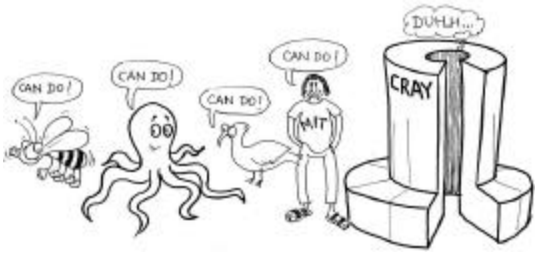
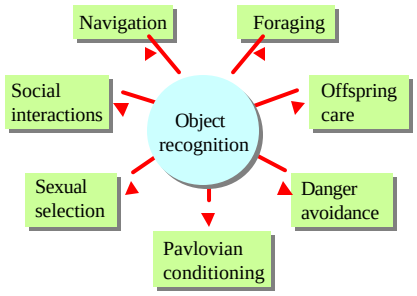
1. Do you want fries with that?
2. Where do babies come from?
3. How does the brain recognize objects?




## The Importance of Recognition




## The Importance of Recognition

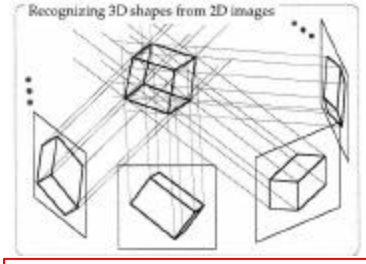
"Not only did Dr. P fail to see faces, but he saw faces when there were no faces to see. In the street he might pat the heads of water hydrants and parking meters, taking these to be the heads of children; he would amiably address carved knobs on the furniture and be astounded when they did not reply. Such incidents multiplied, causing embarrassment, perplexity and fear."

*From 'The man who mistook his wife for a hat' by Dr. Oliver Sacks*

Why the emphasis on ‘shape-based’ recognition?

Color and texture, though important, are often not critical…

**The challenge of shape-based recognition**

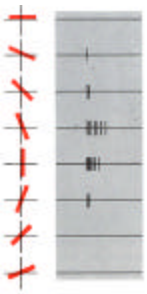



A 3D object can look very different from different view-points

Models of shape-based object recognition:

**Models based on 3D representations**

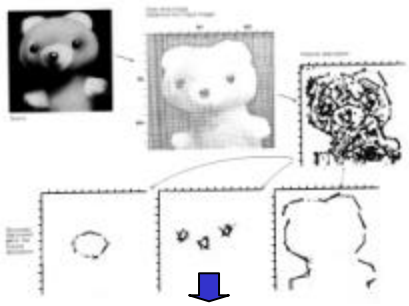
David Marr
(1945-1980)



Oriented bar and edge detector neurons

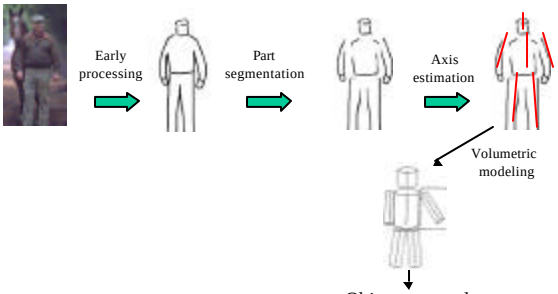
Hubel and Wiesel (1967)

