

CARATTERIZZAZIONE FUNZIONALE DEL SISTEMA VISIVO

- I parte -

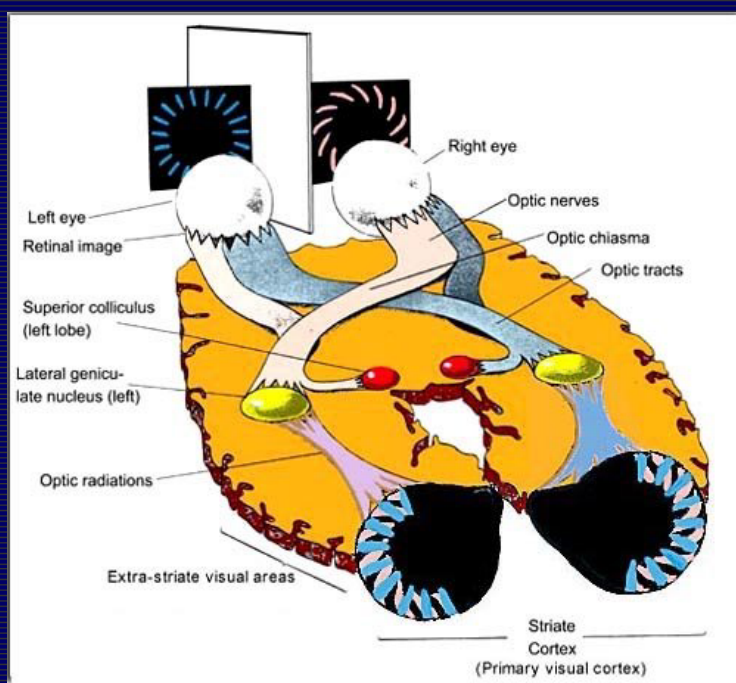
silvio@dibe.unige.it



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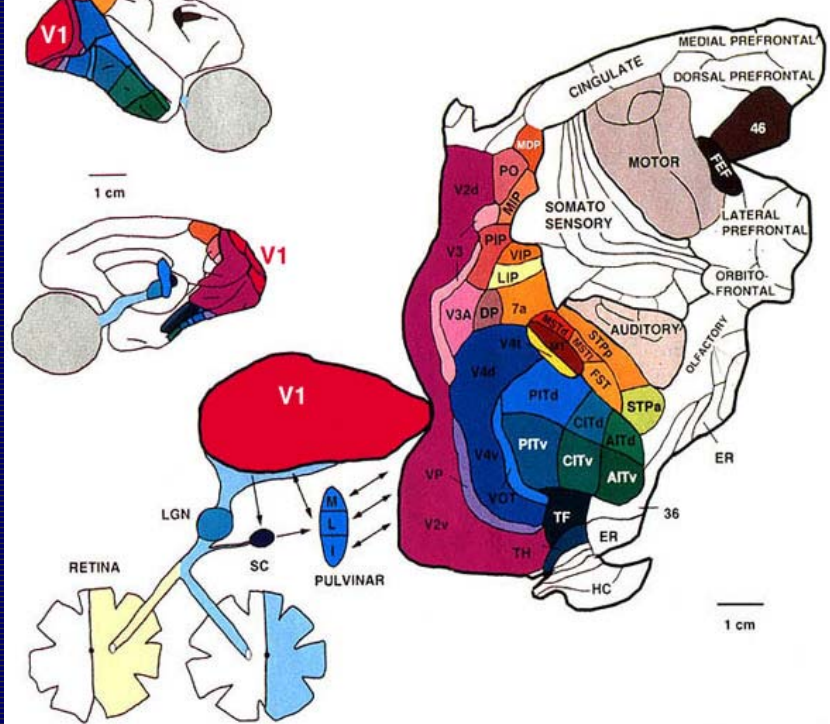
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RETINOCORTICAL VISUAL PROCESSING

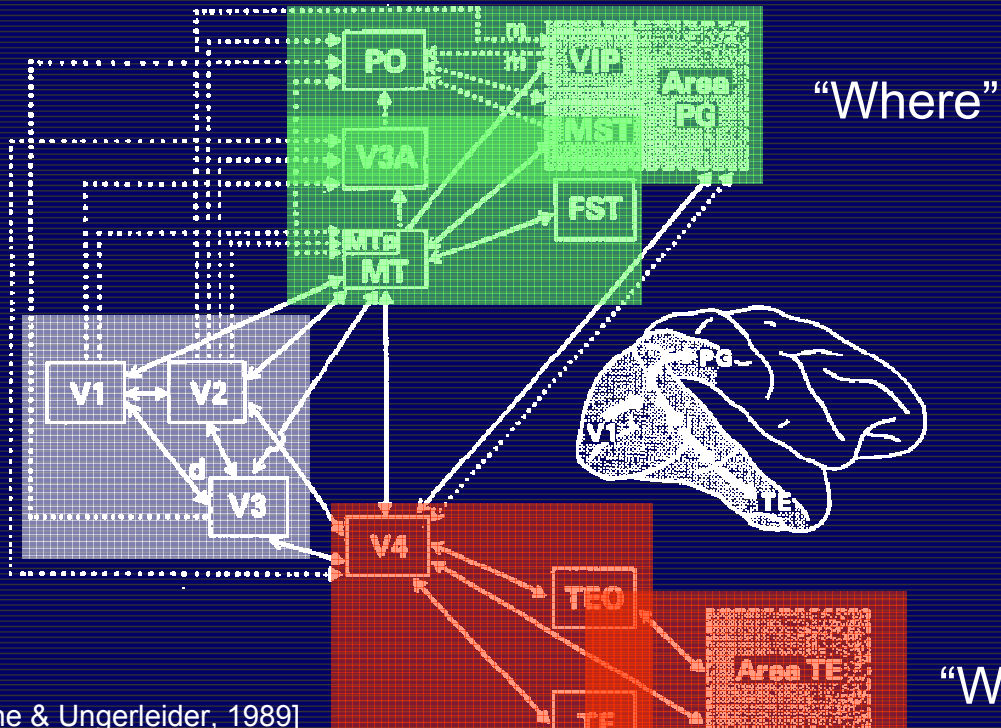


- Different neuronal nuclei (cortical and subcortical)
- More than 30 cortical areas
- 10^3 - 10^5 neurons/mm³
- 10^6 - 10^9 synapses/mm³

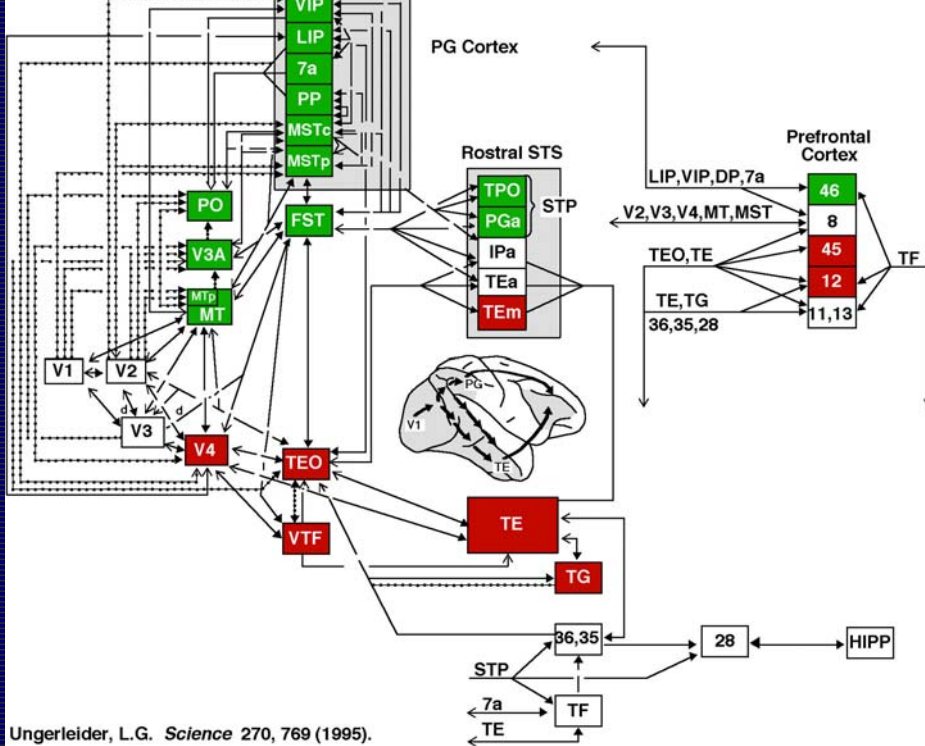
[Miller et al., 1989]



