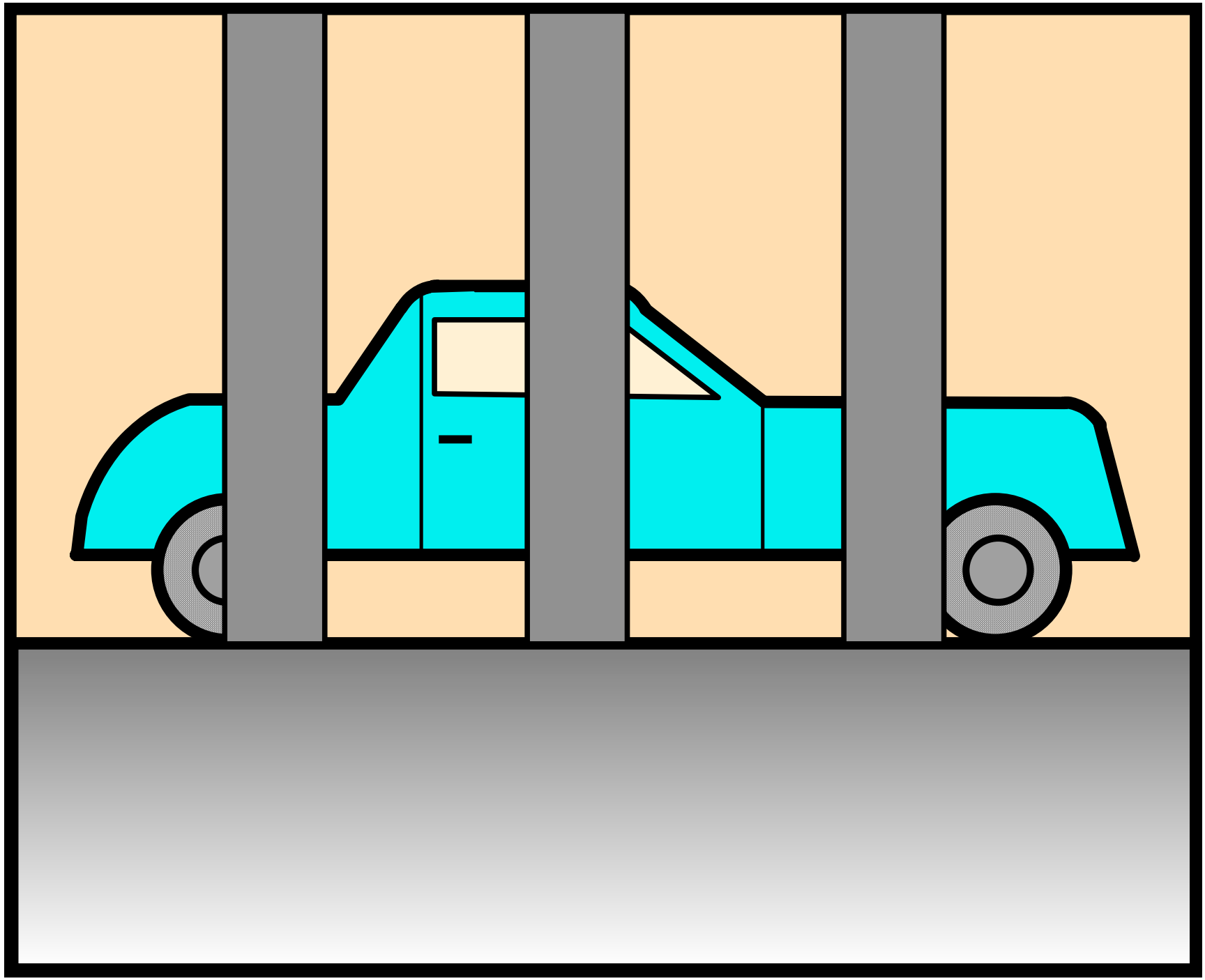
Form perception

Structuralism

Complex mental processes are created by combining fundamental components. Tichener, 19th Century. In other words, perception is an aggregate of simple elements. Eventually more than 40,000 "elementary sensations" were listed.



Gestalt ideas of form perception

Founder of Gestalt Psychology is Max Wertheimer

Wikipedia

Gestalt principles of organization (how figural properties determine perceived patterns):

grouping due to proximity

grouping due to similarity

grouping due to common motion

closure

figure-ground perception

A central tenet: The whole is different from the sum of its parts

Grouping by proximity

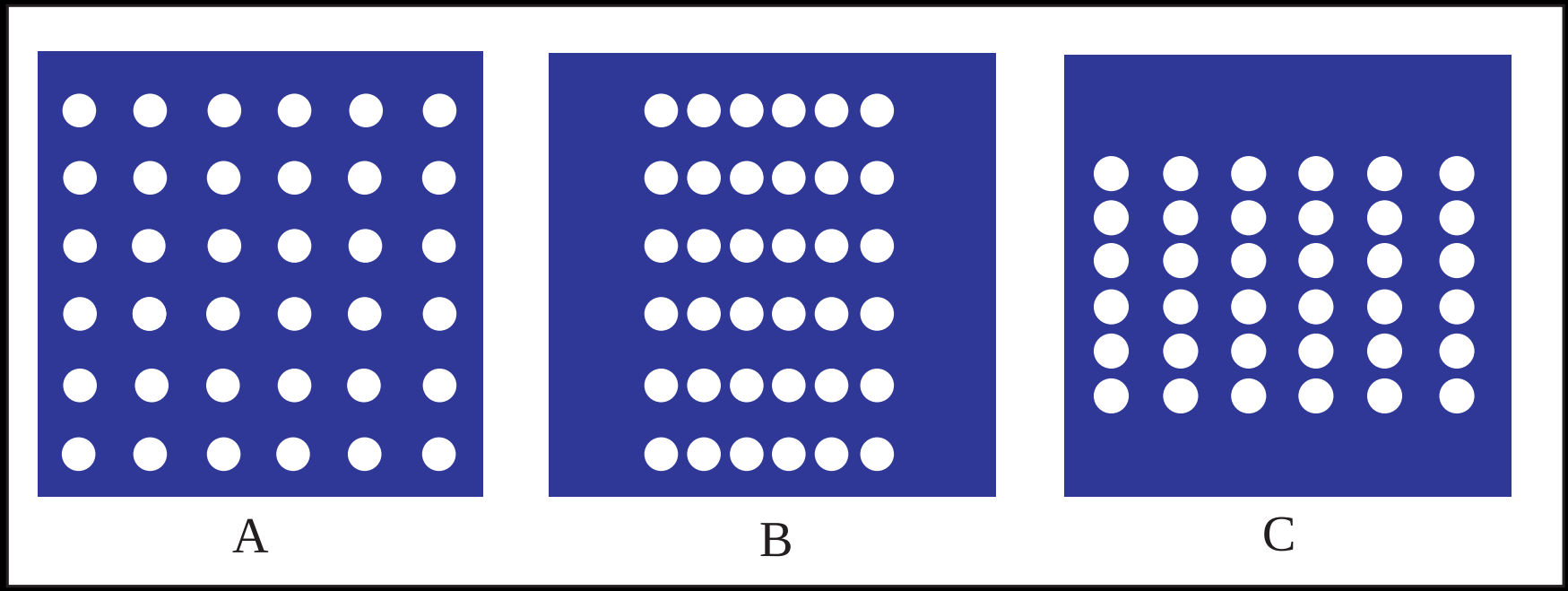


Image by MIT OpenCourseWare.

