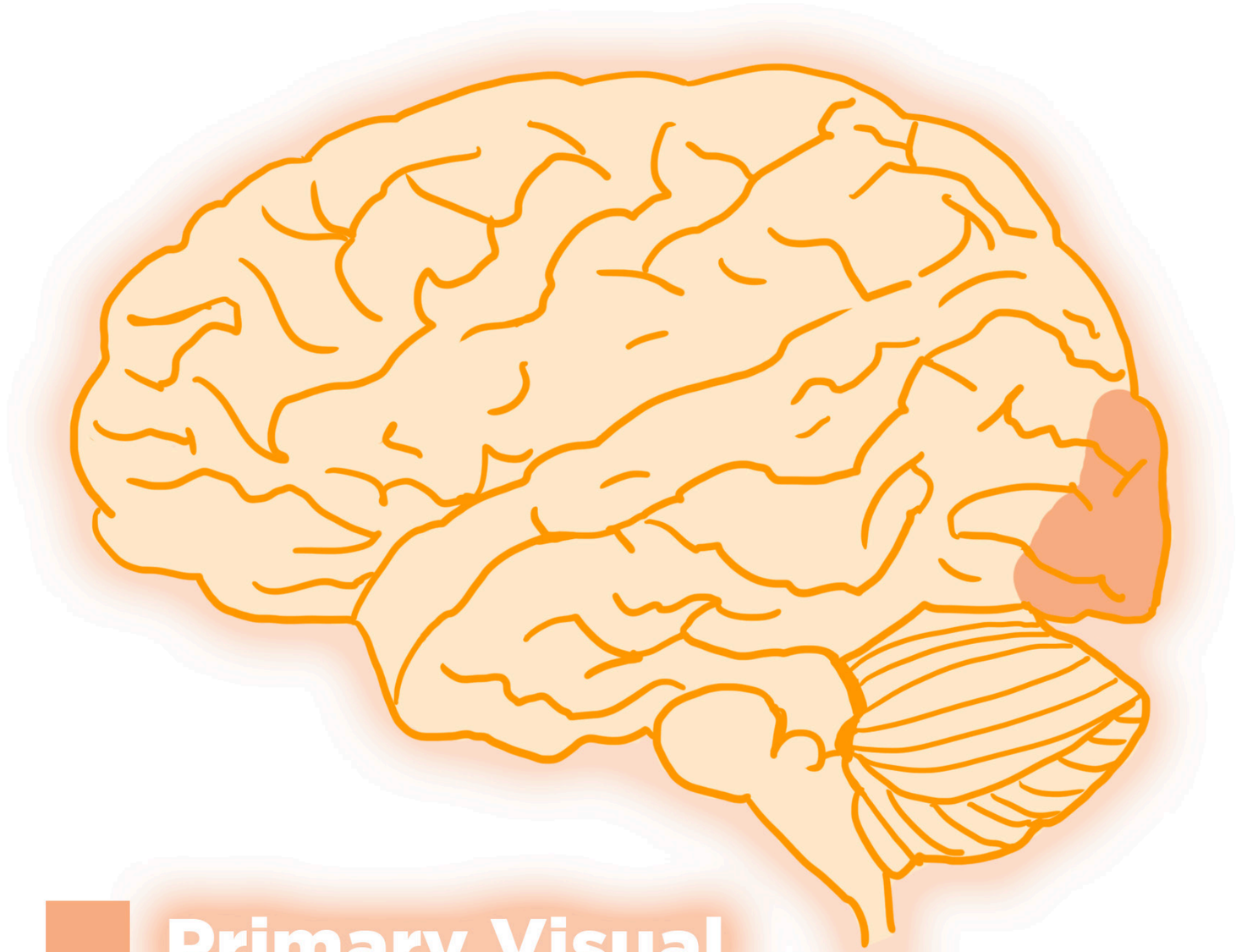
# Primary Visual Cortex (V1)




steven j. barnes

# Learning Goals

- Describe the properties of receptive fields of simple and complex primary visual cortex (V1) neurons.
- Explain what an ‘orientation column’ is in V1.
- Explain what an ‘ocular dominance column’ is in V1.
- Describe the effects of V1 damage.
- The retina-geniculate-striate system is retinotopic. Explain.
- Describe a neuroprosthetic device for the blind and explain how it works.

