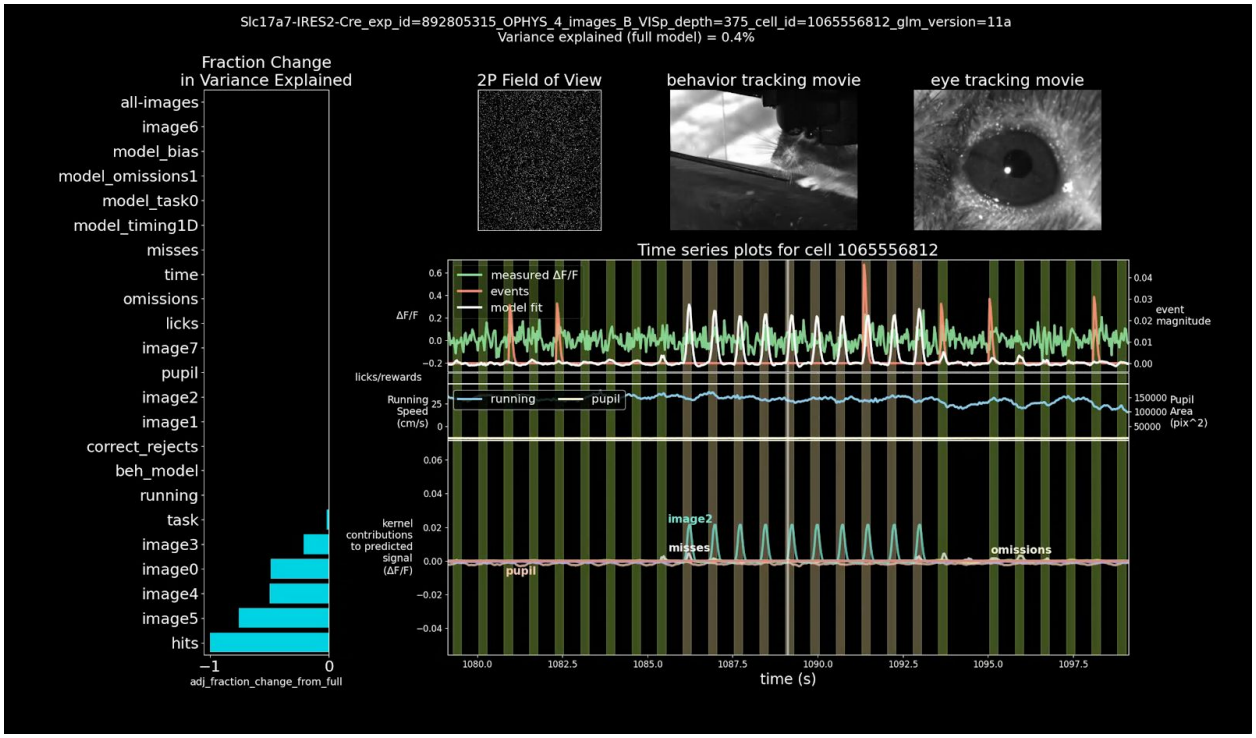


Also of note: the dff model calls this a mixed visual/running cell. The events model calls this a pure running cell.

Example 2:
Here's a more straightforward visually responsive cell. Dff responses definitely aren't very robust/repeatable, but the model is finding an average kernel shape that seems to be doing a decent job. Overall variance explained is 14%.

