

A Model of “Immediate” Visual Recognition in the Brain

➔ Rapid object detection and categorization

HMAX model proposed by Poggio & colleagues

Revisiting the ventral visual pathway

V1 → V2/V4 → IT & face patch network
selectivity vs. invariance

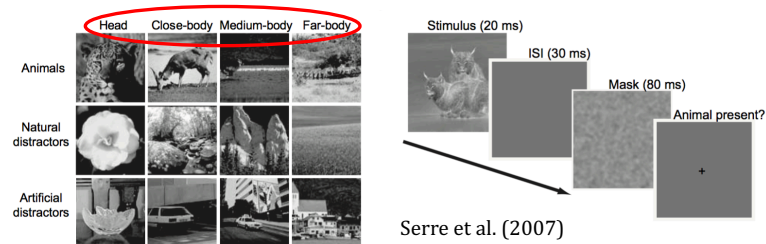
Unsupervised vs. supervised learning
(PCA, neural nets, etc.)

Holistic processing revisited

What good are models for studying the brain?

“Models are kind of cartoons of reality...” (Poggio)

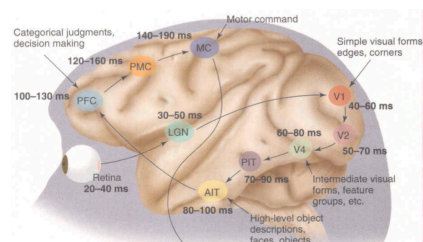
Rapid object detection/categorization

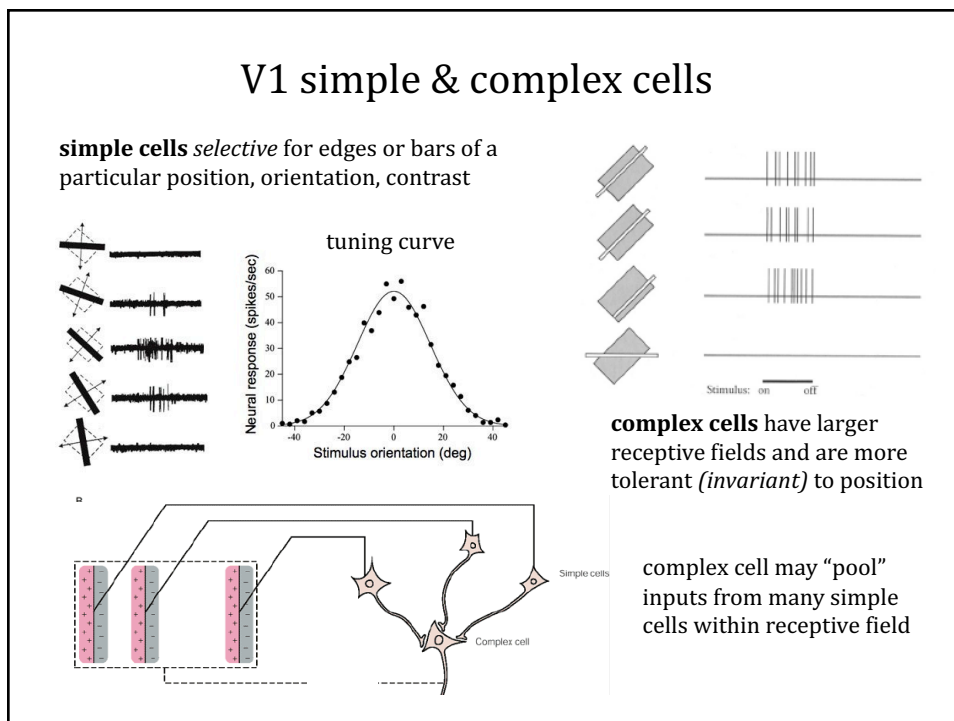
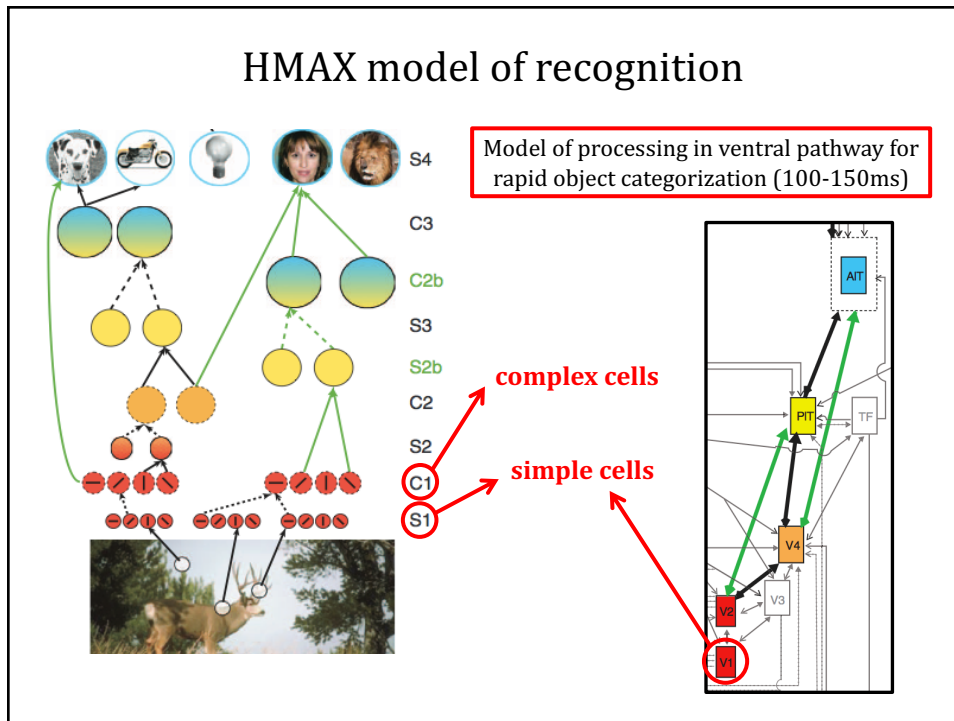