Grouping by shape

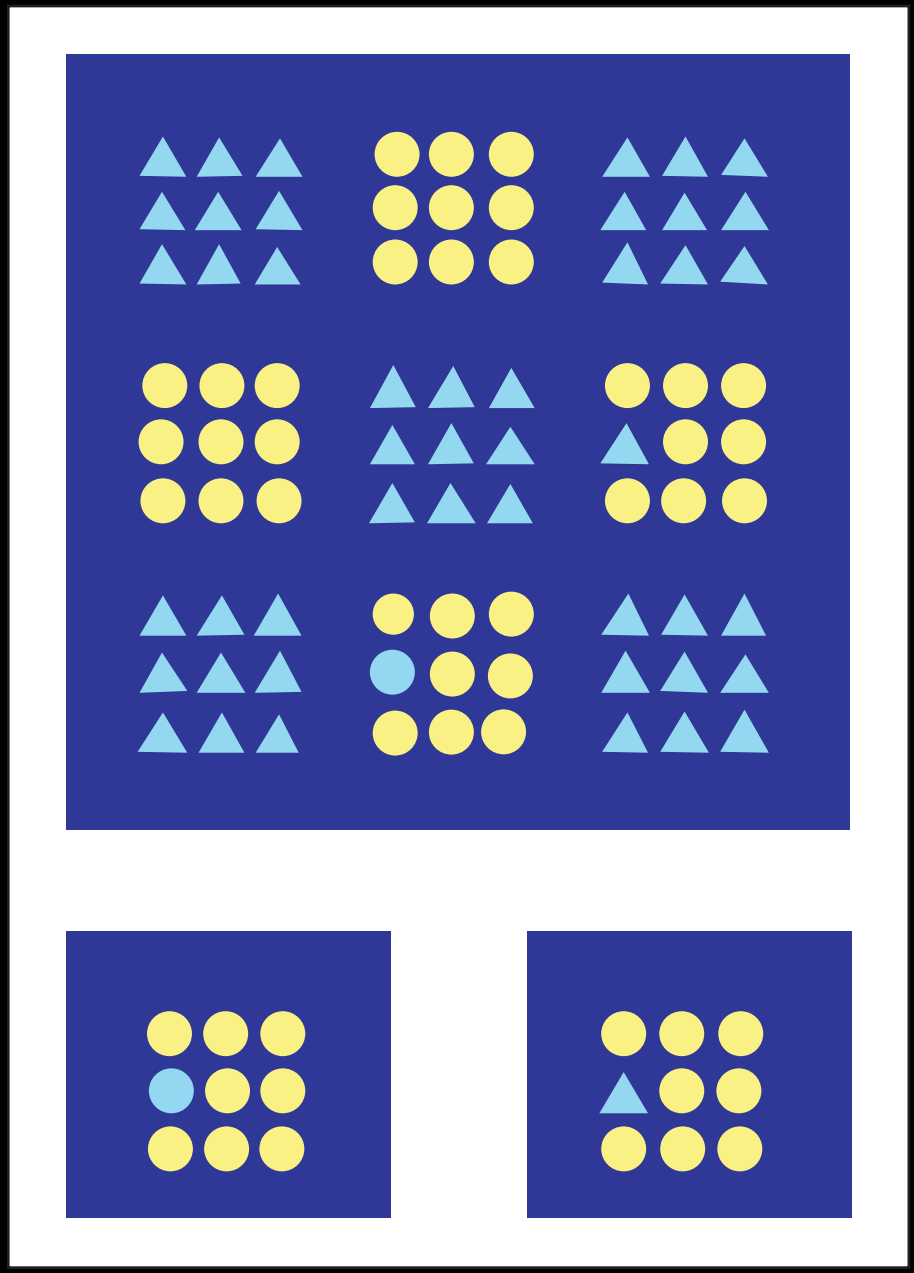


Image by MIT OpenCourseWare.

Three general theories of form perception:

1. Form perception is accomplished by neurons that respond selectively to line segmens of different orientation.

2. Form perception is accomplished by spatial mapping of the visual scene onto visual cortex.

3. Form perception is accomplished by virtue of Fourier analysis.

1. Orientation of line segments and spatial frequency

Form perception with little information about orientation of line segments

Image removed due to copyright restrictions.

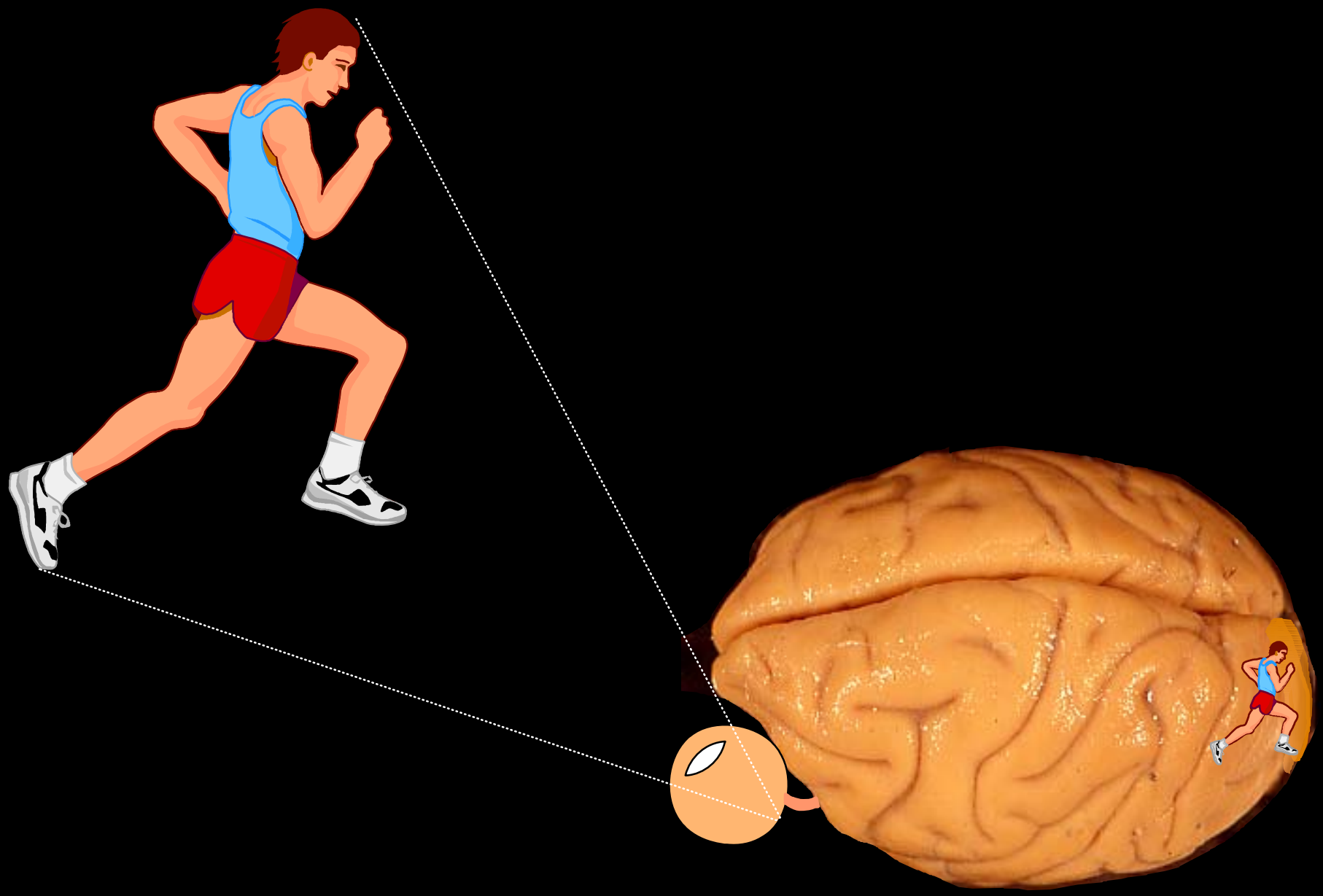
Proof that low spatial-frequency information is used for face recognition