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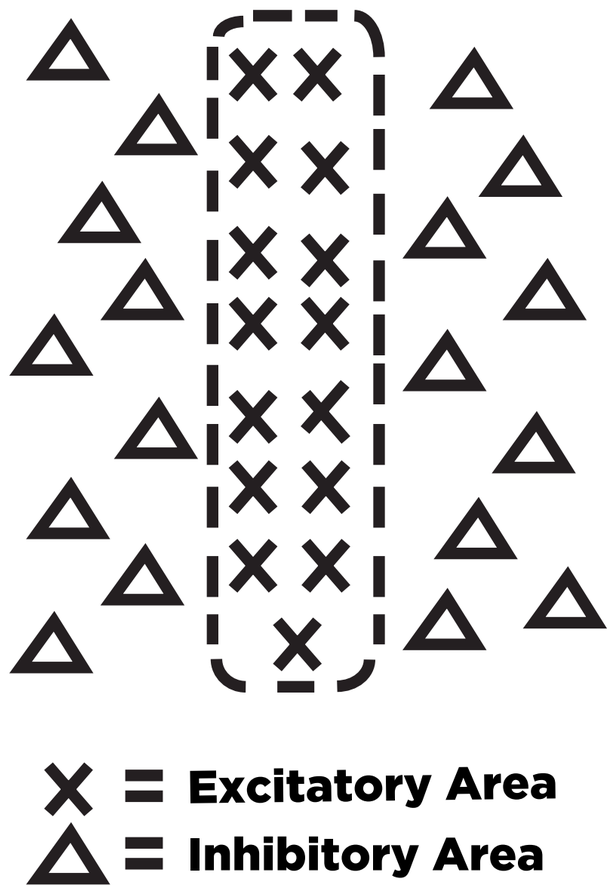
Usually classified into one of two general types: simple, and complex.

# Receptive Fields in V1

# Hubel & Wiesel

simple cells - respond to "bars" of light of a particular width (spatial frequency selective) and of a particular orientation (orientation selective)




# Receptive Fields in V1

# Hubel & Wiesel

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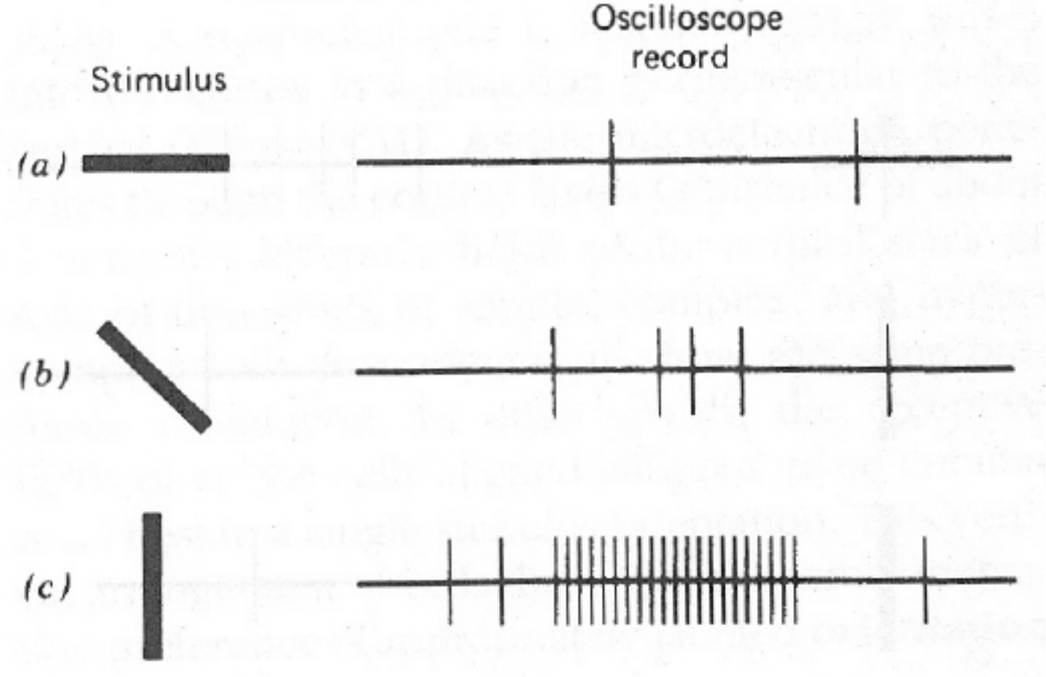
Orientation tuning: Cell is tuned to detect lines of a specific orientation.




# Receptive Fields in V1

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complex cells - respond to "bars" of light of a particular width (spatial frequency), a particular orientation (orientation selective), and moving in a particular direction (direction selective).