CORTICAL FLOW CHARTS

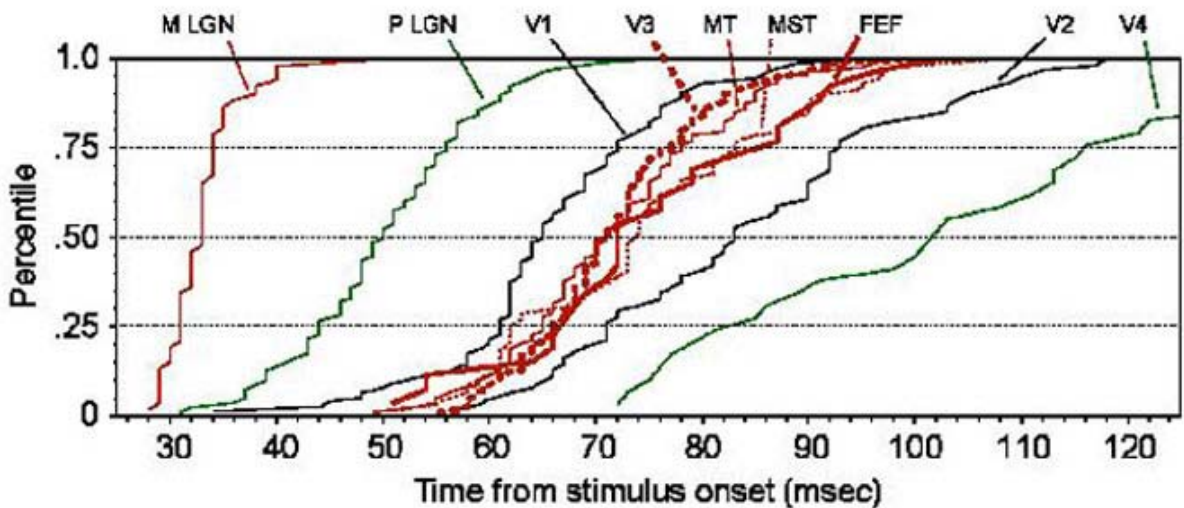


[Ungerleider., 1995]

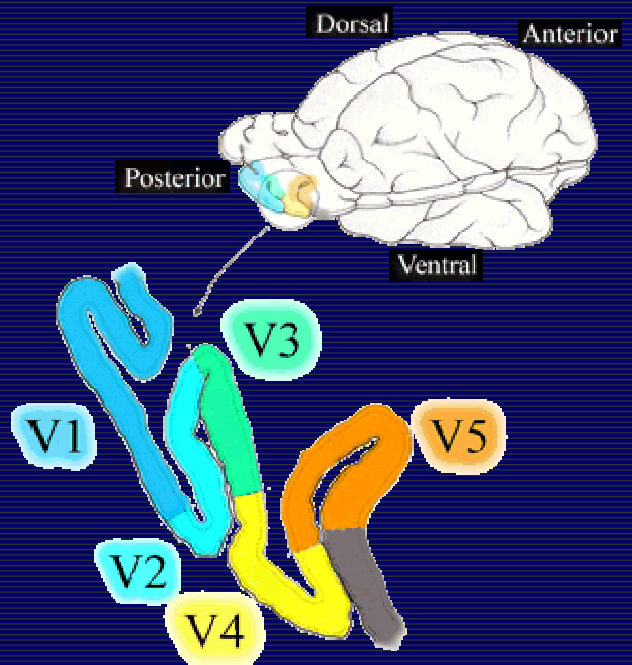
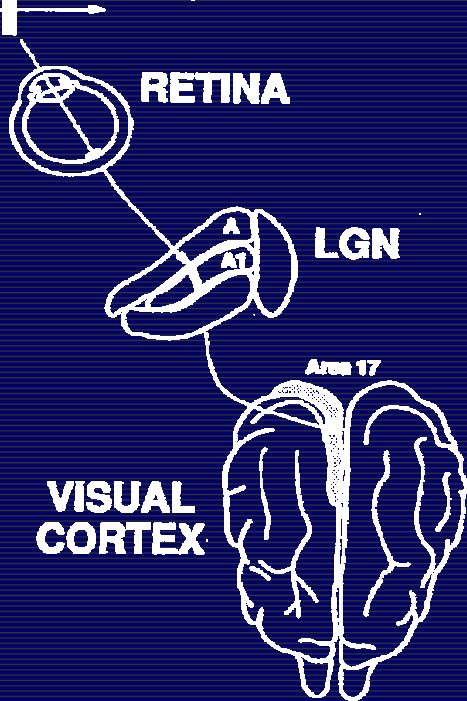


Ungerleider, L.G. Science 270, 769 (1995).

ONSET LATENCIES



Stimulus

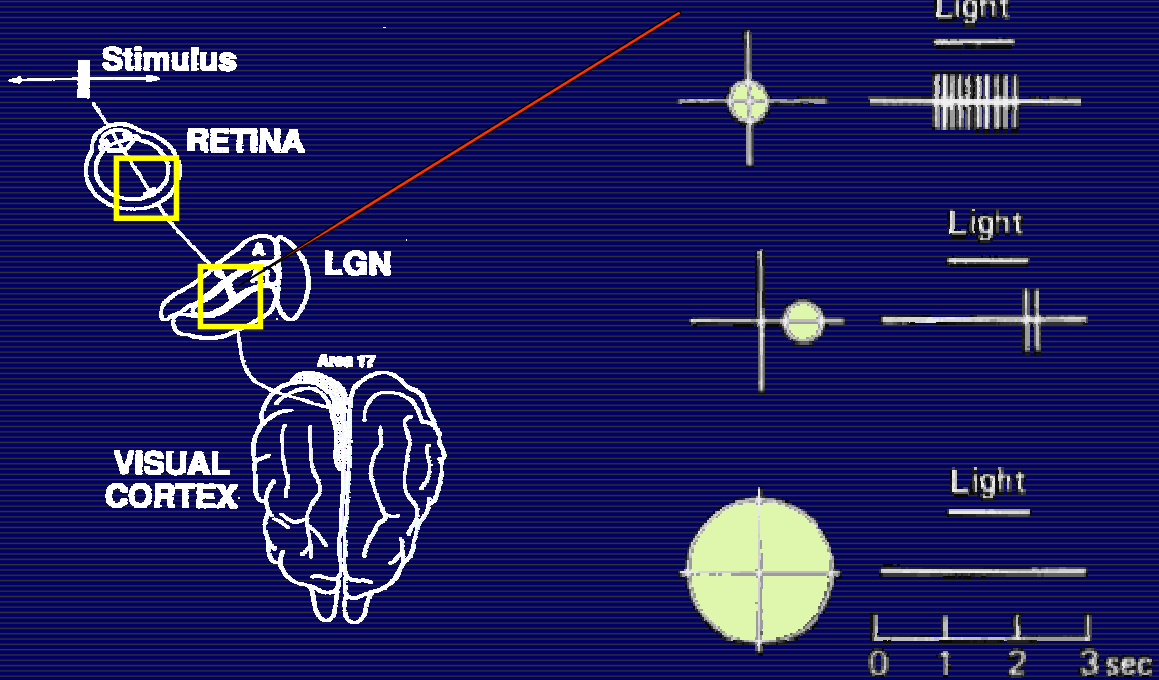


[Miller et al., 1989]