**Marr’s proposal:**

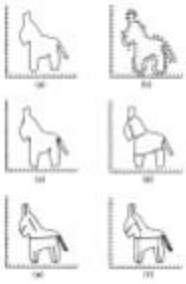


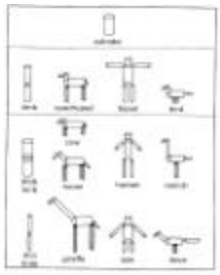
Further processing

**Marr and Nishihara's model [1978]**




**Estimating part axes**

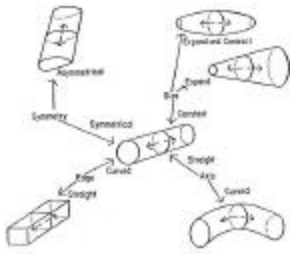




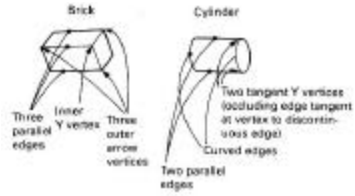
Examples of volumetric representations

**Biederman's Recognition By Components (RBC) theory:**

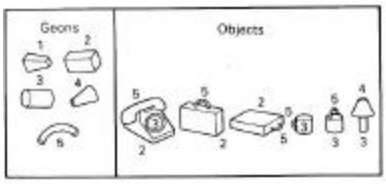
**Biederman's Recognition By Components (RBC) theory:**



More sophisticated volumetric primitives (geons)




'Invariant' features for two geons

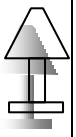


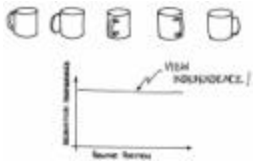

**Biederman's Recognition By Components (RBC) theory:**

Early processing

Segmentation

Detect invariant features and build geon based model





Different views lead to the same set of geons and their relations. Therefore, the model achieves **view invariance**.

**Biederman's Recognition By Components (RBC) theory:**

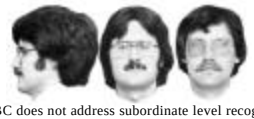
Attractive features:

1. Suggests how to achieve viewpoint independent recognition
2. Has low storage requirements

**Biederman's Recognition By Components (RBC) theory:**

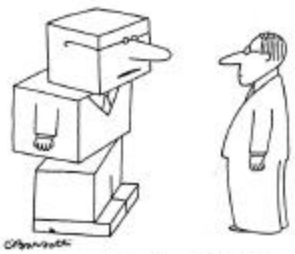
Unattractive features

1. Invariant features difficult to extract in real images



2. RBC does not address subordinate level recognition

3. Geons are poor at representing many natural objects which may not have simple parts-based descriptions.
(the expressive power of geons – Biederman's claim…)



"We're offering you the job on probation, Winslow. You have three months to become one of us."

**A more fundamental problem with Marr's and Biederman's models:**


3D object recognition is often not view-point independent…

**Viewpoint dependent recognition performance of primates**

Evidence from:
-Psychophysics
-Physiology

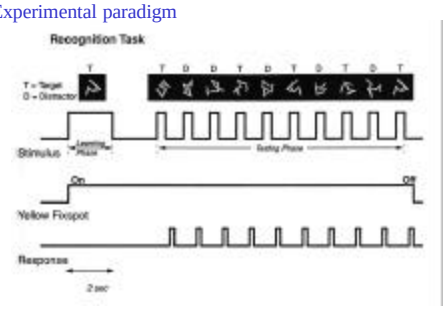
Experimental stimuli

**Viewpoint dependent recognition performance of primates**

Assessing the effect of rotations about different axes on recognition

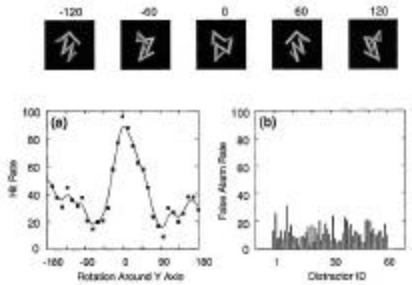
**Viewpoint dependent recognition performance of primates**