Image removed due to copyright restrictions.

Image removed due to copyright restrictions.

Image removed due to copyright restrictions.

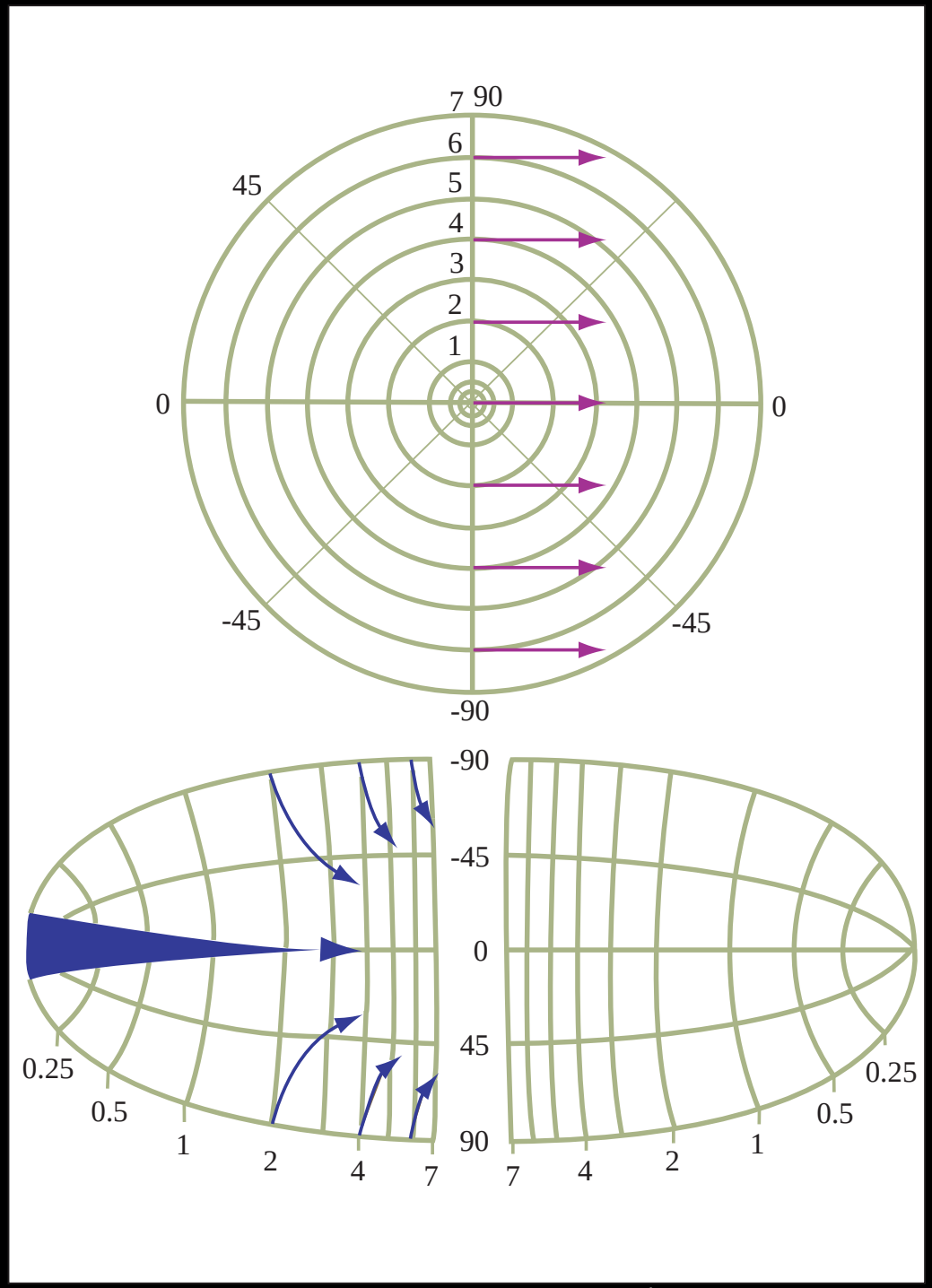
2. Topographic mapping



extreme isomorphism

Cortical layout of neurons activated by arrows

visual field



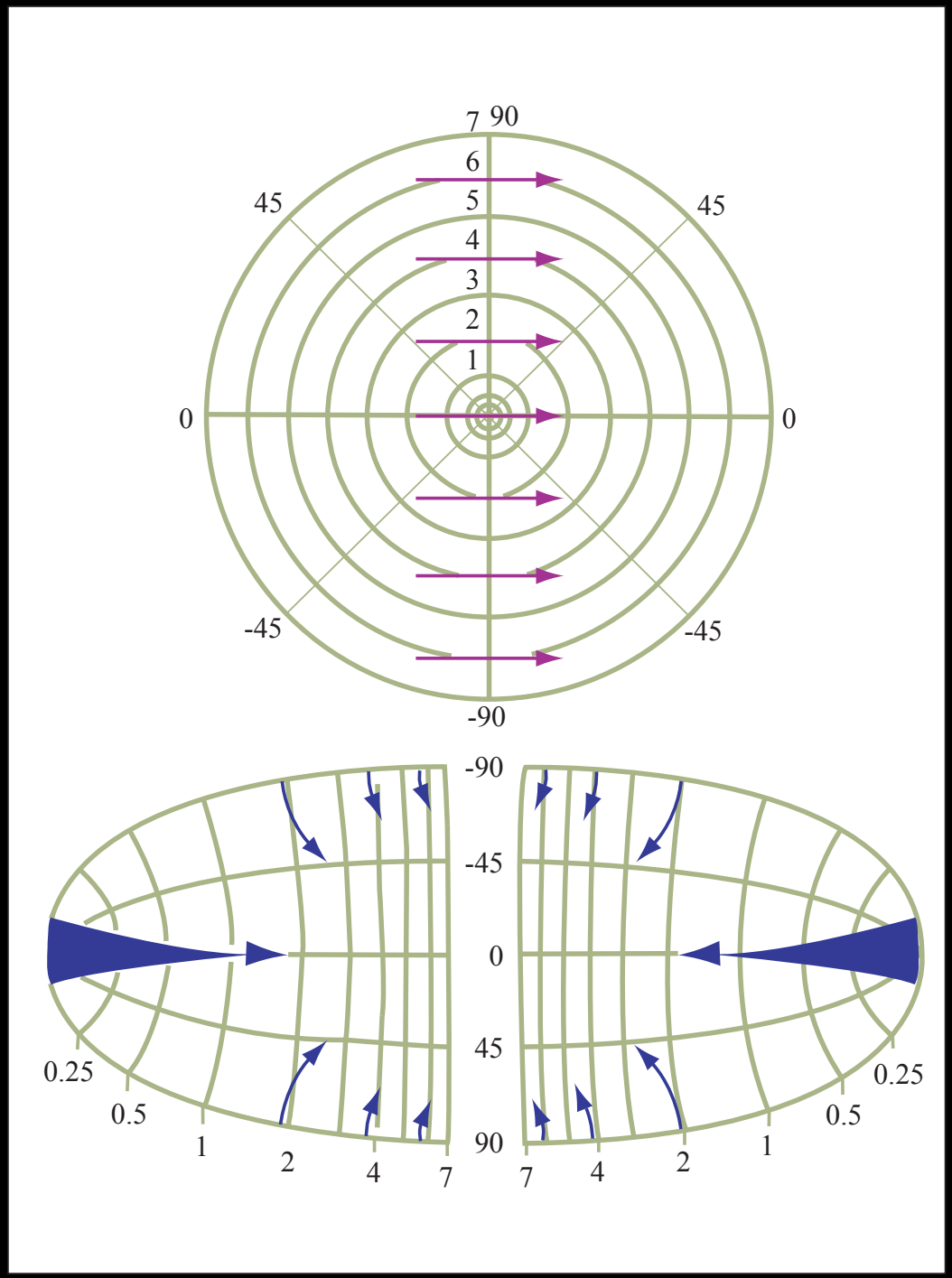
all arrows in contralateral hemifield

monkey area V1

Image by MIT OpenCourseWare.