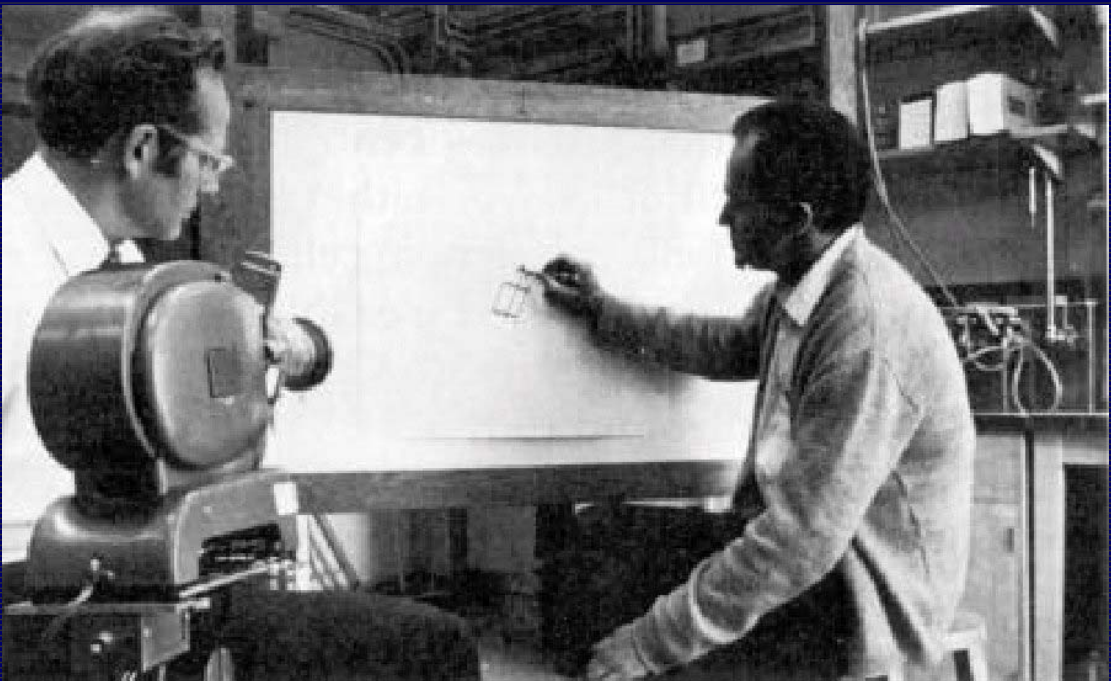
FUNCTIONAL PROPERTIES

How to functionally characterize
the visual neurons?

Which kind of information do they
handle?

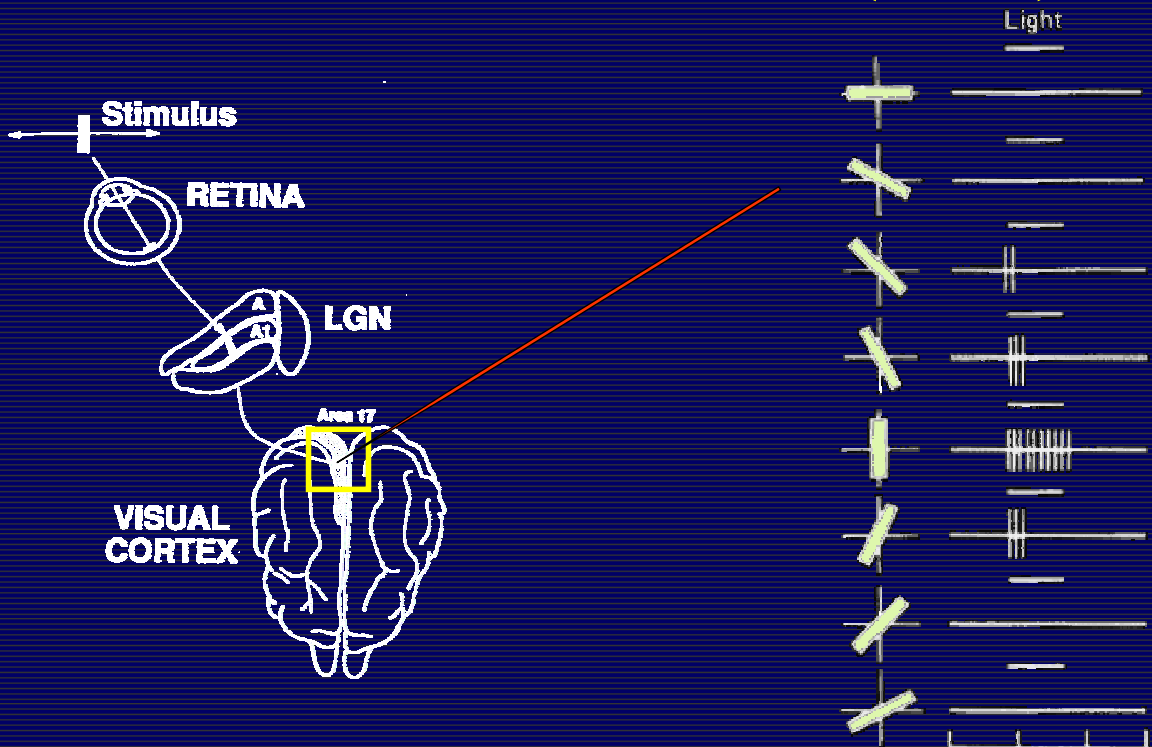


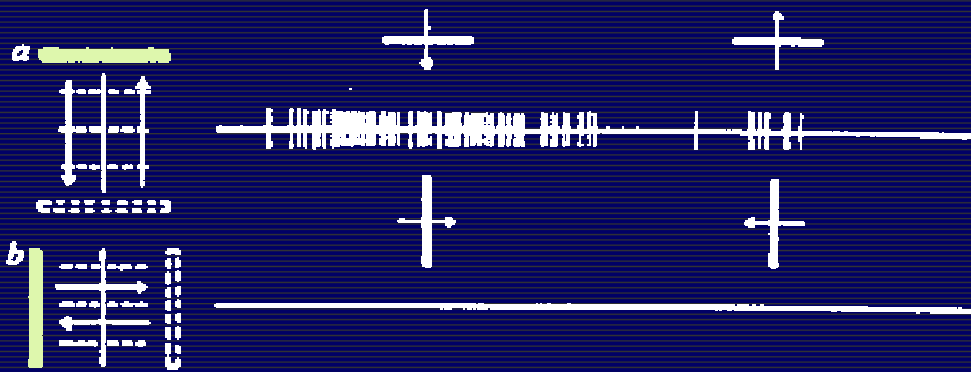
TRIGGER FEATURES (cont'd)





TRIGGER FEATURES (cont'd)

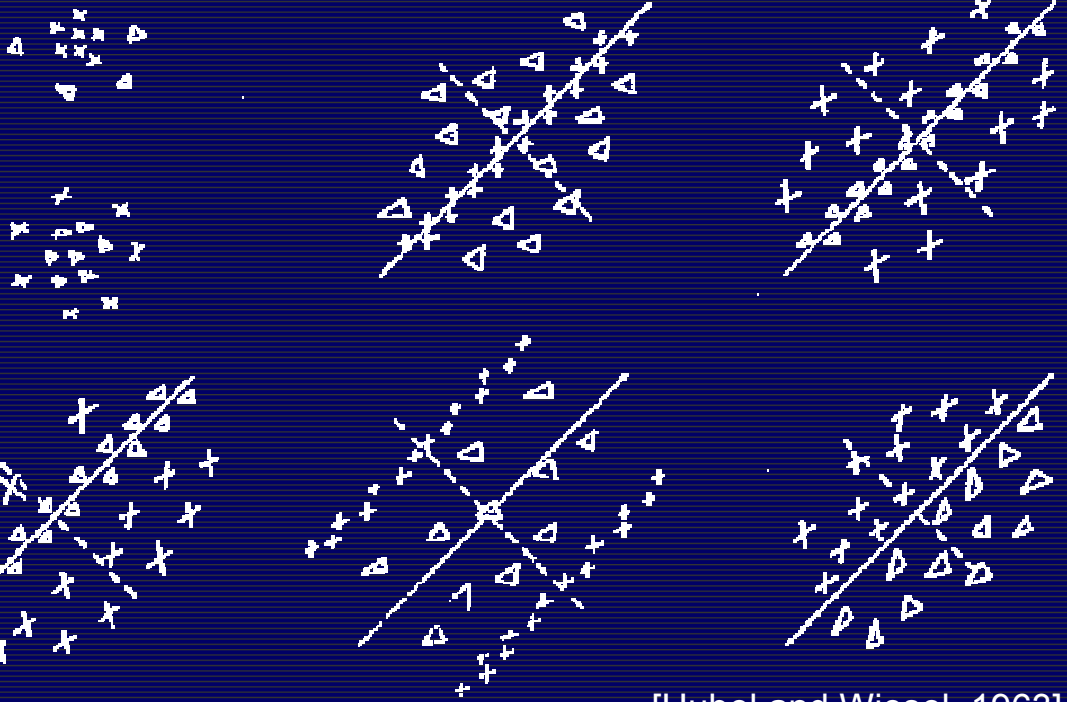




[Hubel and Wiesel, 1962]