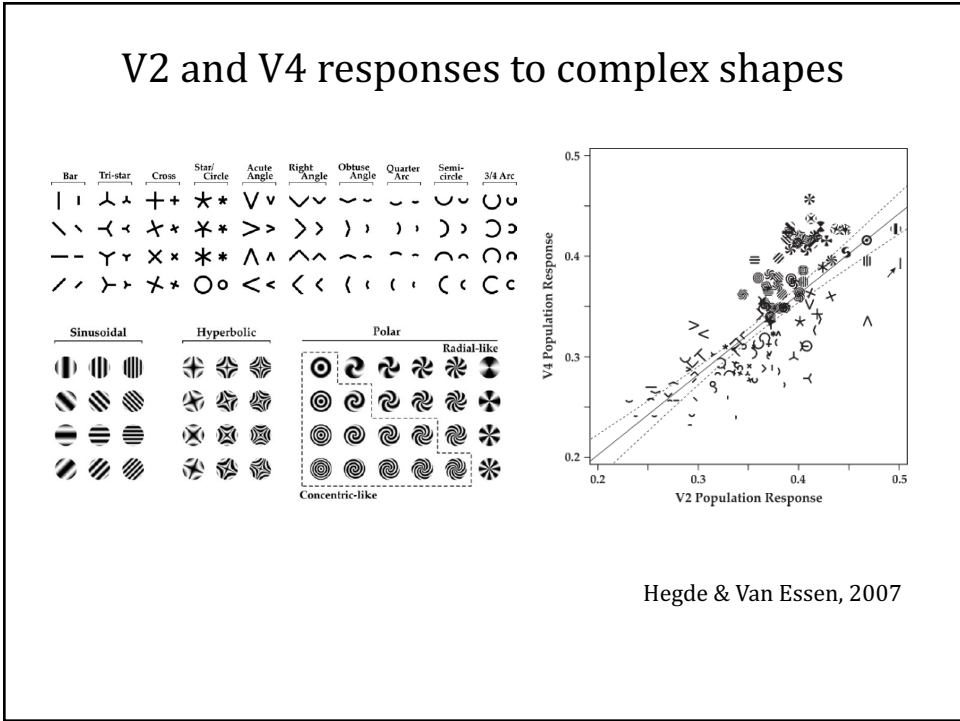
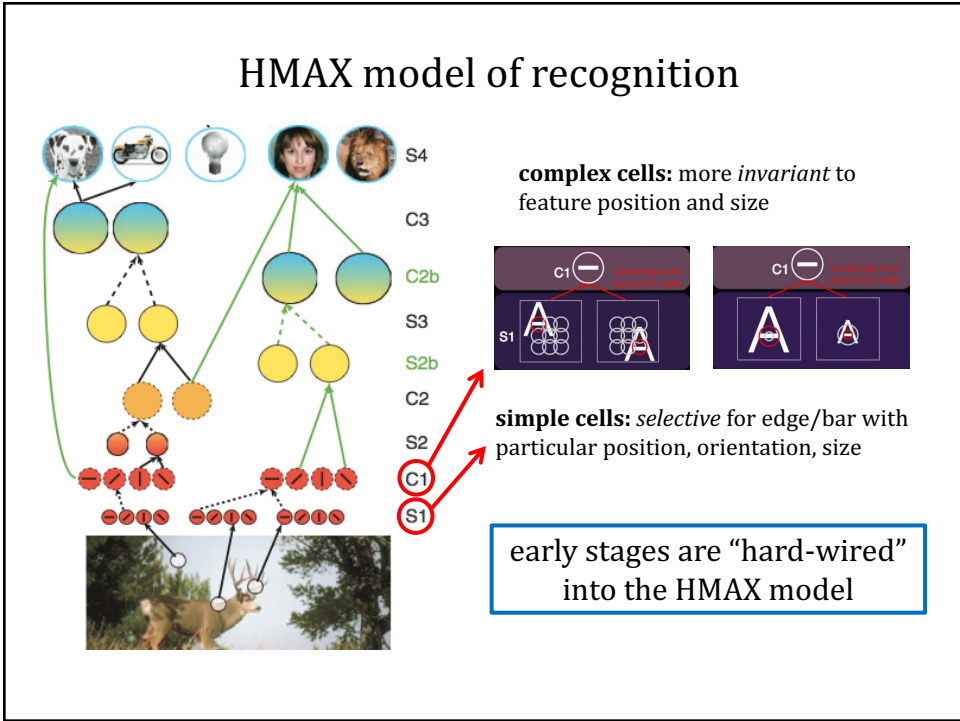
- 1,200 images, half contain animals and half are “distractors”
- respond as quickly as possible: does the image contain an animal or not?
- human subjects were ~80% correct