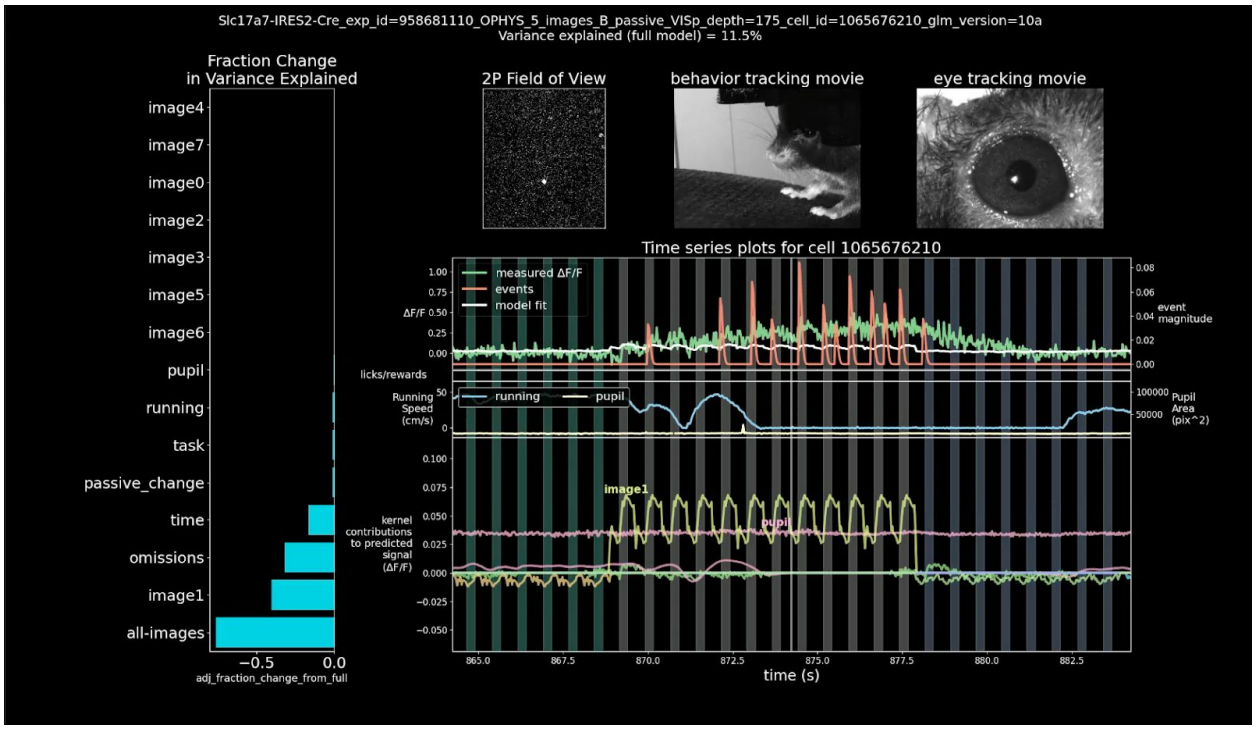


Events are very unreliable/sparse, probably because the dff signal itself is so noisy. But because the model has to learn a general set of weights for each regressor, it ends up predicting a reliable response. Variance explained falls to 0.4%:

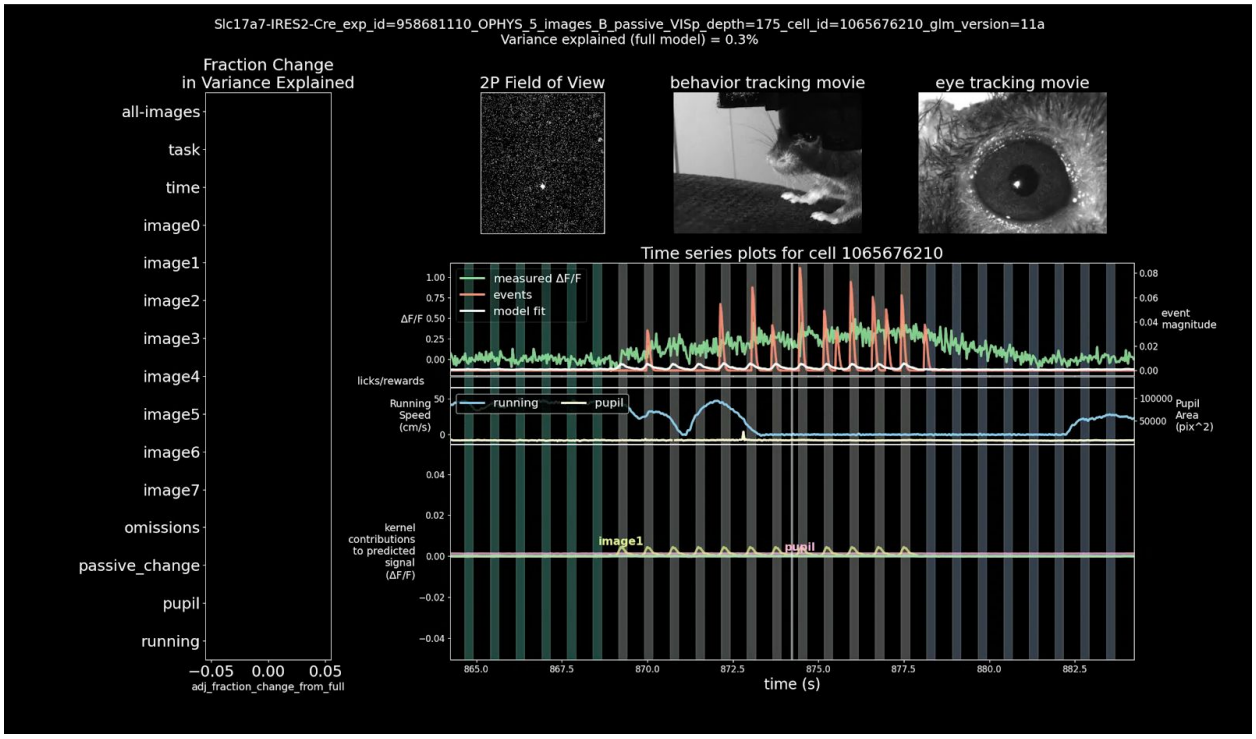


Also, the dff model classifies this as a visually responsive cell (high dropout values for image responses). The events model somewhat inexplicably categorizes this as a ‘hit’ cell, which would put it in the ‘cognitive’ group of cells. Though with such a low overall var-explained, it’d probably get filtered out of any population analysis using the events model.

Example 3:
Here’s another visually responsive cell that the dff model does a decent job on. Again, it’s kind of noisy, but the model seems to find a decent approximation of the average:

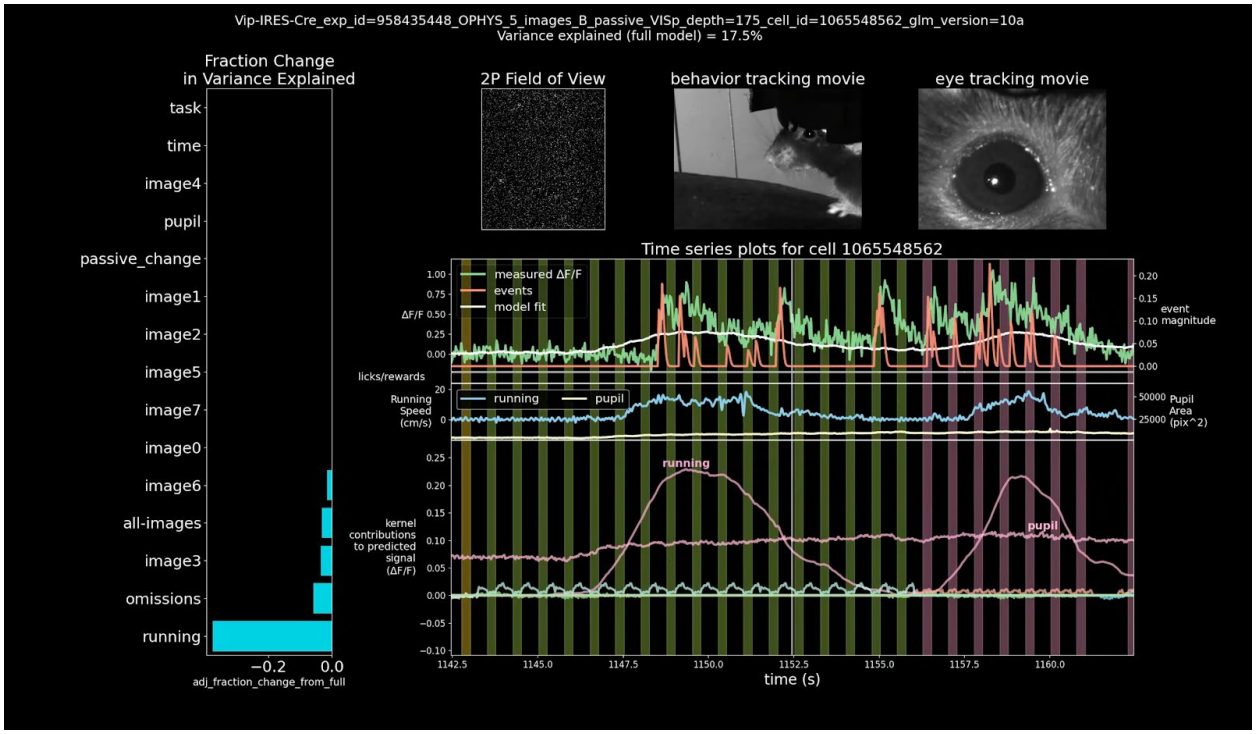


And it almost completely fails to fit the events. I’m assuming because the events aren’t reliable, so it has to find the average between presentations of images that result in big responses and presentations of images that result in no response:

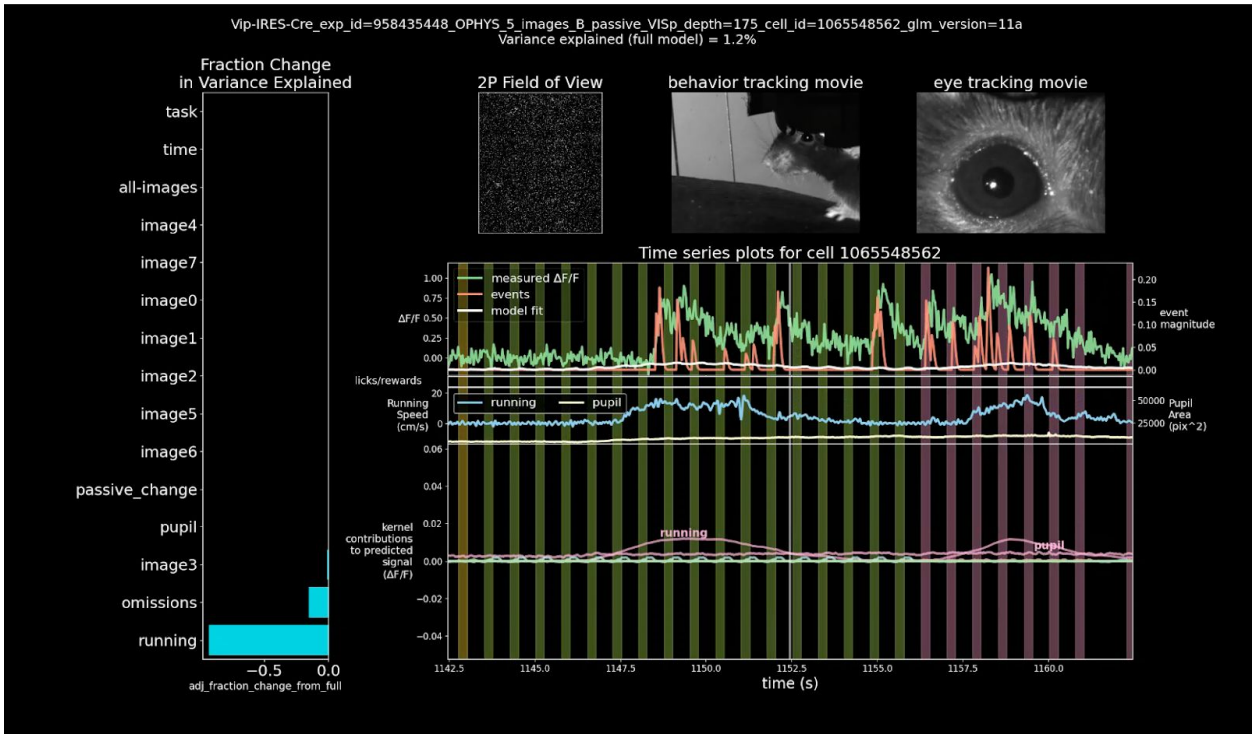


Example 4:

Here's a Vip cell that seems to code for running. The dff model captures some of the slow variation in the dff signal that scales with running speed. Var explained = 17.5%:



But since there's a much less clear linear relationship between running speed and events, the events model can't fit well. Var explained drops to 1.2%:

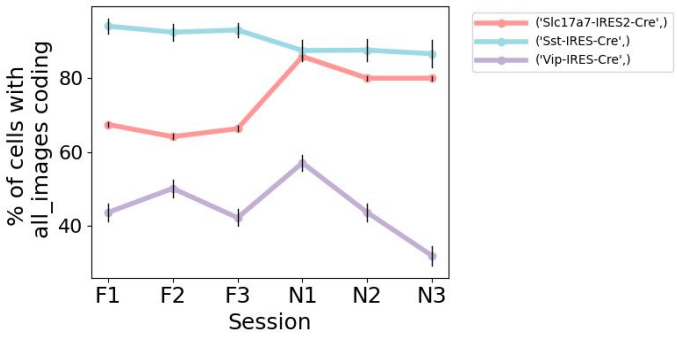


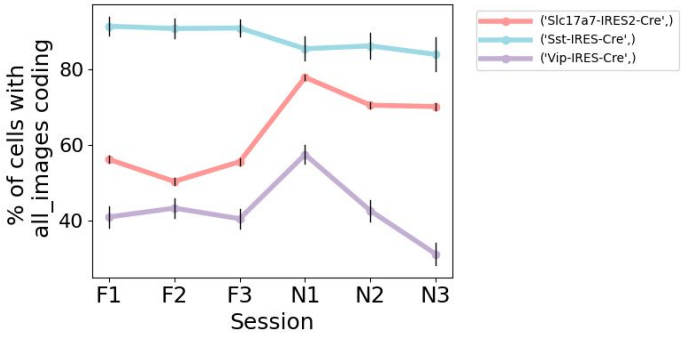
But it does maintain the 'running' label

Summary of examples:
Overall, it seems that the drop in variance explained could be due to the removal of the baseline variation in the events trace vs. the dff trace. The events are shorter transients that are simply harder for the linear model to fit given the more continuous running/pupil inputs.

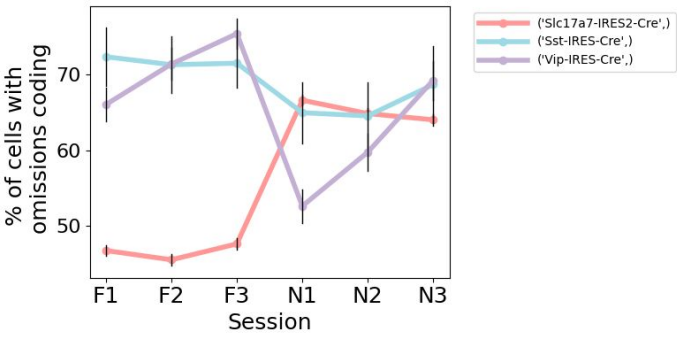
It's also important to note that not all cells show a decrease in variance explained. So it's possible that while the model fails to fit some aspects of the events responses, others (such as reliable image responses) might be easier for the model to fit.

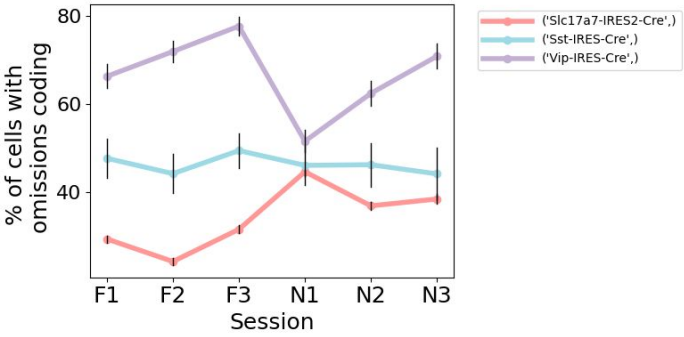
All Images Coding Score 10a LEFT, 11a RIGHT. These scores are very consistent. We see some small shifts, but the qualitative pattern matches.