TRIGGER FEATURES (cont'd)





[Hubel and Wiesel, 1963]

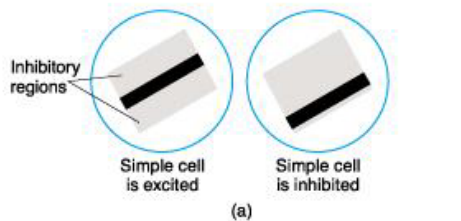
CORTICAL RECEPTIVE FIELDS

► Response Characteristics of Neurons to Orientation in the Primary Visual Cortex

(a) Simple Cell

(b) Complex Cell

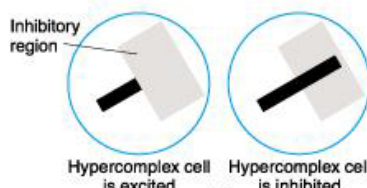
(c) Hypercomplex Cell



(a)

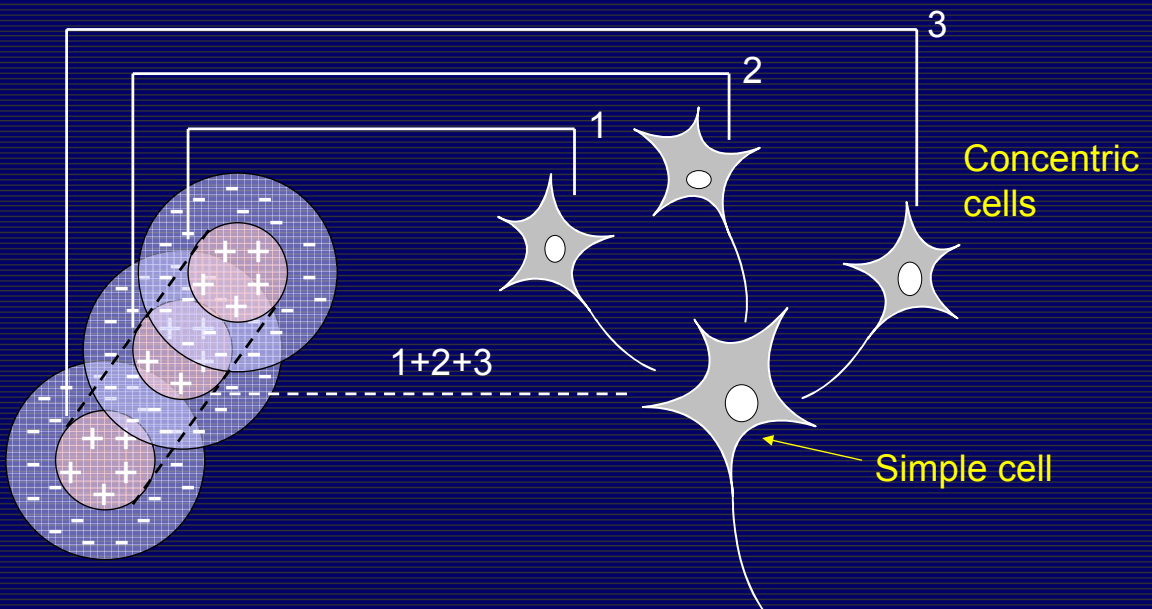


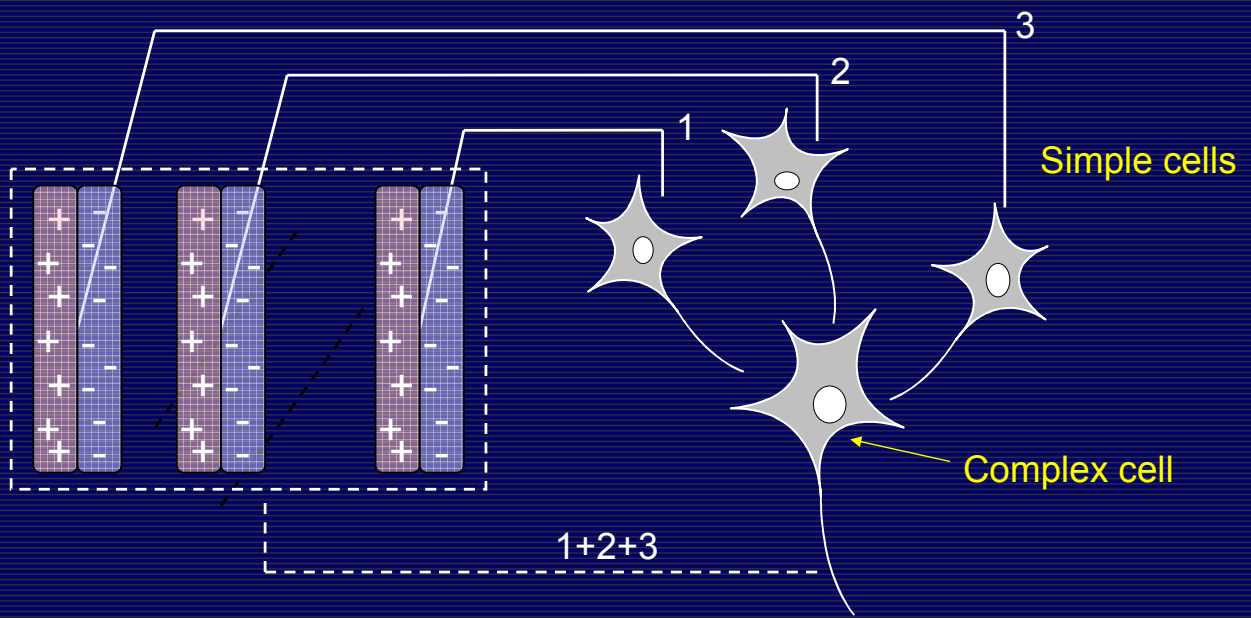
(b)