# Receptive Fields in V1

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- Optimal stimulus: oriented bar or edge moving in a particular direction.
- Larger receptive fields than simple cells.
- The location of the stimulus within the receptive field is not so important.

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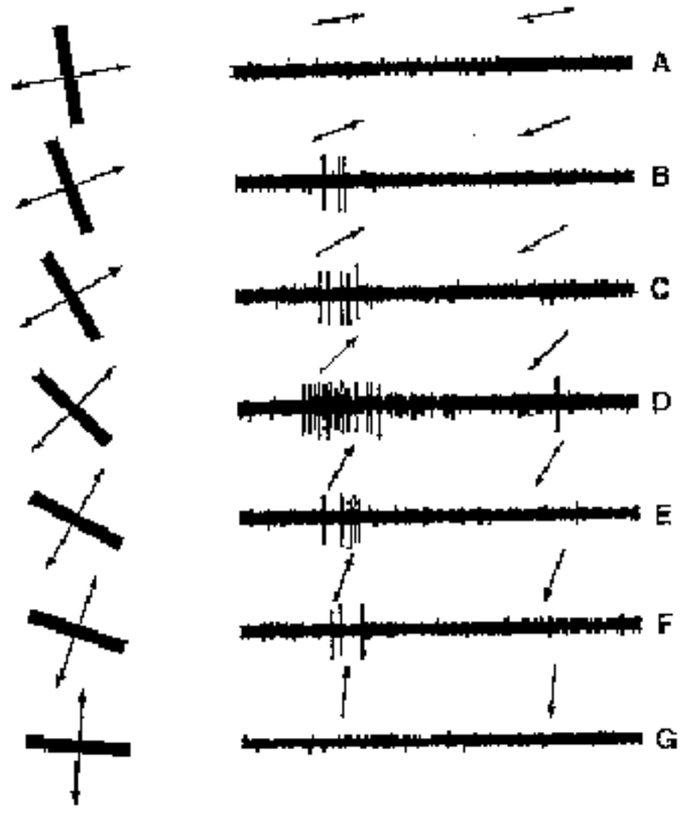



# Receptive Fields in V1

# Receptive Field Plasticity

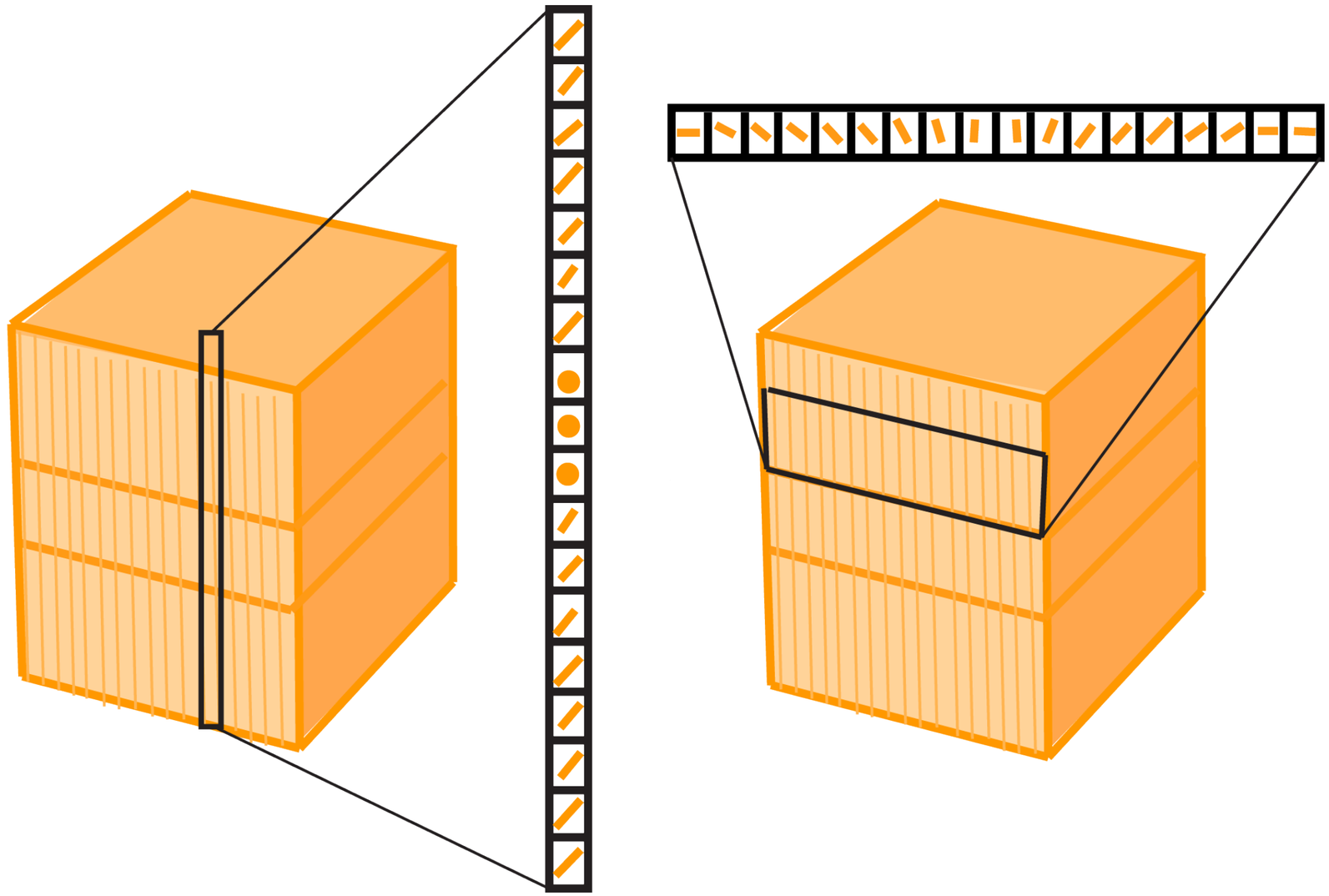
Receptive fields (RFs) are malleable: Under natural viewing conditions, an RF map is different from moment to moment as the statistics of the visual input change.