Cortical layout of neurons activated by arrows

visual field



monkey area V1

arrows across midline

Image by MIT OpenCourseWare.

Cortical layout of neurons activated by a circle

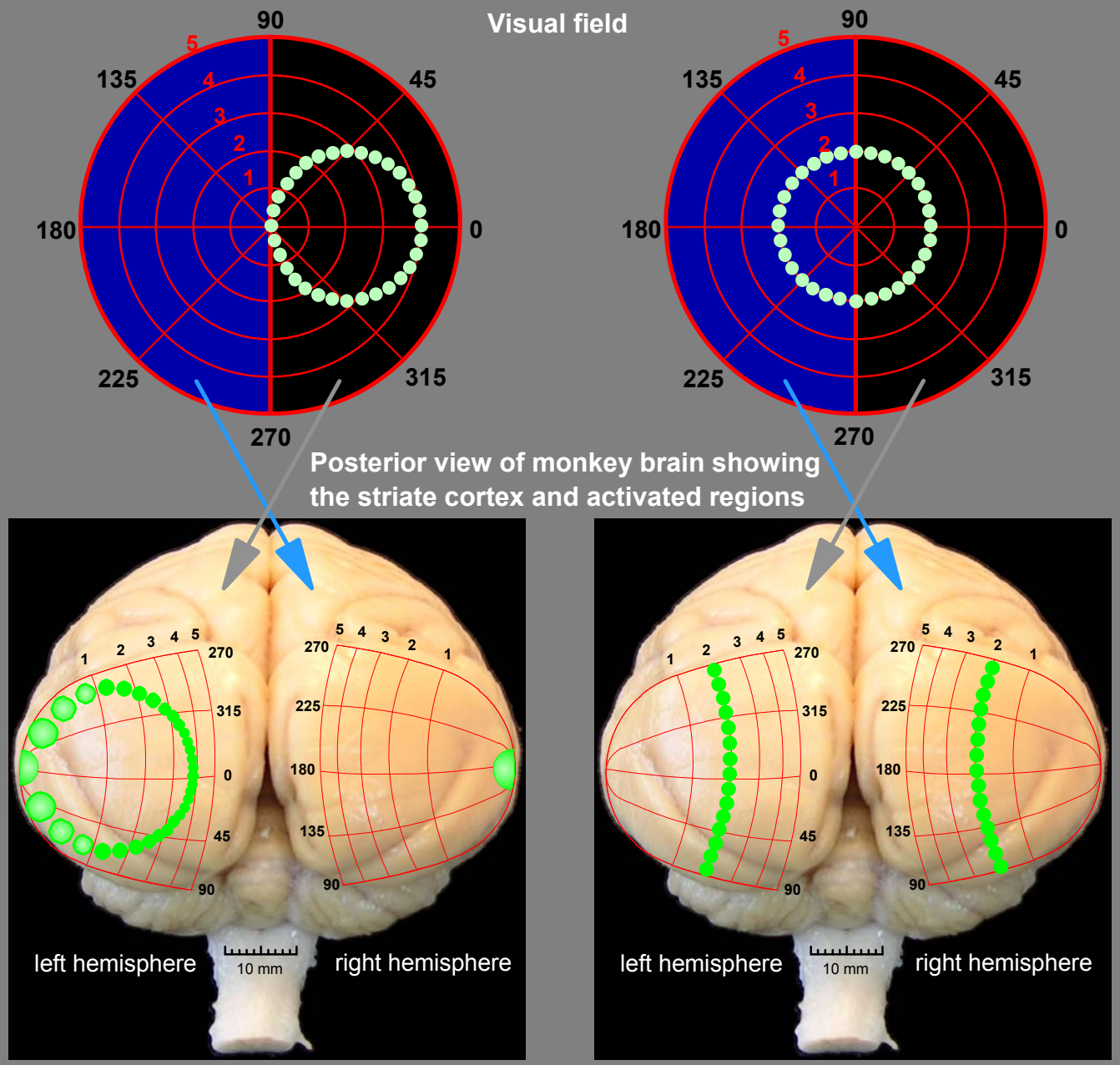


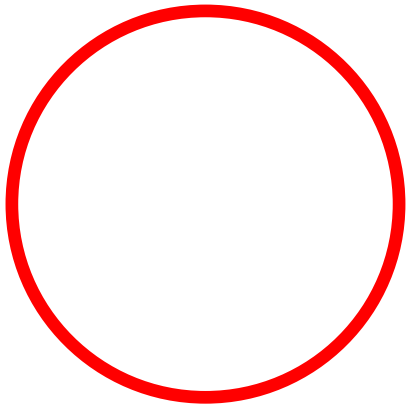
Figure 5B, C. Schiller, Peter H., and Edward J. Tehovnik. "Visual Prosthesis." *Perception* 37, no. 10 (2008): 1529. Courtesy of Pion Ltd. Used with permission.