It takes about 100 ms for visual signals from the eye to reach the first cortical areas engaged in object/face recognition

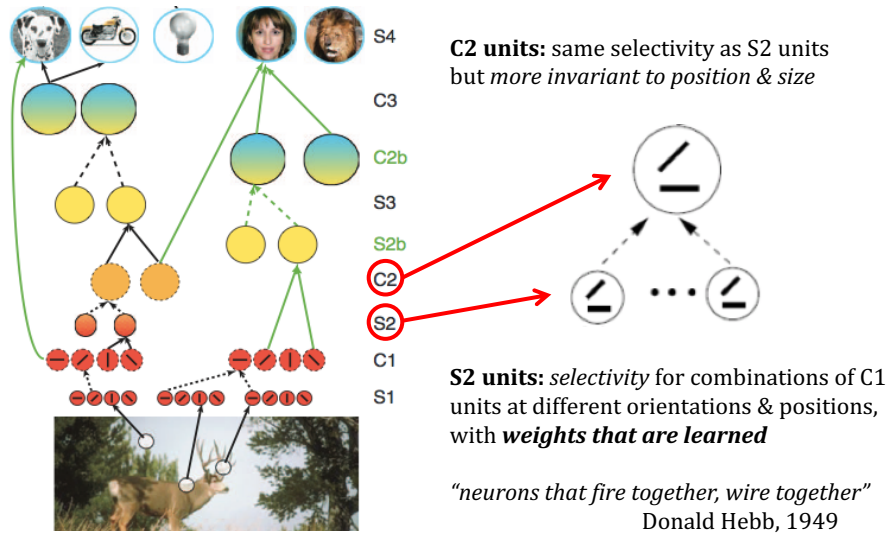
Thorpe & Fabre-Thorpe (2001)