Current View: A neuron's RF is a plastic property of the neuron that is continually fine-tuned on the basis of contextual signals.

# Plasticity of V1 Receptive Fields

Two major organizing principles:

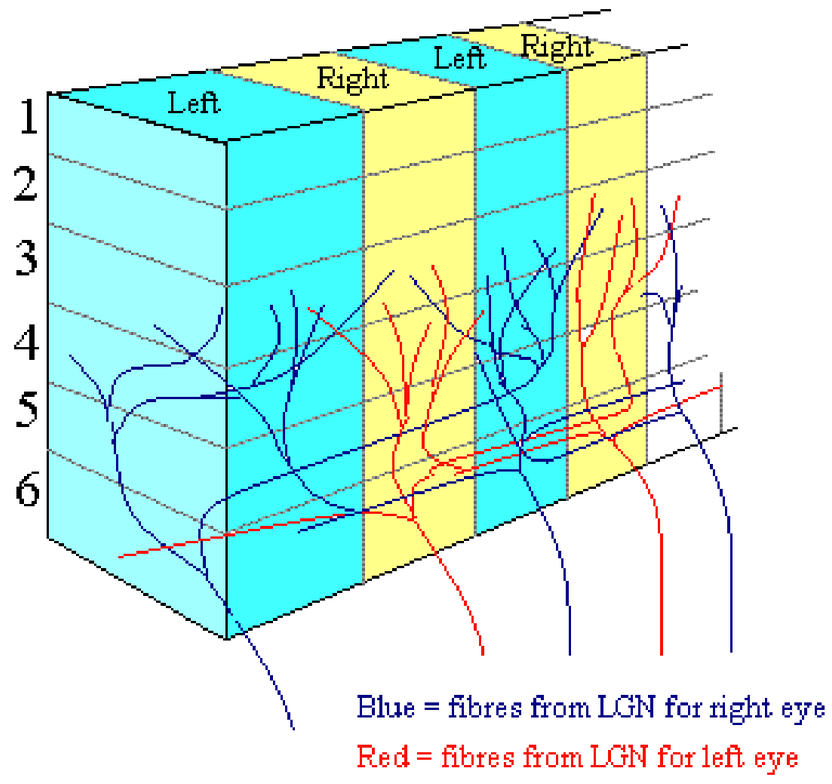
1. Orientation columns



# Modular Organization of V1

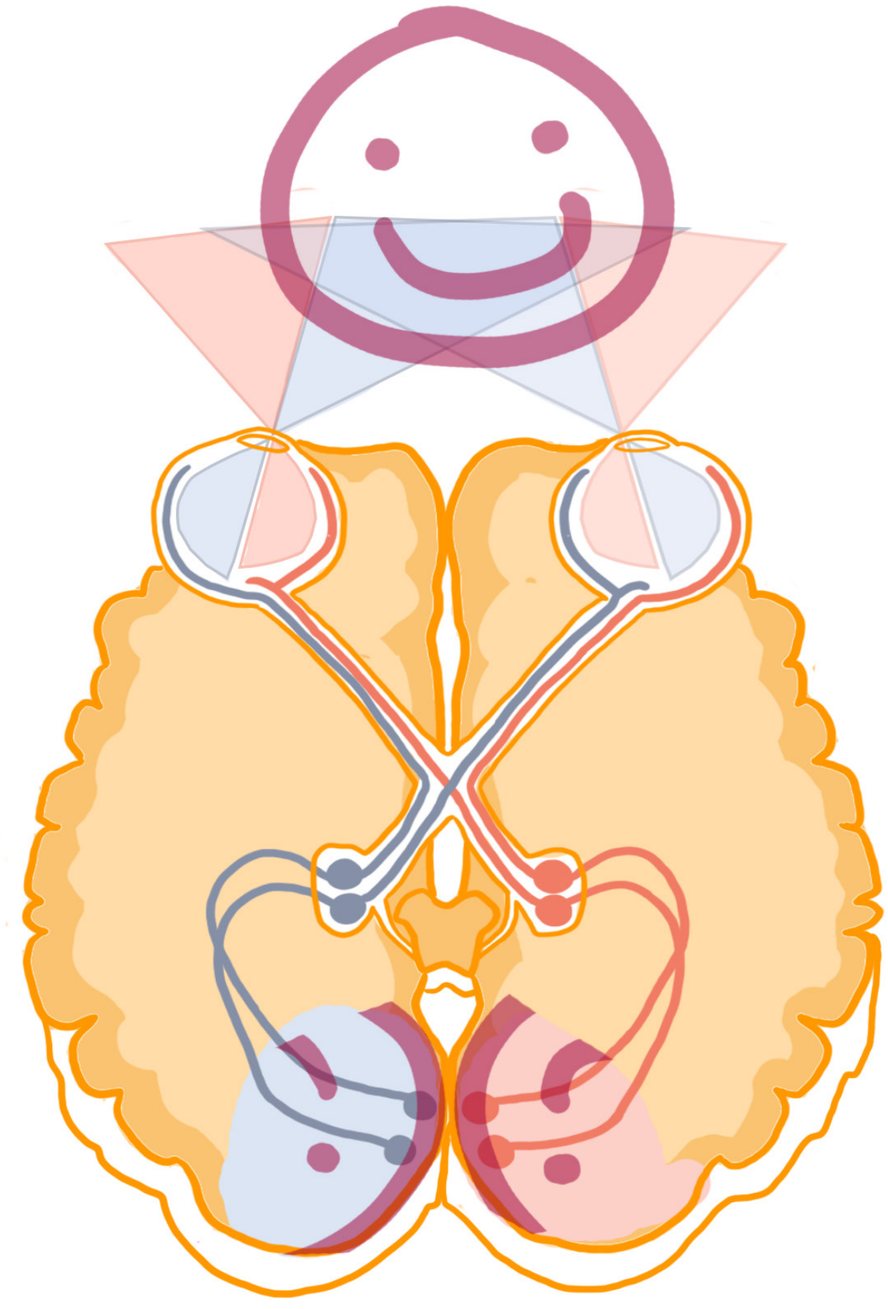
Two major organizing principles:

1. Orientation columns
2. Ocular dominance columns

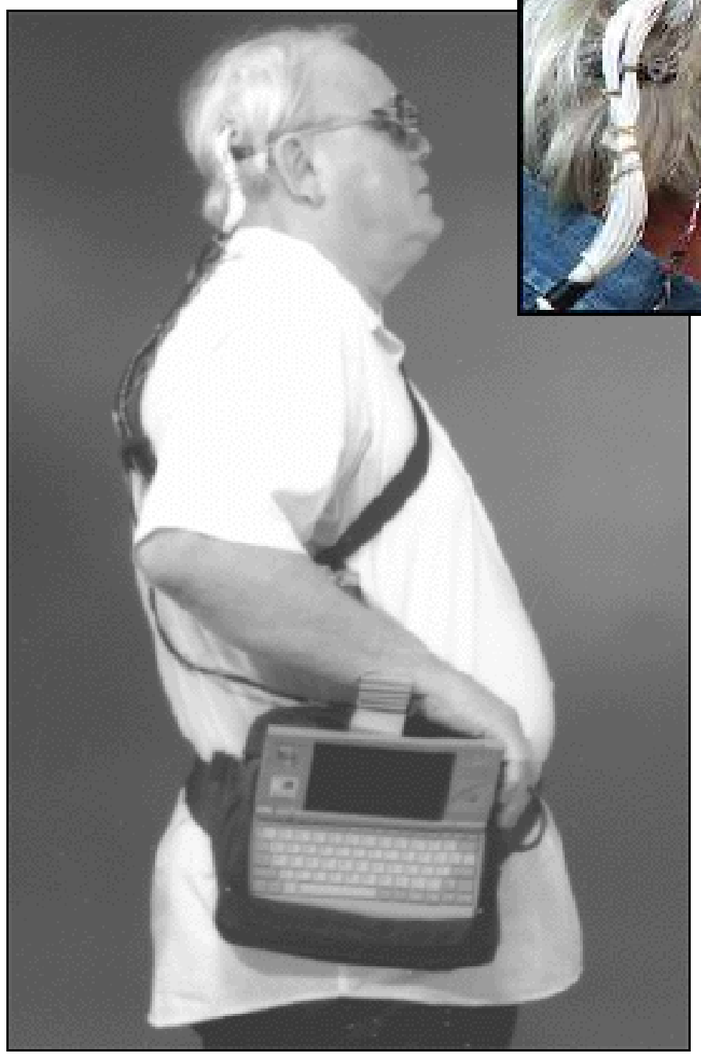


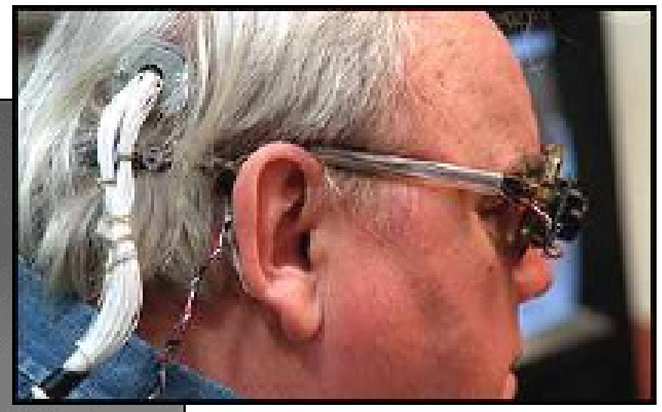

# Modular Organization of V1

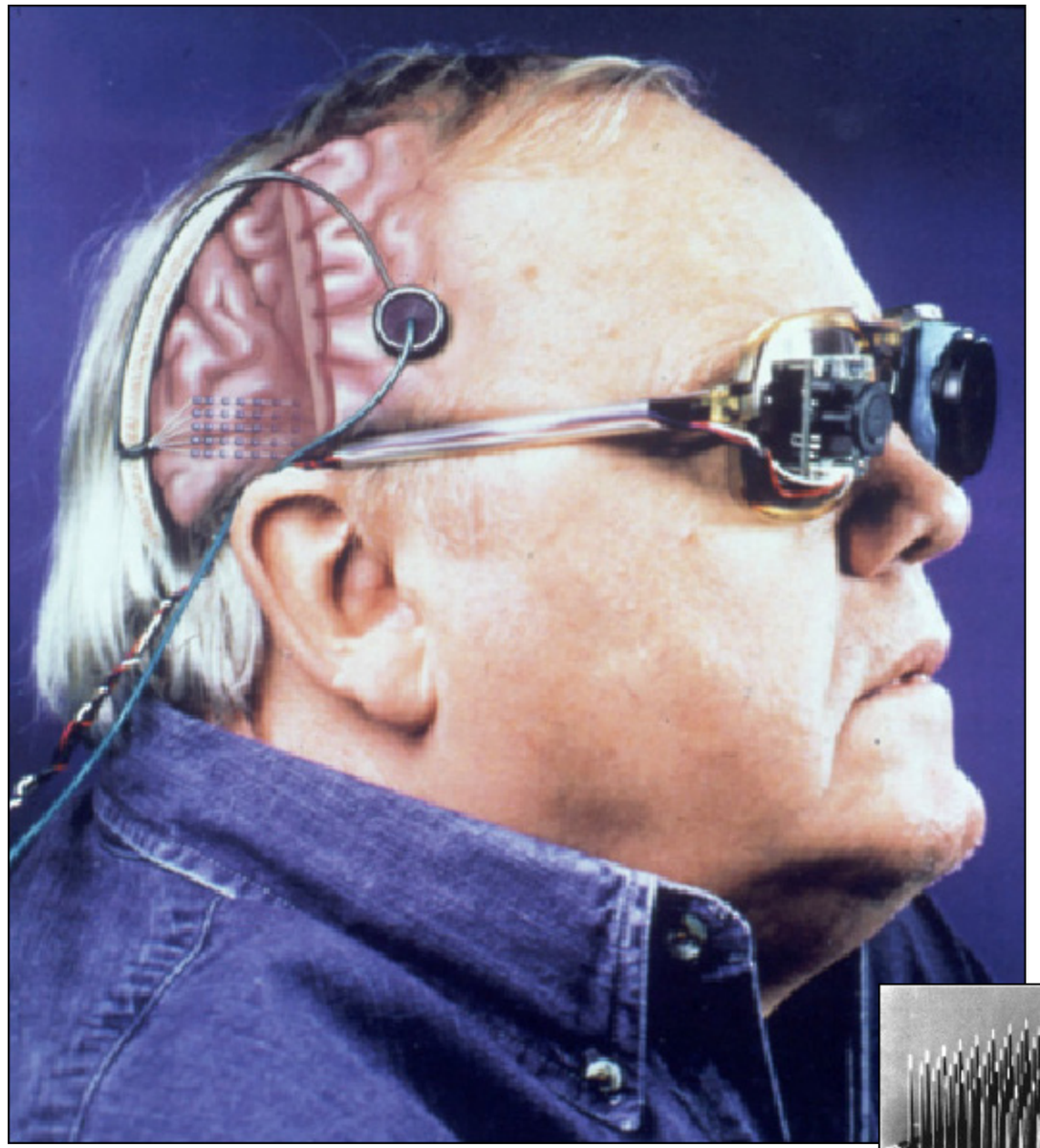
The Primary Visual Cortex has a retinotopic layout: The topography  of information collected from the outside remains intact on the surface of the primary visual cortex.