The Giotto Story:

When Pope Benedict, the 12th, in 13th Century set out to have the walls of the great cathedral of St. Peter redecorated, he sent messengers all over Italy to find out who were the best painters. Specimen were gladly given. When a messenger came to Ambrogio Bondone **Giotto** (1267-1337), he did not provide a sample painting. Instead, he took a sheet of paper and a pencil dipped in red color, and drew a perfect circle. "Here is your drawing," he said. The Pope, upon examining all the productions submitted, chose Giotto without hesitation.

To this day in Tuscany there is the saying:

The round O of Giotto



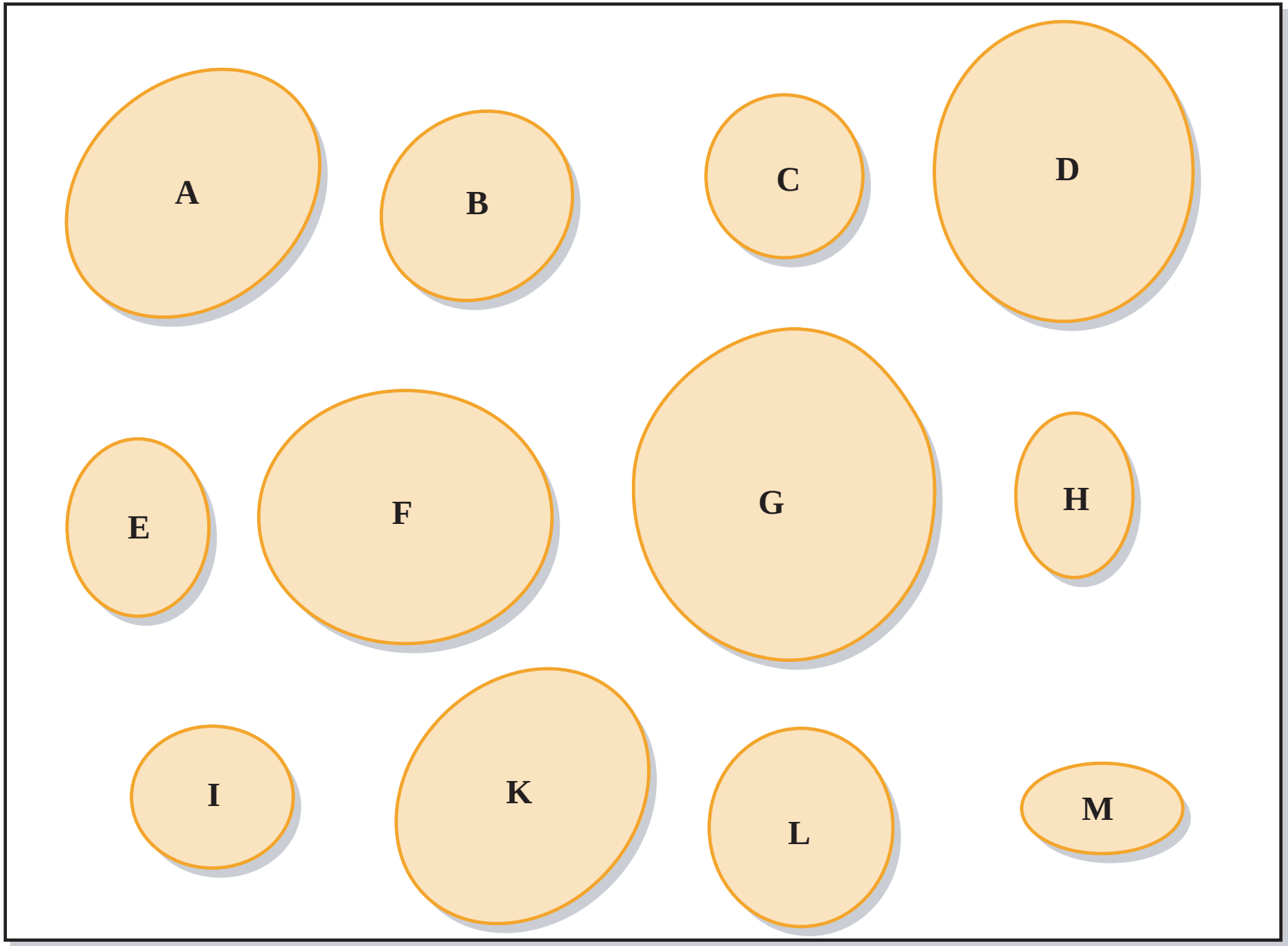


Image by MIT OpenCourseWare.

