**The Orientation Map In V1**

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**Cells in V1 Detect Edges**

There are these cells in your brain known as "edge" detectors. As their name implies, they increase their activity when you look at the edge of an object. Now these cells don't just respond to any edge - the edge has to be at a certain angle. Some cells are activated when the edges are vertical, others like 45-degree edges, others horizontal. Such cells are said to "prefer" and orientation.

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**Cells with Similar Orientation Preferences Are Clustered**

These edge detecting cells are located in region of the brain known as VI, which sits in the back of your head. Here is a picture of the surface of VI. Every pixel here is a cell and its color corresponds to the orientation of the edge that the cell prefers. Notice how cells with similar orientation preferences cluster to together, for example, cells that prefer vertical edges huddle around similar cells.

**The Model**

This authors of the article attempted to provide a detailed and parsimonious explanation regarding the formation of orientation selective cells and the periodically structured maps these cells create. In summary the model proposes the following explanation: by virtue of listening to the local activity of highly structured group of cells in your eye, the cells in V1 come to prefer oriented edges and form periodic maps.

**Cells in the Eye Are Highly Organized**

To introduce the model, I'll begin by explaining the highly structured patterns of cells in the eye.

There are two types of cells in the eye: On-cells and off-cells. I'll first describe how they are physically organzied across the layer of the eye.

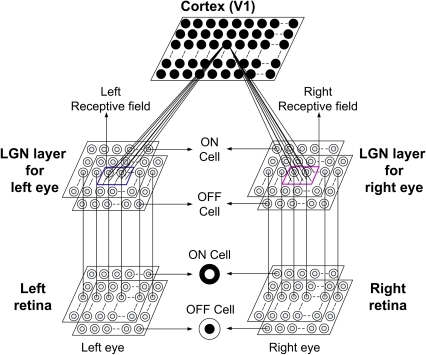
These 2 types of cells are so well organized in your eye that they always come in pairs, seemingly forming a group romantic couples evenly distributed across a dance floor. These pairs are known as dipoeles.

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Notice how the cells are always of opposite signs; essentially the couples are heterosexual, are rarely do we find an queer couples.

Notice also how the couples face each other at a certain angle.

And finally notice how the this angle changes gradually from one couple to the next (This is biological organization at its finest!)

**Dipoles Send Output to V1 Cells**

In short, each dipole is connected to a cell in VI. The 2D position of the cell in V1 is simlar to the 2D position of the dipole. This is a crude way of putting things, but for the sake of this presentation assume the following: A dipole on the upper left half of the eye will connect to a V1 cell on the upper left half of V1. Notice what this implies. The dipole and the V1 cells share the same 2D positions.

To summarize, we have a highly structured array of cells in the eye that come in pairs and whose angle varies smoothly across the retina. When light reaches one of these couples, they combine their activity, then send it down to a single cell in V1.

**Model’s Results:**

**Edge Detection in V1 Depends on Angle of Cell Couple in the Eye**

When the light from an object reaches an On-Cell in your eye, it increases its activity, as its name implies. When the light from an object reaches an off-cell, the opposite happens: the cell's activity is suppressed or decresed. The activity from both cells is then averaged , and sent up to a neuron in V1, which then becomes activated.

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With this in mind, let's talk about what would happen if light from a horizontal edge reaches a horizontal dipole - what happens to the V1 neuron that connect to this dipole. If the angle of the edge is the same as the angle formed by dipole, then the cells will cancel out each other's activity: the off cell will decrease its activity, the on cell will increase its activity, leading to an aggregate activity of zero. Hence there is no activity that will be sent to the VI neuron, and we will conclude that the cell is not responsive to that oriented edge.

On the other hand, if the angle of the edge is orthogonal to the angle formed by the dipole, then the combined output is positive: nothing happens to the Off-Cell, but the On-Cell will become activated. This activity is combined, sent up to a VI neuron, and we will conclude that this cell is responding to the oriented edge.

Machine generated alternative text:
preferred orientation **Orientation Maps with Iso-Orienation Domains**

The authors ran a computer simulation to see what happens when the eye is presented with a many different edges at different orientations. They looked at how these responded to these edges, how they combined their activity and sent it to vI cells . The result was an orientation map, similarly organized like the orientation maps in real brains.

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preferred orientation 

But the computer simulation generated orientation maps with a striking feature. Namely, the simulated maps contained areas of where an orientation was over-represented, and these areas were distrubuted along the cortical surface in a hexagonal manner. This is a precise prediction of the model, and very testable as well. If this model is true how orientation maps are formed, then we should see similar patterns in real brains…

**Iso-Orientation Domains Found in Real Brains**

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Monkey 
Cat 
Ferret 
Tree shrew The authors then looked at the brains of different mammalian species, and they found that these iso-orientation domains were indeed distributed in a hexongal manner in these species. This figure shows the presence of iso-orientation domains in the orientation maps of 4 difference species: 2 monkeys, 2 cats, 2 ferrets, and 2 tree shrews. Without getting into the details of what this figure actually is, ill just say that these yellow areas are regions where orientations share a high degree of similarity, excatly like the model predicted.

**Discussion**

This model provides a remarkably simple explanation of how orientation maps are formed. It does not invoke any kind of experience dependent plasticity, or a complicated set genetic rules.