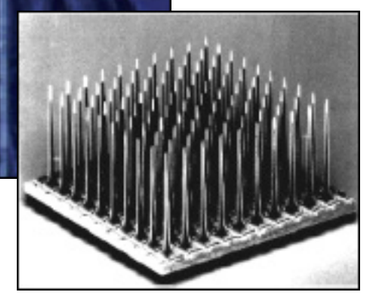


# Retinotopic Organization of V1



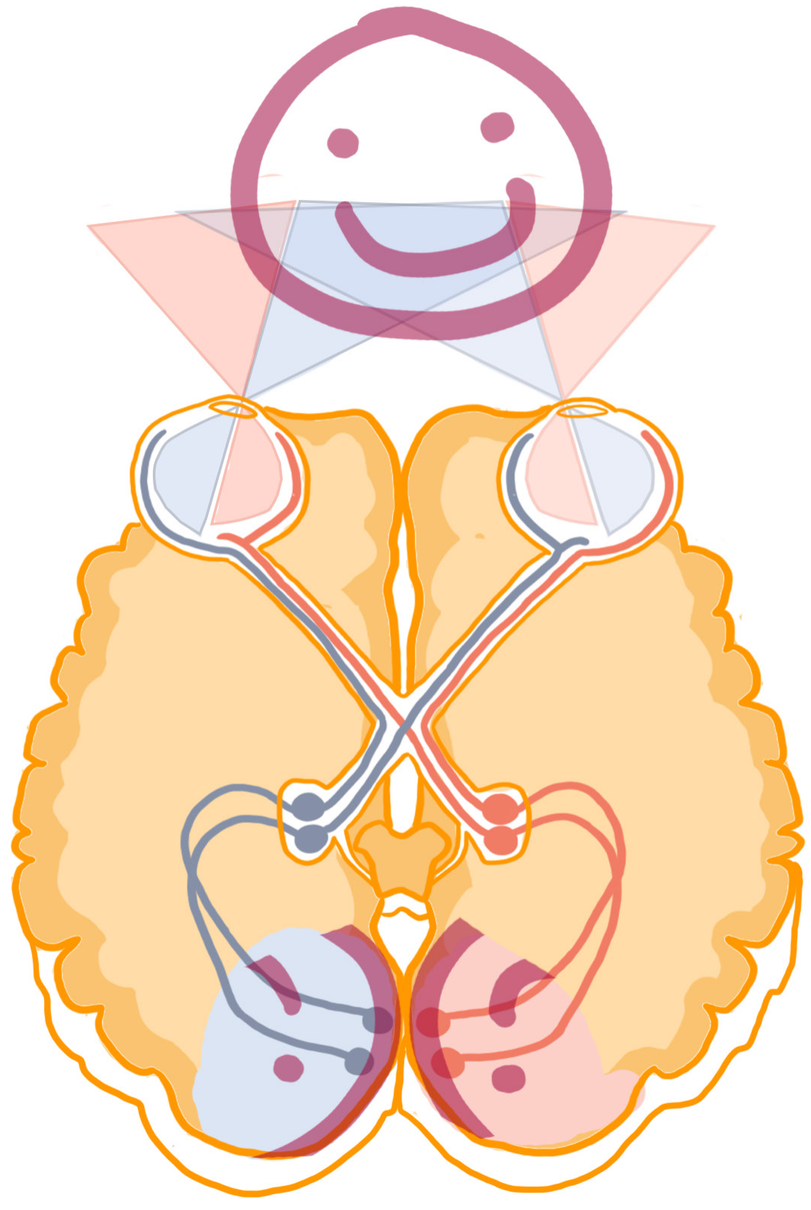






# Retinotopic Organization of V1

# What happens when you damage the primary visual cortex?



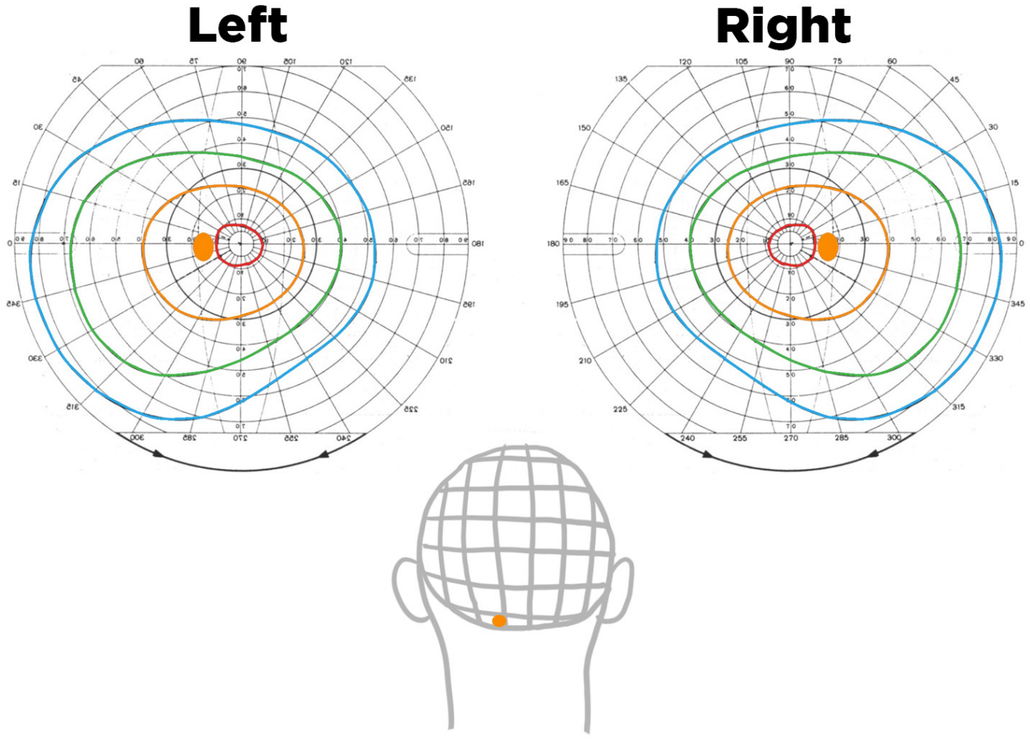
## V1 Damage

# Scotoma

In 1916, an army private was wounded by a shell-casing fragment that entered his skull.  When tested 10 d. later, he was unaware of any defects in his vision.

# V1 Damage

# Scotoma




One of Dr. Holmes's visual field maps.

In 1916, an army private was wounded by a shell-casing fragment that entered his skull. When tested 10 d. later, he was unaware of any defects in his vision. Mapping revealed a tiny patch of blindness, or scotoma (small black area on the two maps). The scotoma was identical in shape in both eyes, yet the brain injury was on the left side. This illustrates that the visual cortex receives information from both eyes.

# V1 Damage

# Blindsight

Patients with large lesions to the primary visual cortex occasionally retain some visual abilities.  For example:

- Better than chance performance on forced-choice discrimination tasks.
- Spatial navigation and coordination is surprisingly good (i.e. avoid obstacles, interact with environment).

# V1 Damage