3. Spatial frequency analysis

Fergus Campbell and John Robson

deLange functions

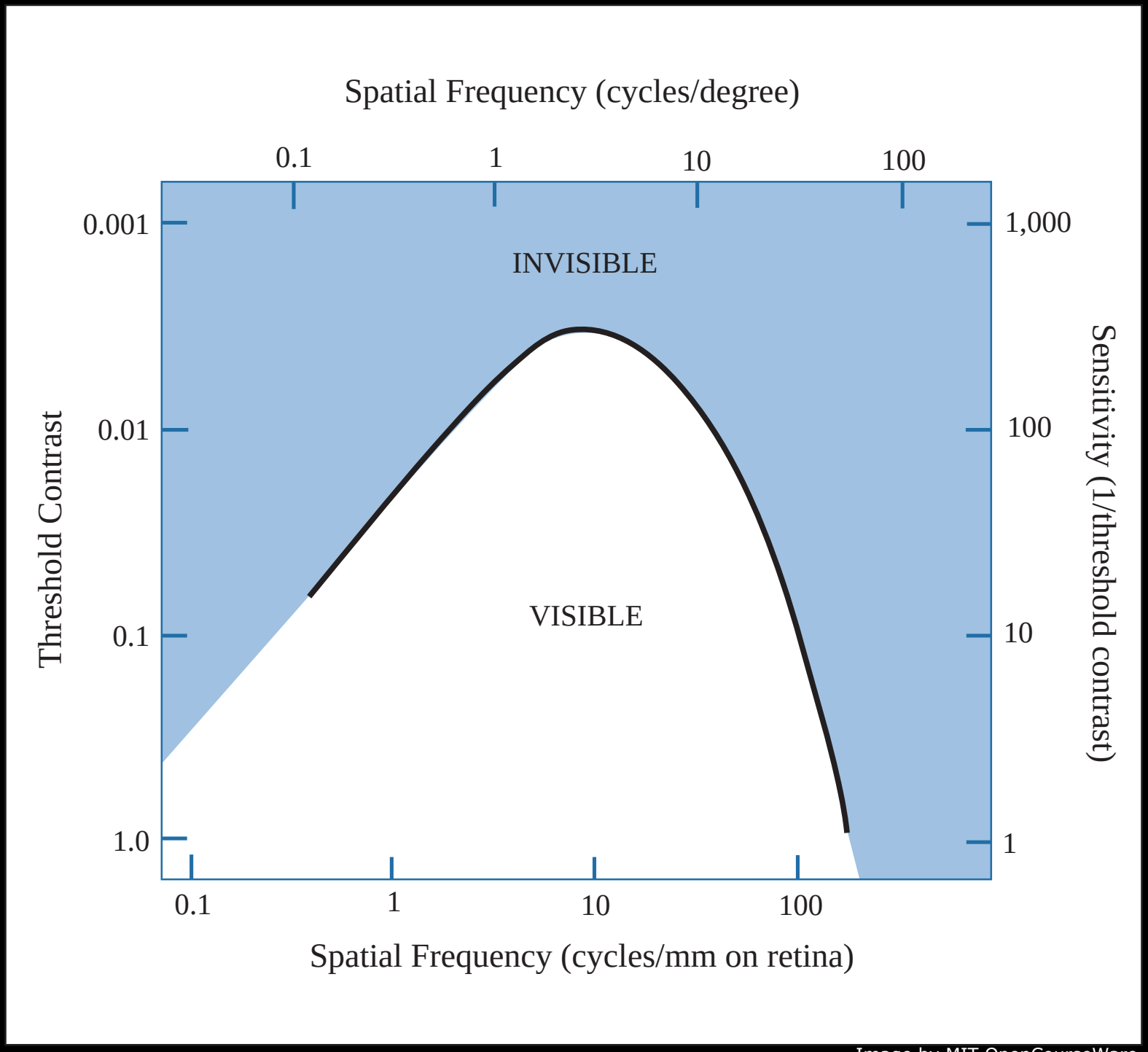
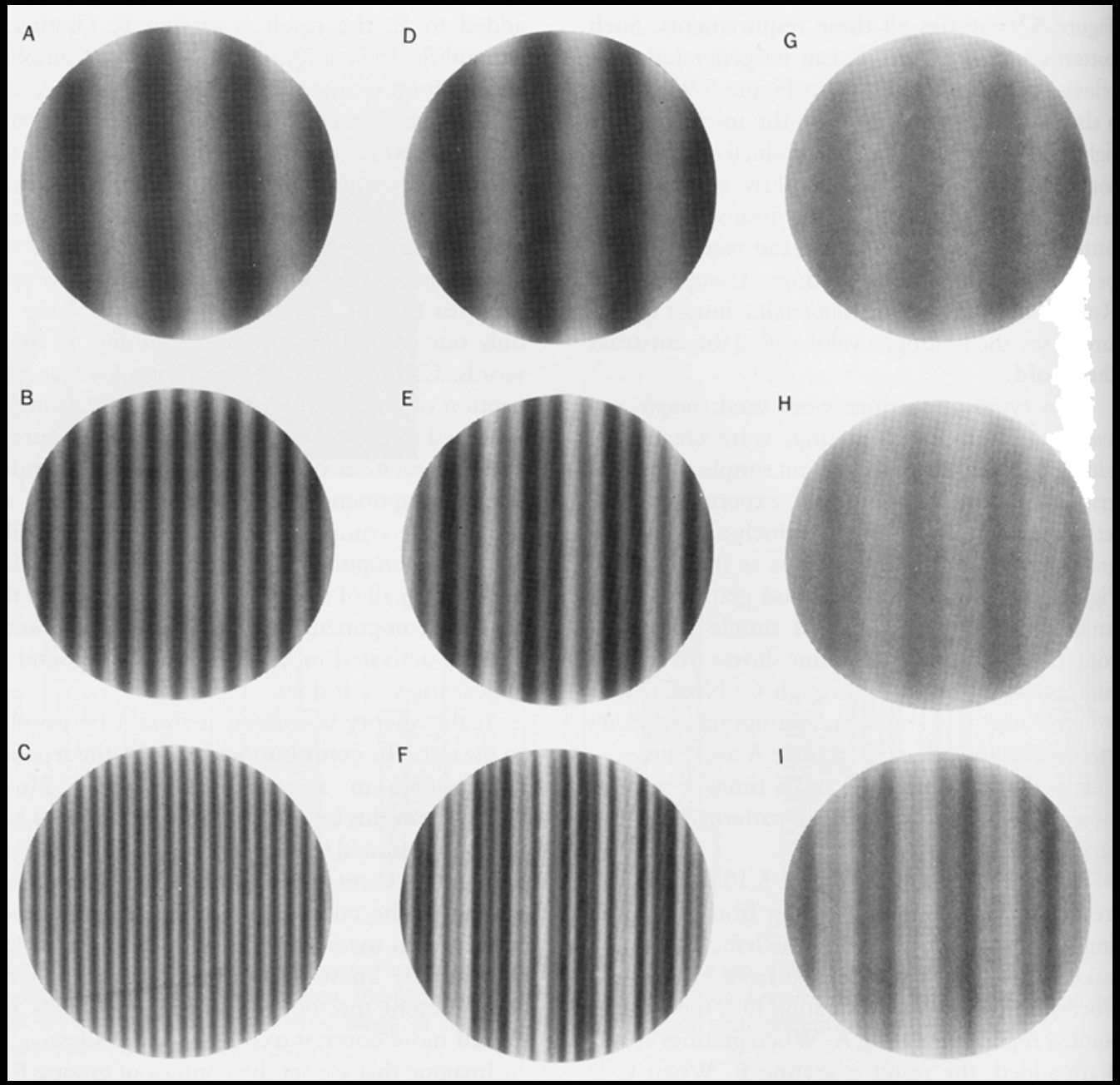