Experimental paradigm



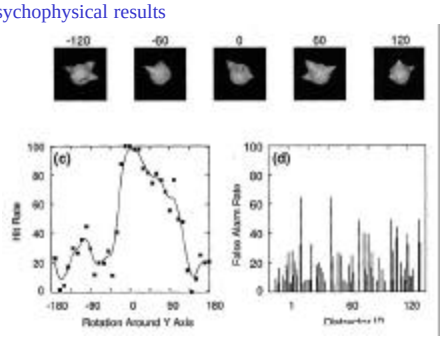

**Viewpoint dependent recognition performance of primates**

Psychophysical results



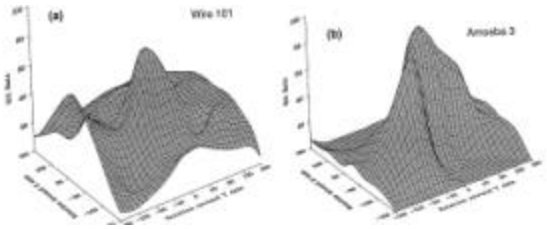
**Viewpoint dependent recognition performance of primates**

Psychophysical results



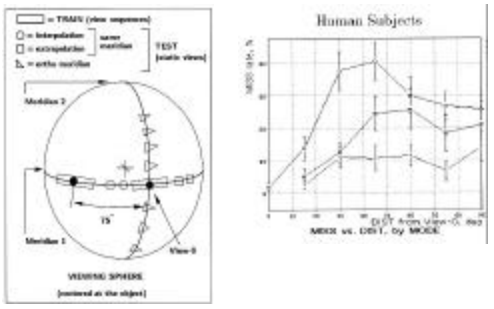

**Viewpoint dependent recognition performance of primates**

Psychophysical results




**Viewpoint dependent recognition performance of humans**

Psychophysical results





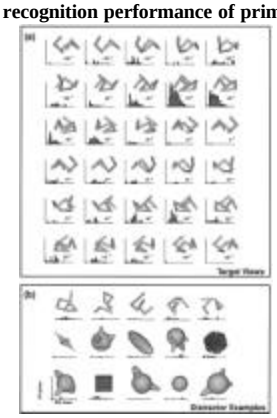


**Viewpoint dependent recognition performance of primates**

Physiological results

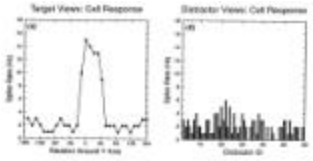
**Viewpoint dependent recognition performance of primates**

Physiological results



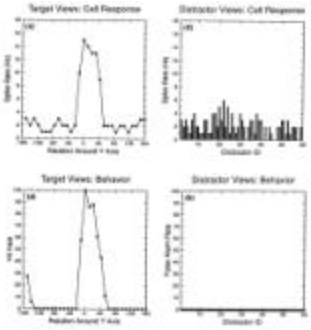
**Viewpoint dependent recognition performance of primates**

Physiological results



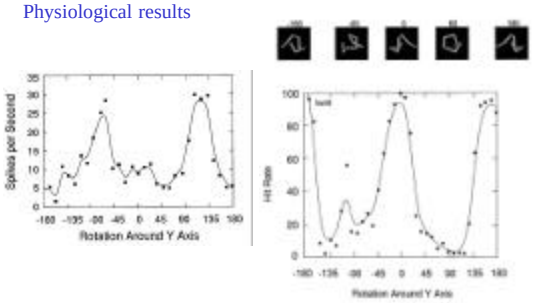
**Viewpoint dependent recognition performance of primates**

Physiological results

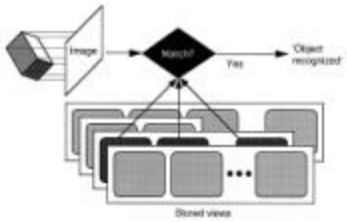


**Viewpoint dependent recognition performance of primates**

Physiological results



View-based recognition scheme




**Open questions:**

1. How much 3D information do the views retain?
2. How is a view represented?
3. How are objects extracted from backgrounds (if at all)?

Summary