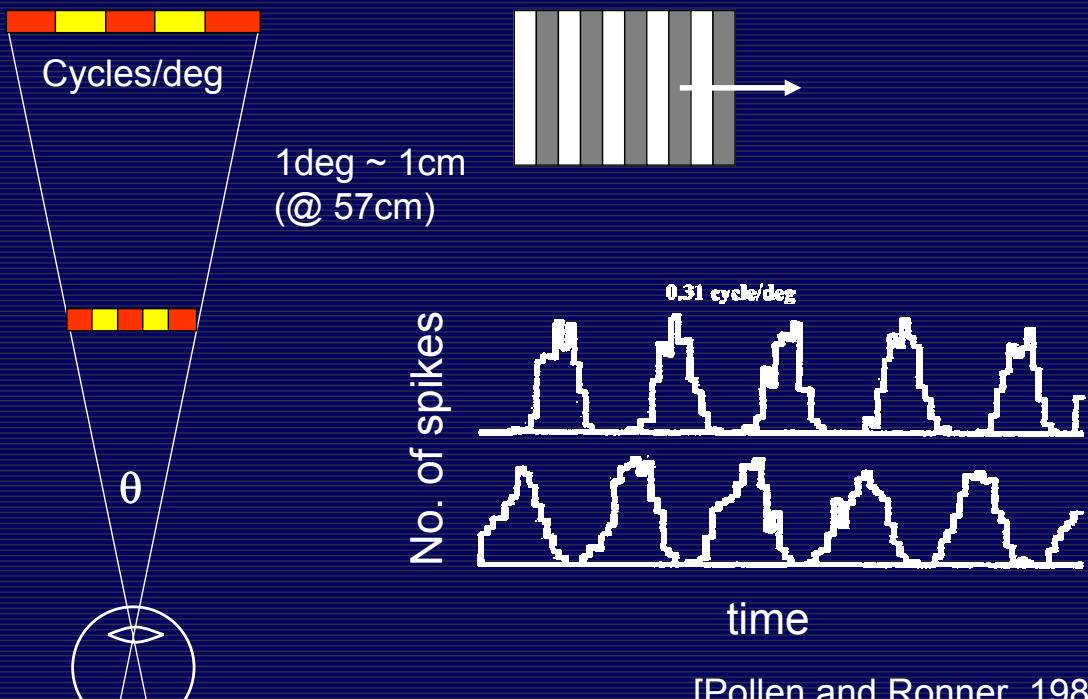
- **Simple cells** respond best to bars or edges in a particular location in the receptive field and with a particular orientation
 - they have well separate on and off subregions
- Most of the cells in the striate cortex are **complex cells**
 - like simple cells, they respond best to straight-line stimuli with a particular orientation
 - unlike simple cells, the position of the stimulus within the receptive field does not matter

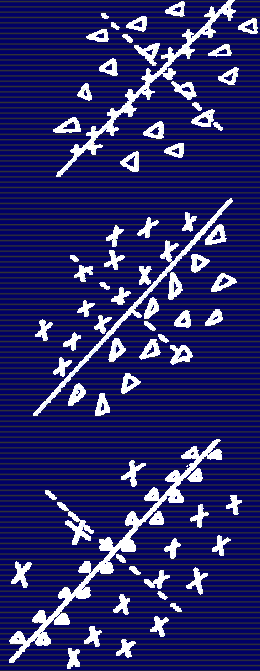
HIERARCHICAL MODELS



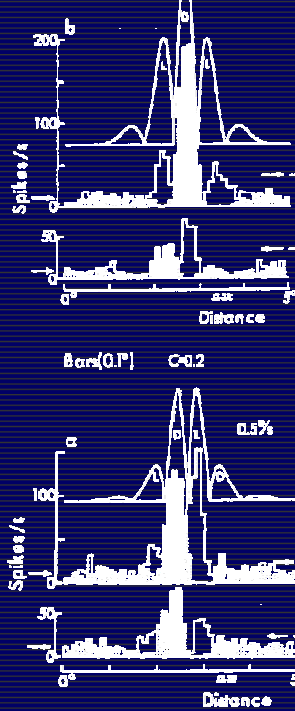


TRIGGER FEATURES (cont'd)

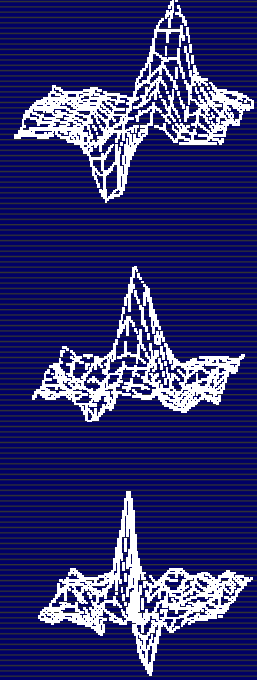




[Hubel & Wiesel, 1963]

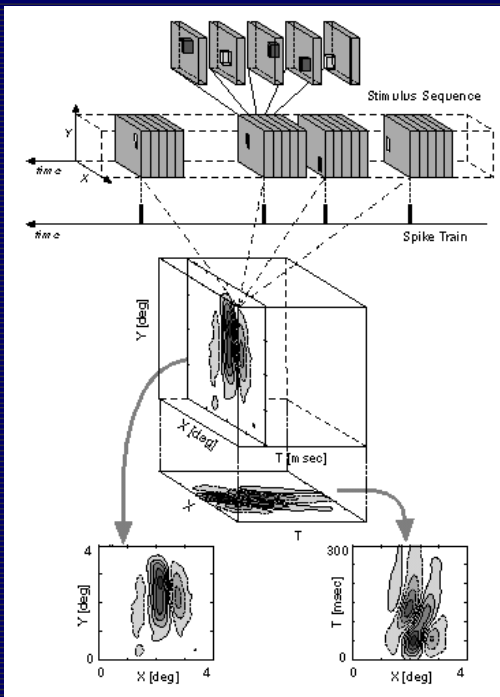


[Kulikowski & Bishop, 1981]

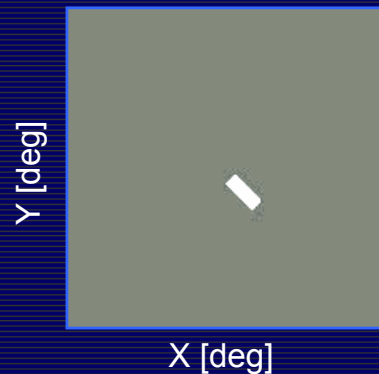


[Jones & Palmer, 1987]

SPATIOTEMPORAL RFs IN V1



Stimuli used in reverse correlation experiments

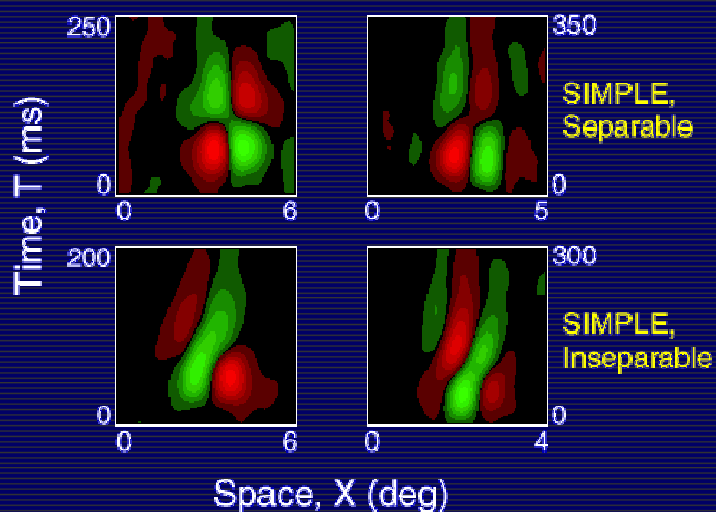
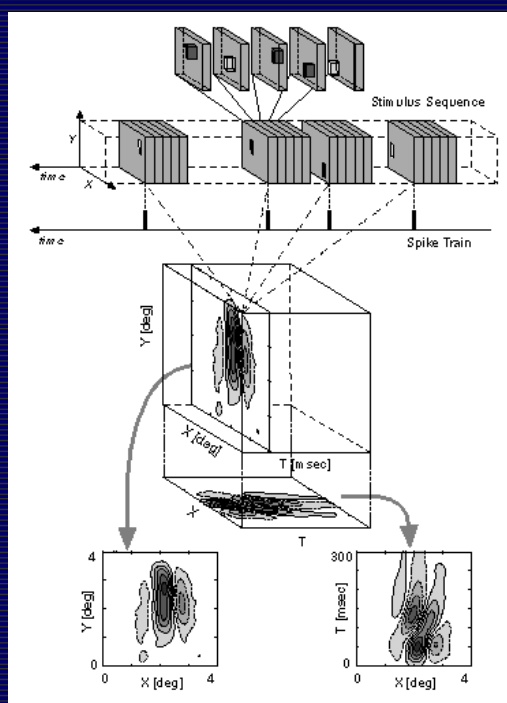


The position of a bar stimulus is selected randomly from 20x20 two-dimensional grid positions. Individual stimuli are typically 25-50 msec in duration, and are presented at the rate of 20-40 stimuli/second. The orientation of individual bars and the stimulus grid is always matched closely to the