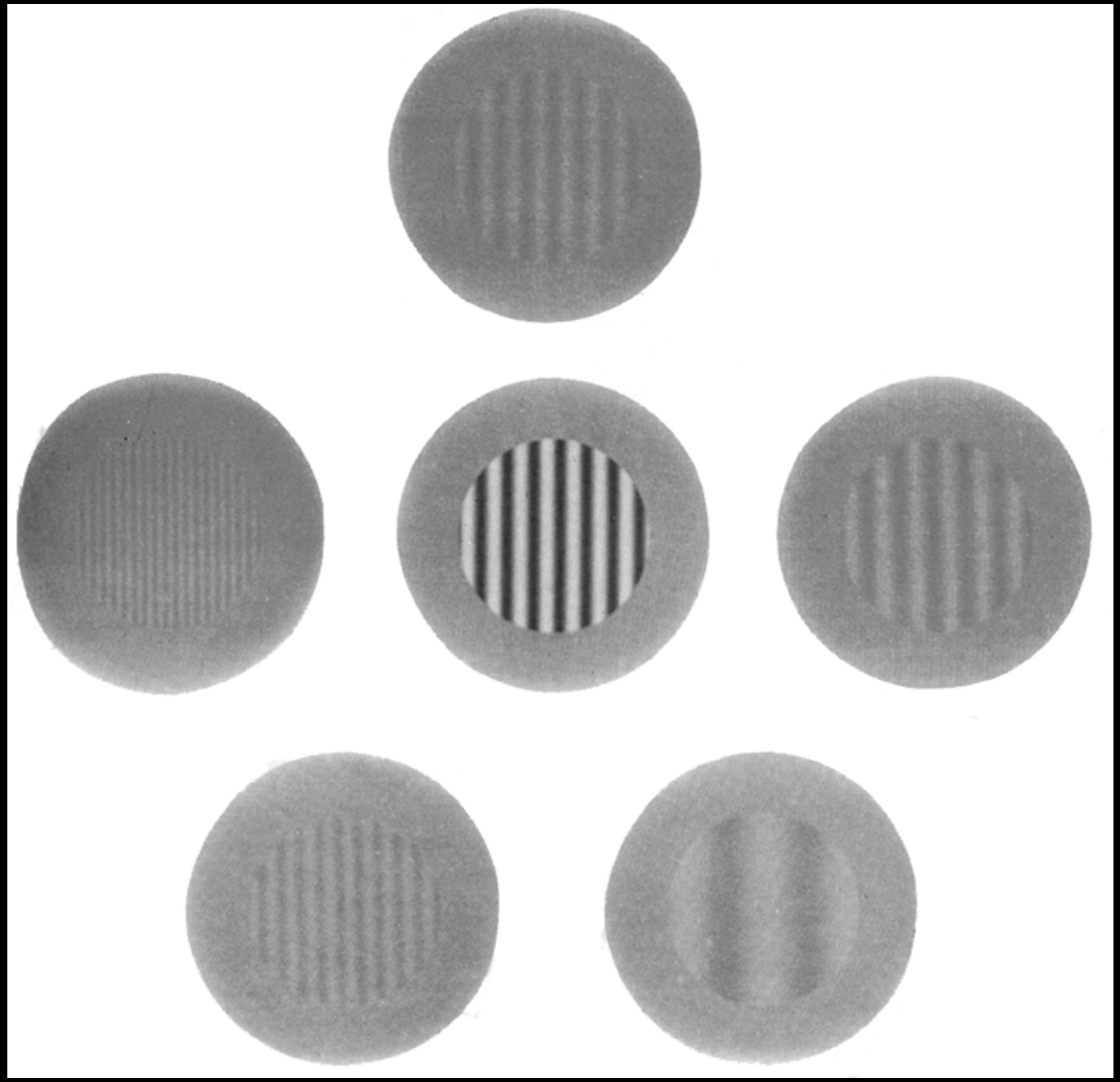
Image by MIT OpenCourseWare.

Generating compound gratings from a set of simple ones

simple gratings | compound graings | compound graings at low contrast



Frequency-specific adaptation



Frequency-specific adaptation

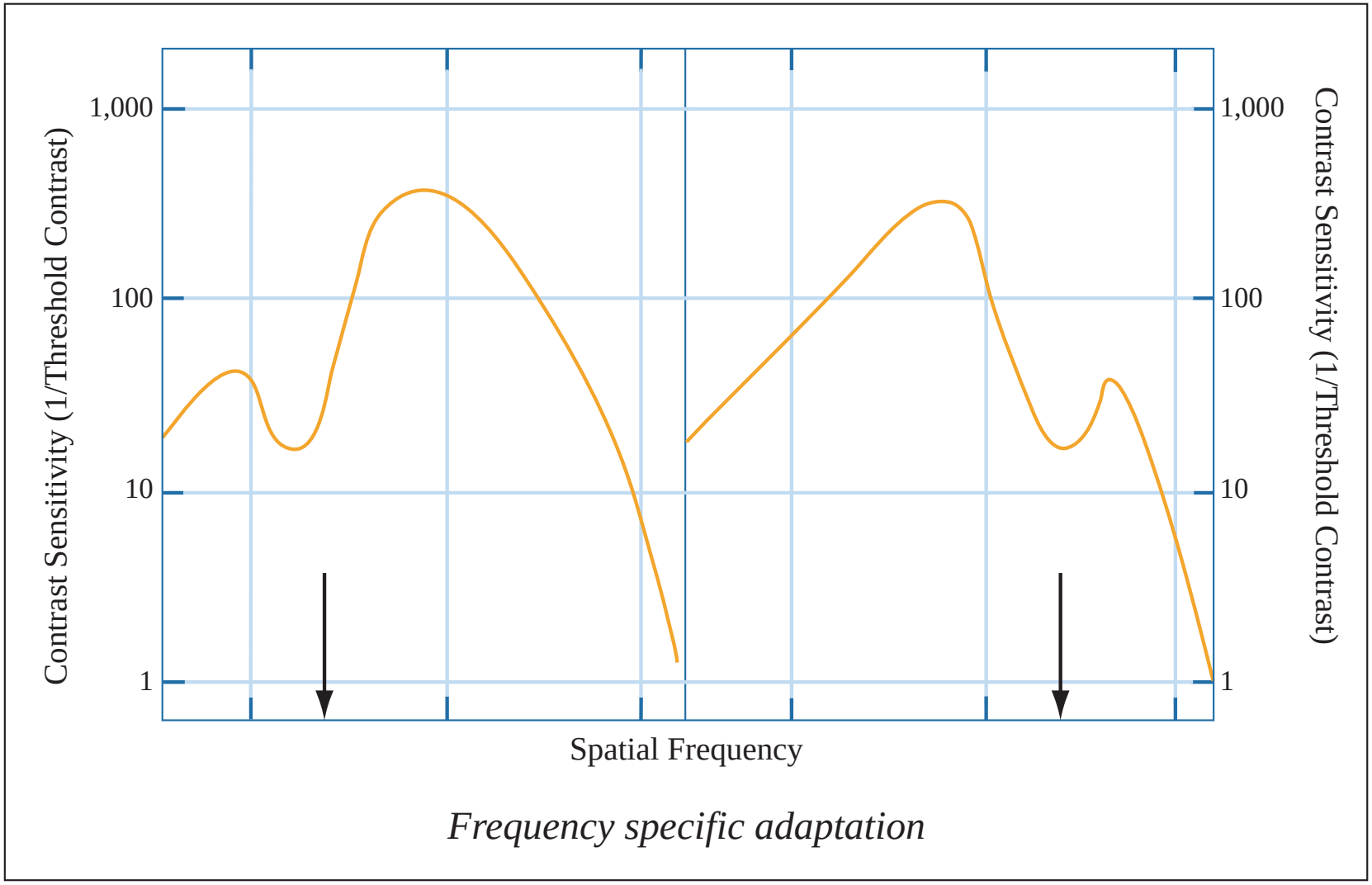
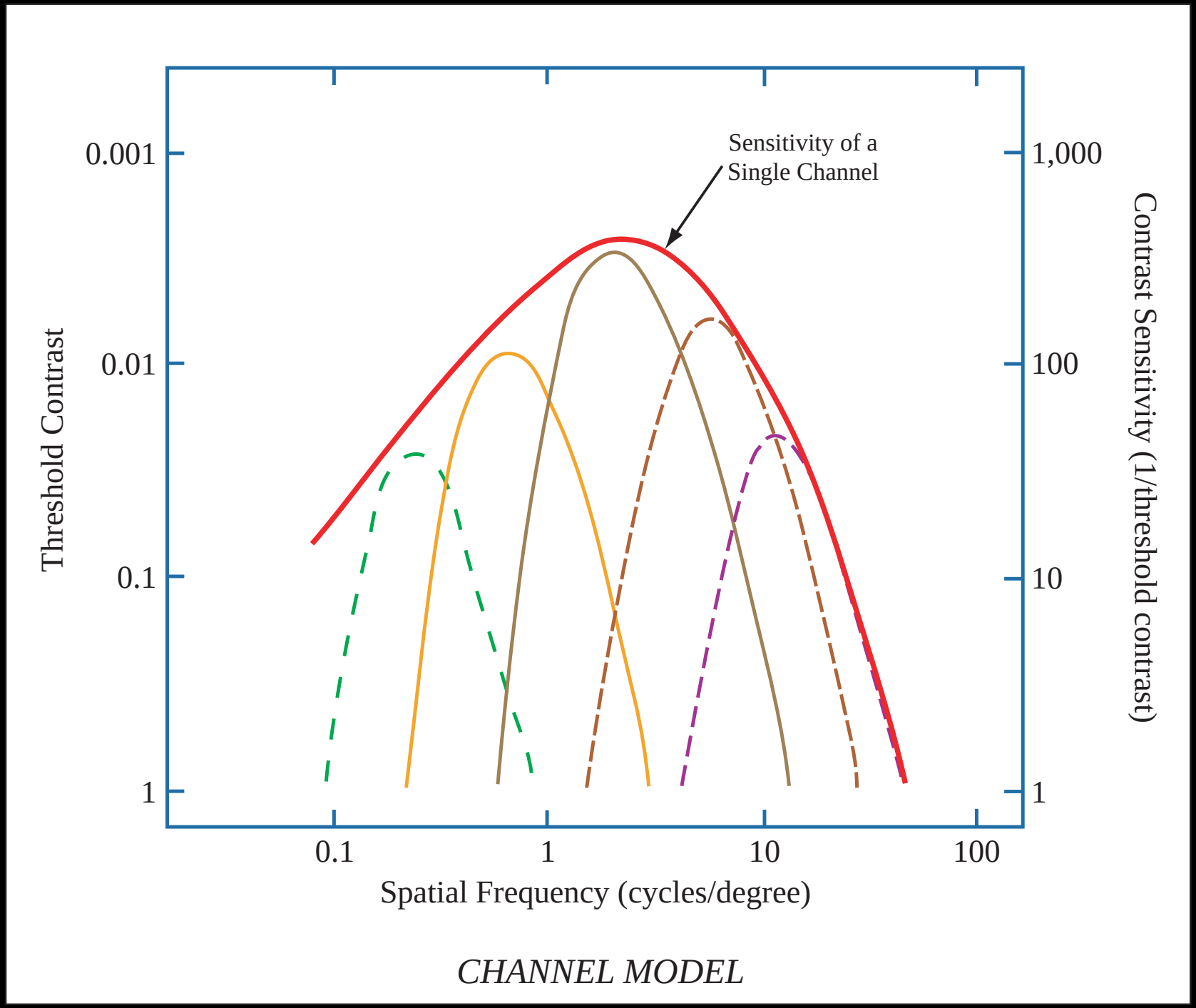