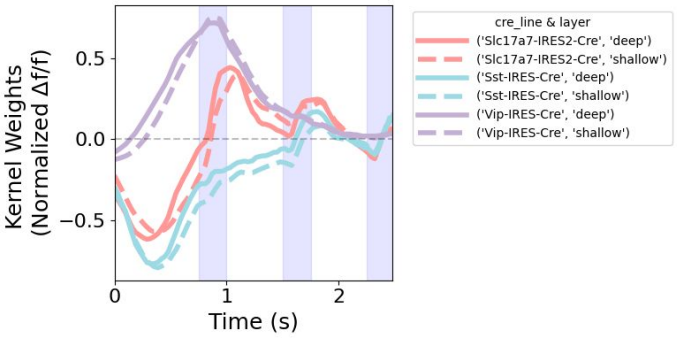


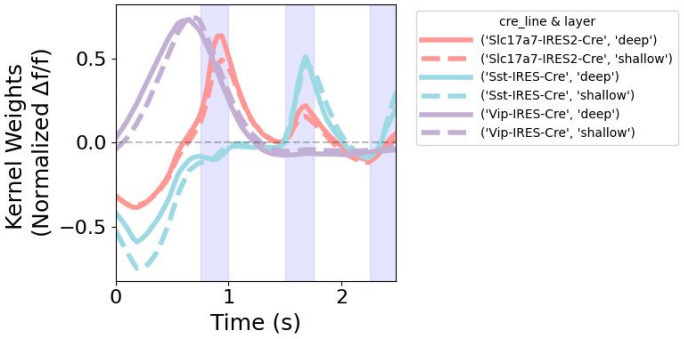
Omissions Coding Score 10a LEFT, 11a RIGHT. We see a large decrease in the SST population using events. This is to be expected given that calcium signals from the previous image could blur into the omission period. Similarly for the Slc cells.



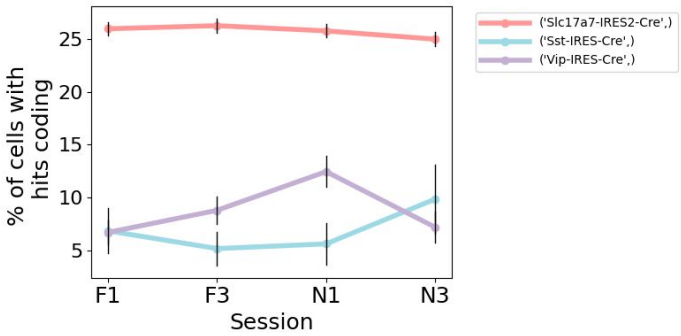


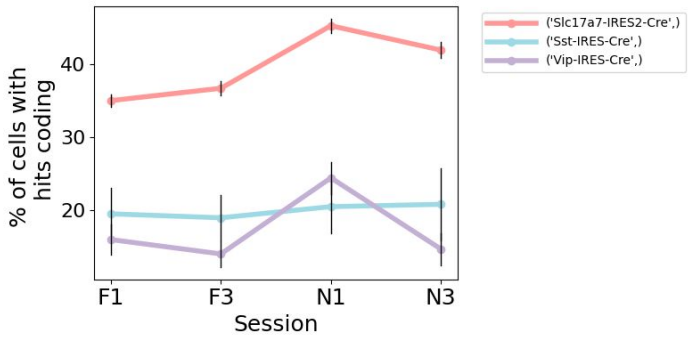
Omissions Kernels 10a LEFT, 11a RIGHT. Note a relative decrease in SST inhibition during the omission, and an increase in the SST activity on the 2nd post-omission image presentation. Note the VIP peak of activity is shifted forward in time before the 1st post-omission image presentation.





Hit Coding 10a LEFT, 11a RIGHT.





Hit Coding 10a LEFT, 11a RIGHT.