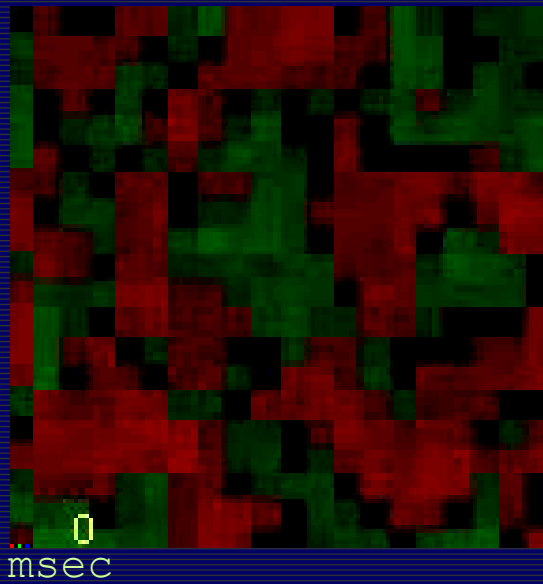


[Ohzawa et al., 1996]

SPATIOTEMPORAL RFs IN V1

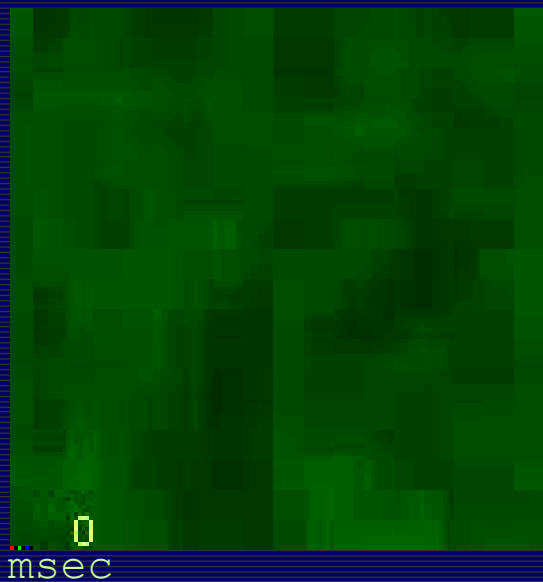


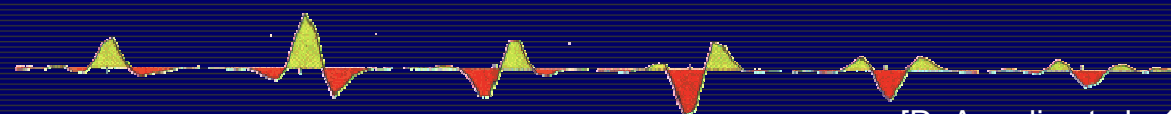
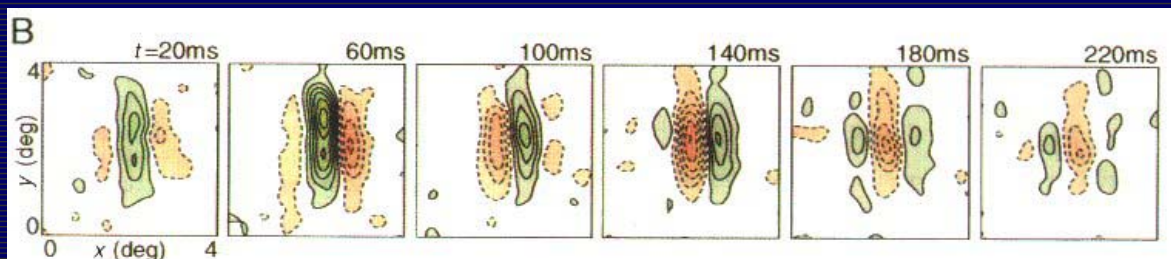
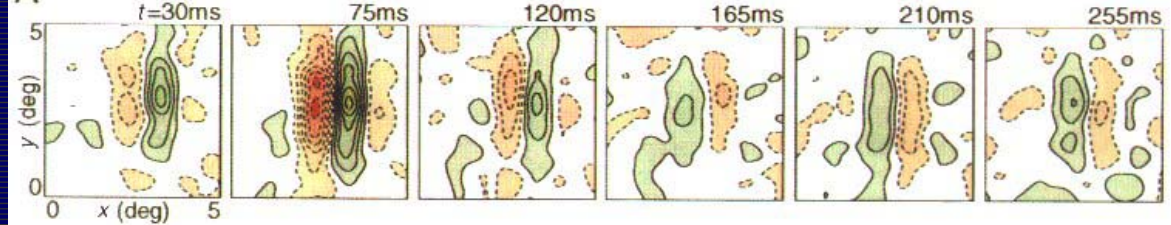
[DeAngelis et al., 1995]



[Ohzawa et al., 1996]

SPATIOTEMPORAL RFs - V1 (complex cell)

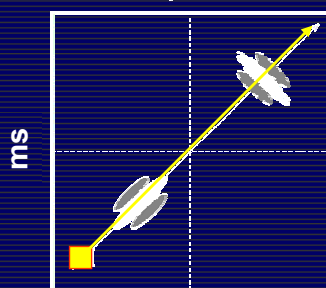




[DeAngelis et al., 1995]

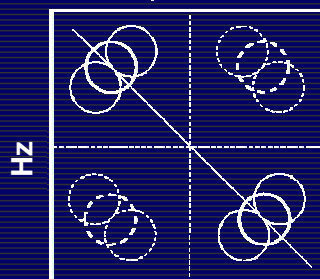
SPATIOTEMPORAL FUNCTIONALITY

x-t plot

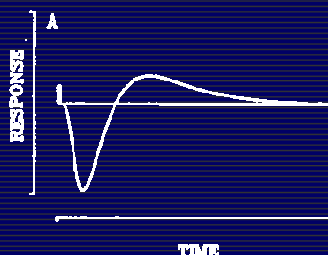
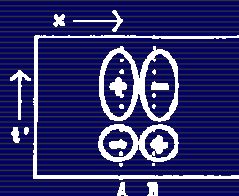


deg

energy spectrum

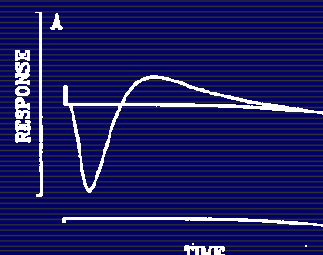
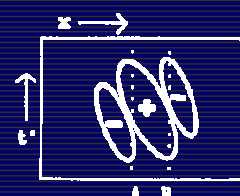


SPATIO-TEMPORALLY
SEPARABLE

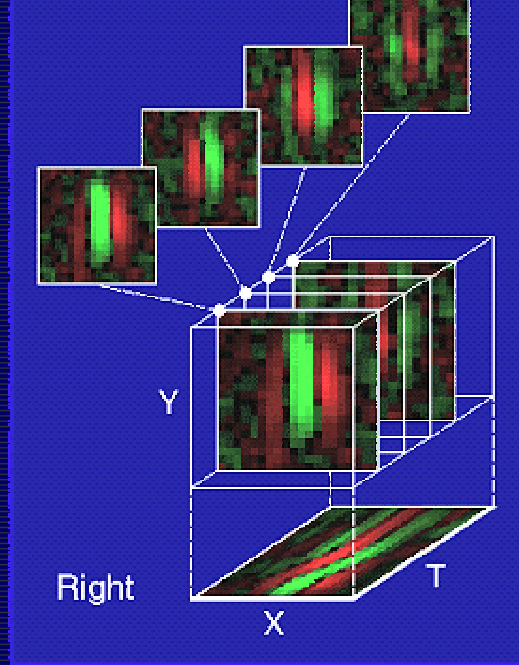
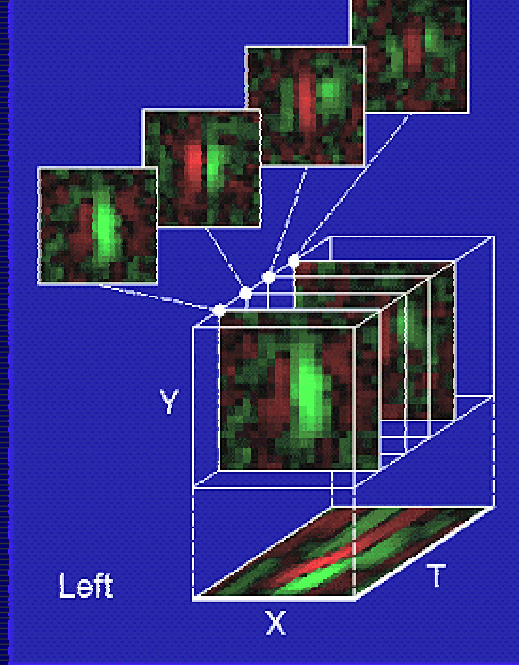


