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Independent Small Group Discussion Write-up

1. What was the motivation for this study? (e.g. big picture questions motivating experiments, prior work motivating experiments, etc)

The development of retinal pathways is still largely unknown. Although it was though there are certain "critical periods" in development, plasticity can last beyond the restricted time that was first proposed. Directionally selective responses were tested through ferret's development. Ferret are a special case since eye and directional specific layers and patches develop connections with early visual experience. The development of cortical direction columns was tested (on the level of the neuron) to see if stimuli like a movement in gratings is sufficient to produce directional selectivity in the ferrets.

2. List the key methodological details (species, preparation, recording/ anatomical techniques, data analysis methods)

Intrinsic signal imaging techniques were used to track the development of cortical direction columns (later measure signal with DSI, direction selectivity index). The typical sine- or square-wave grating was used to produce responses for movement and directional selectivity. The training stimulus produced a much stronger response (DSI) than those that were "orthogonal" (almost opposite?) of the stimulus that the ferrets had seen before. They also measured the differences between trained and untrained columns as well as comparing DSI to OSI that the ferret developed. Two-photon calcium imaging was also used to contrast the DSI of individual layer-2/3 neurons.

3. For each figure, describe the important points including how the authors interpret the findings and what the findings may actually show.

Figure 1)

This shows the effects of the training on the directional column early in the experiment

a & b) Orientation columns were trained on horizontal gratings they show rapid development in response to the stimuli

c &d) Orientation columns were trained on vertical gratings, more blackening of image.

e) Direction domains develop after 8 hours, direct effect for DSI to the training stimulus.

f) Trained directions of motion for stimuli seen during early development were prominently marked with DSI in those columns.

g) Again the ferrets responded better to motions they were trained for and performed at baseline for new motions.

Figure 2)

They used individual two photon imaging to test the development of layer-2/3 neurons in visually experienced vs inexperienced ferrets.

a) Individual layer-2/3 neuron tuning for visual experience in ferrets. The bottom figure shows the direction indices (DI) and orientation indices (OI) for ferrets with 3 weeks of stimulus experience (probably to vertical stimuli).

b) The green bars indicate the preferred orientation, and red is for direction. This clearly shows a sparsity for the naive animals OSI and DSI, given a single directional stimuli the cells are almost entirely tuned to that particular direction.

c) This shows b more clearly, the preferred/opposite response ratio was significantly altered for the naive ferrets. However they show a strong response to trained stimuli.

Figure 3)

This shows directional selectivity for individual cells

a) Two-photon imaging for direction selectivity of individual cortical neurons, this showed significant difference after the motion training. DI observed in individual cells.

b) This also shows the differences at the neuron level for the flash and motion training.

c)Direction index increased significantly following motion training, there is a clear difference between the before and after training.

Figure 4)

a)Visual experience has a role at the level of the individual cortical neuron. Visually experienced ferrets have groups of similarly tuned direction preference neuron whereas for the naive ones its almost random.

b & c)Spatial coherence of direction preference was best for average local coherence values in experienced groups and motion training. Flash training surprisingly showed the least clustering.

d) The direction of motion preferred by individual cortical neurons is influenced by their neighbors as shown before and after training

e) Some cells seemed to be uncertain (or moderately uncertain) for what direction they preferred before training but it was more certain after training.

f & g) Direction preference reversal and clustering were related in all group besides in figure g with the flash training

4. What is your assessment of the overall findings? Did the experimental data support the authors' interpretation? Why or why not?

It seems that directional selectivity was significantly altered by the directional stimuli in early development for ferrets. It seems that with just orientation flash training, it will not allow the same effects for directional selectivity, this is very related to the changes in directional selectivity that we see early in development. I'd be curious to find out if this plasticity period is more "plastic" and what the deadline on the critical period might be.

5. Describe new insights that you gained from the small group discussion of this paper.

I learned about why the difference in imaging indicates the difference in fluorescence in V1 cells when presented with different directions. And we also discussed the mechanisms possibly underlying the changes in pattern long term potentiation. It seemed weird there was an effect so soon after.

6. List all of your questions and/or points in the paper that you did not understand.

I don’t understand why the flash condition showed less of change in figure 3c.