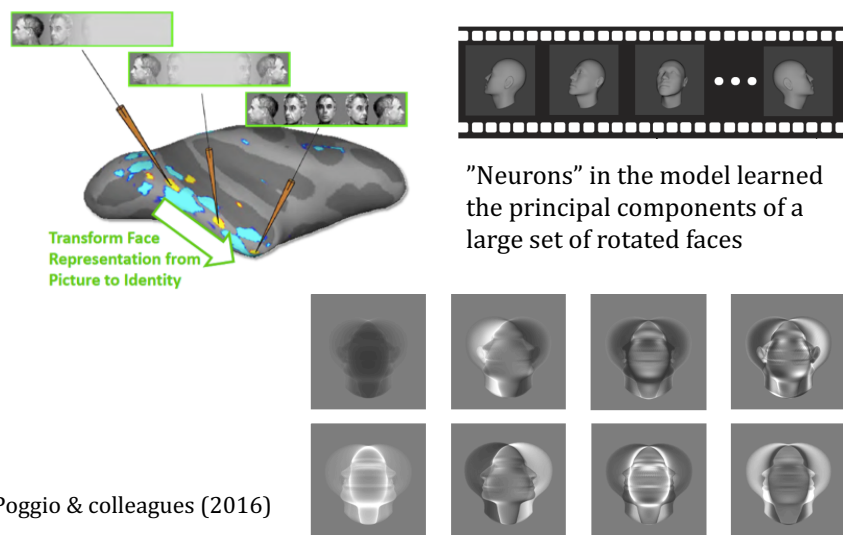




Unsupervised learning of common patterns

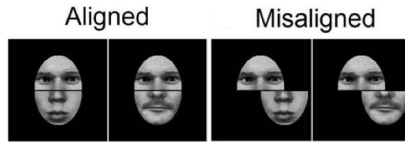


Learning rotation invariance



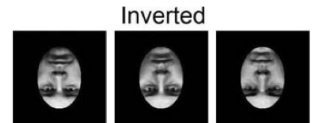
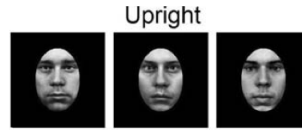
Holistic processing of faces

composite face effect



Identical top halves seen as different when aligned with different bottom halves

face inversion effect



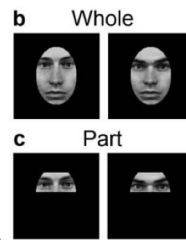
Inversion disrupts recognition of faces more than other objects

whole-part effect

Study

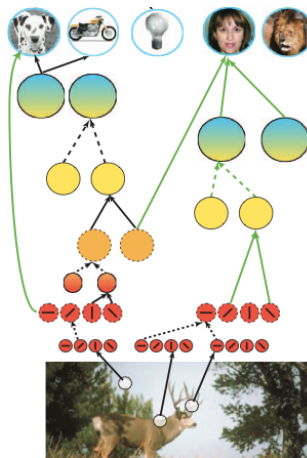


Identification of "studied" face is better in whole vs. part condition

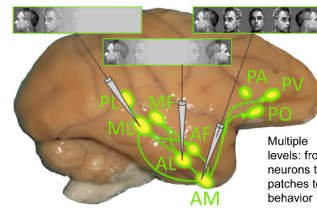


HMAX model mimics these effects when the receptive field of S2 cells spans multiple facial features

HMAX model of recognition



- learning of wiring and weights for top-level object classification by *supervised learning*



Multiple levels: from neurons to patches to behavior

- good match to neural responses, V1 → IT
- good performance on natural images

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