TIME

SPATIO-TEMPORALLY
INSEPARABLE

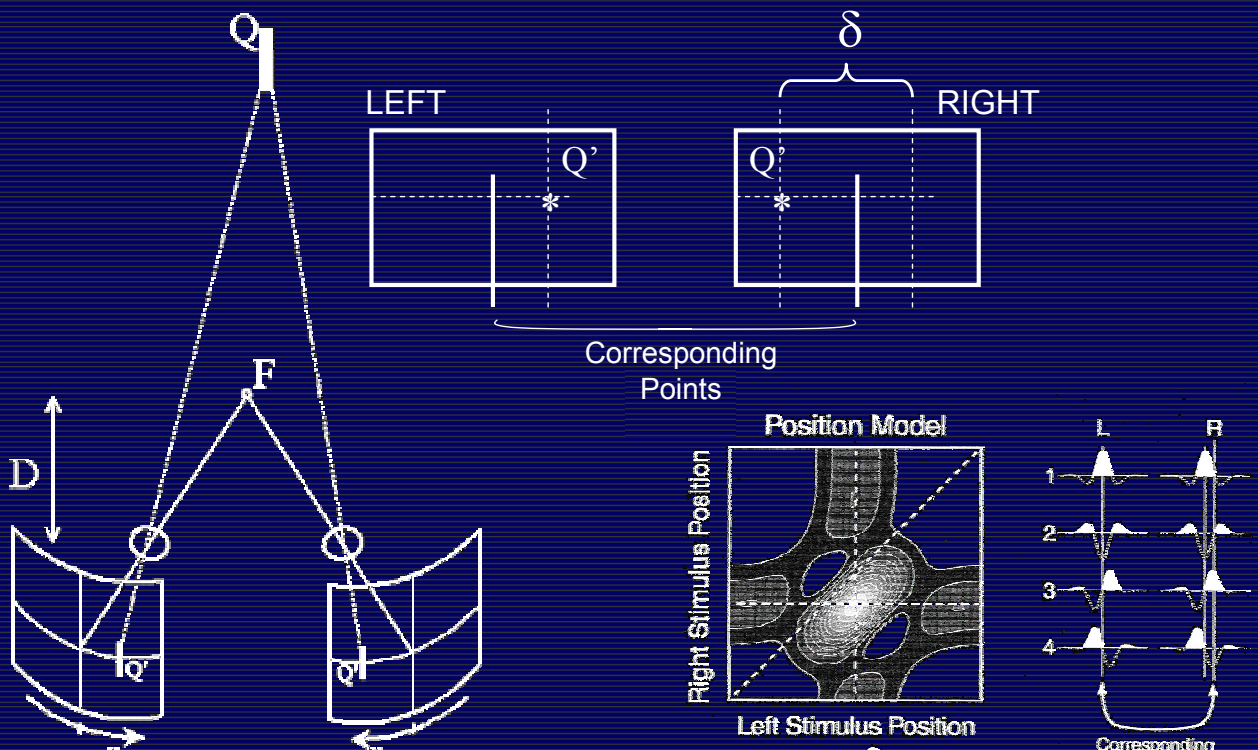


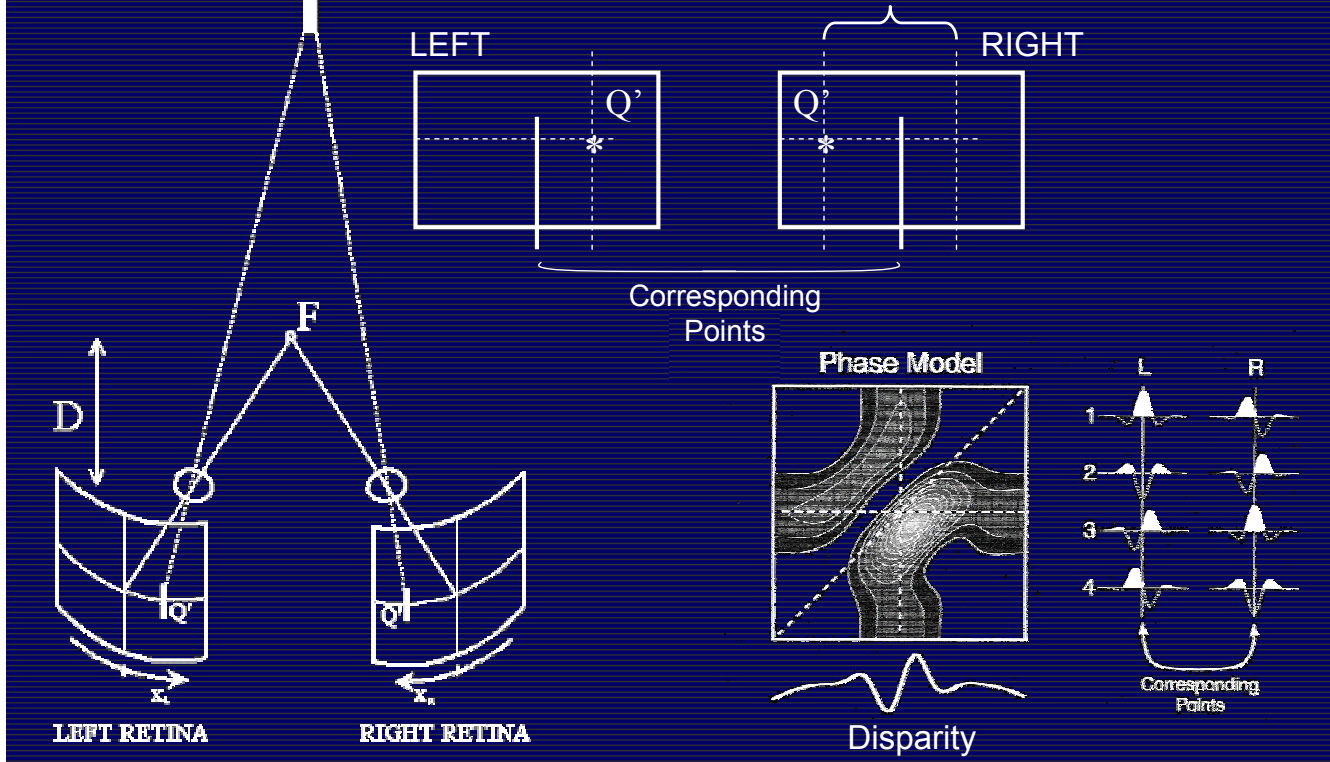
TIME



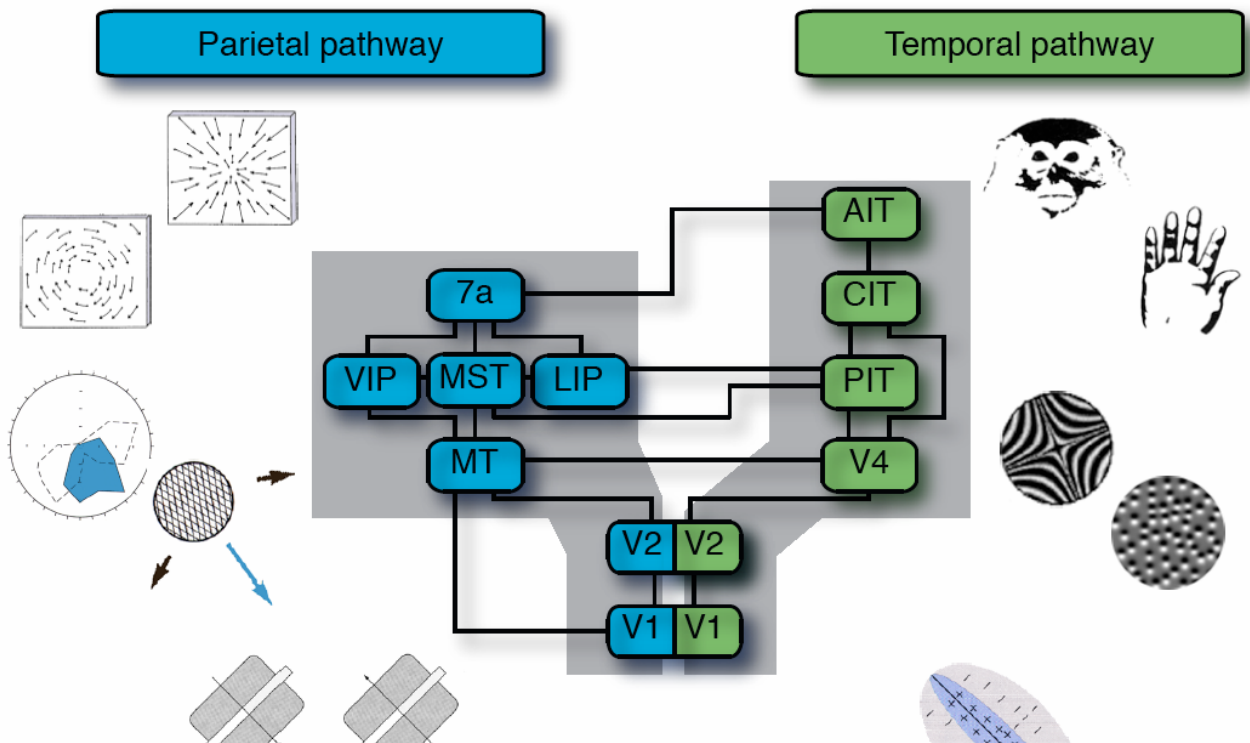
[Ohzawa et al, 1997b]

THE STEREO PROBLEM





Hierarchical elaboration of response selectivities

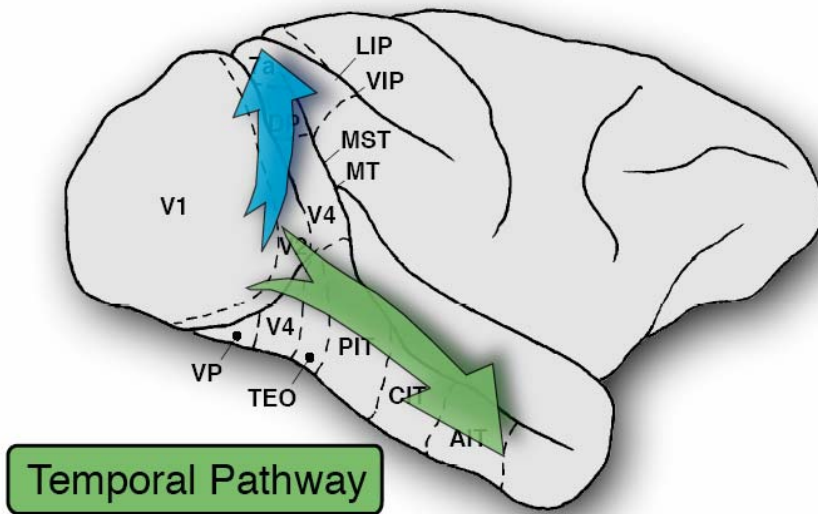


Parietal Pathway

"Where"

Spatial relationships

Motion



Temporal Pathway

Pattern

Identity

"What"

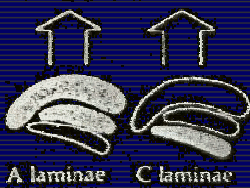
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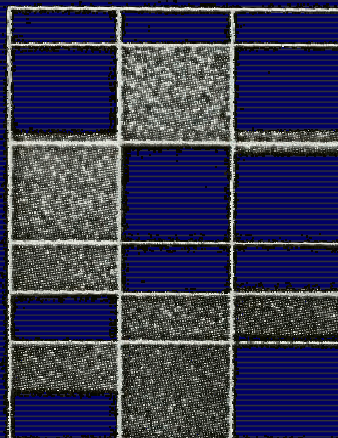


SCHEMATIC DIAGRAM OF CORTICAL CONNECTIONS

AFFERENTS

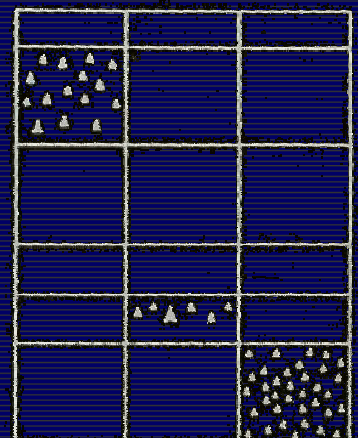


RECEPTIVE FIELD TYPES



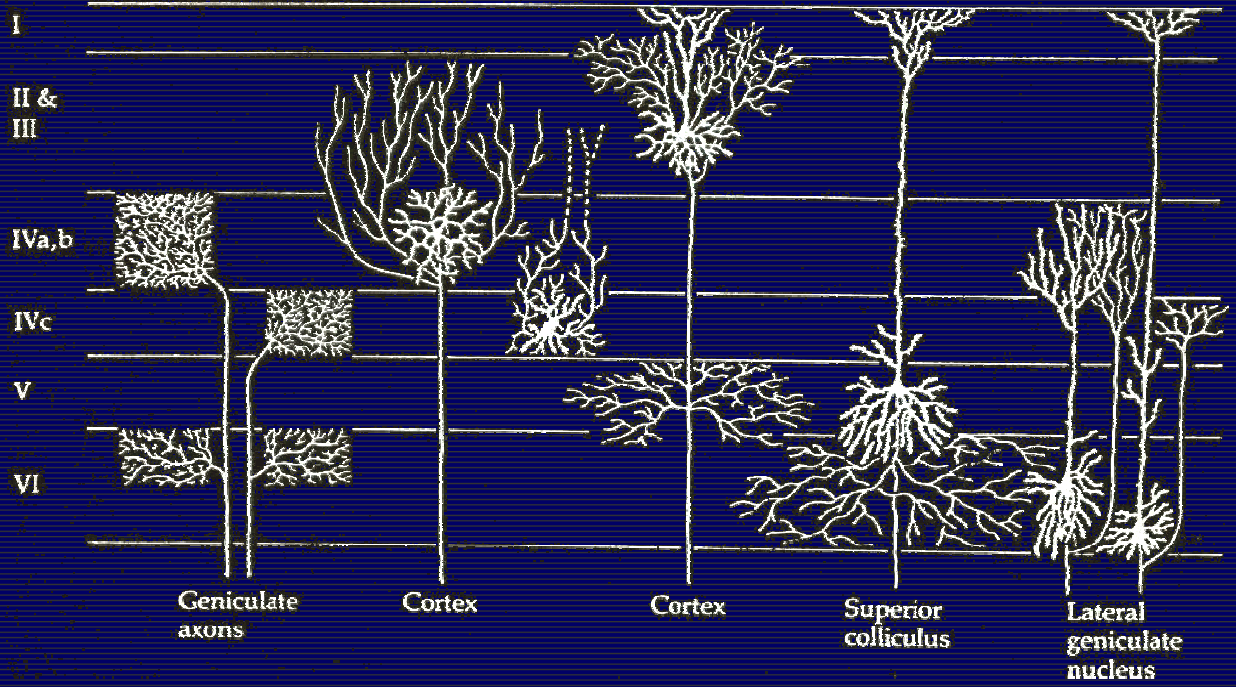
Simple Standard complex Special complex

EFFERENTS



Other cortical areas Superior colliculus Lateral geniculate nucleus

CORTICAL CONNECTIONS (cont'd)



[Gilbert & Wiesel, 1981]