Image by MIT OpenCourseWare.

Channel model



Four essential properties of spatial frequency analysis:

spatial frequency

contrast

orientation

phase

When information about these four properties is available,
one can reconstruct any visual pattern

Shape-selective responses in inferotemporal cortex

IT neuron response to various shapes

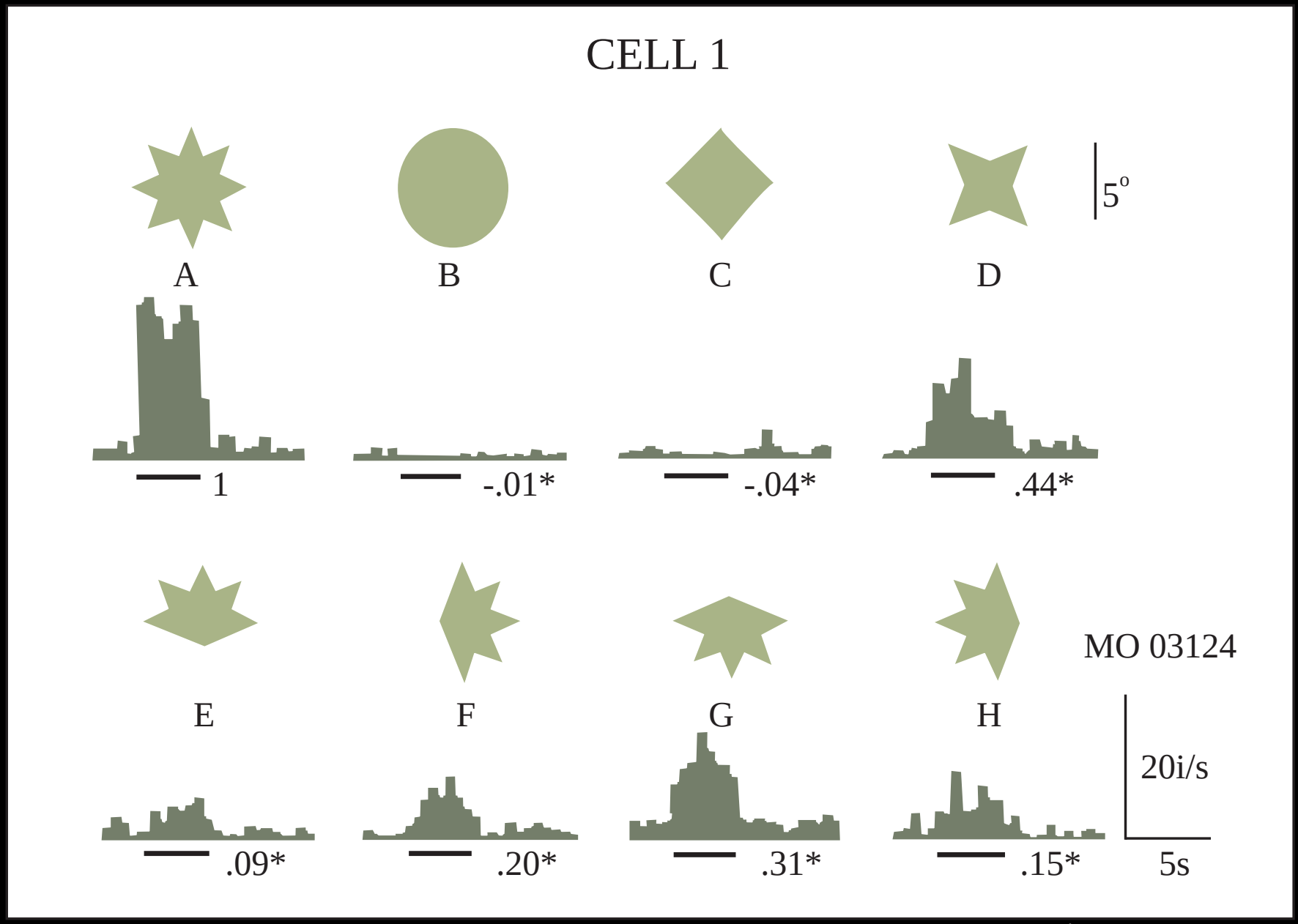


Image by MIT OpenCourseWare.

IT neuron response to various shapes

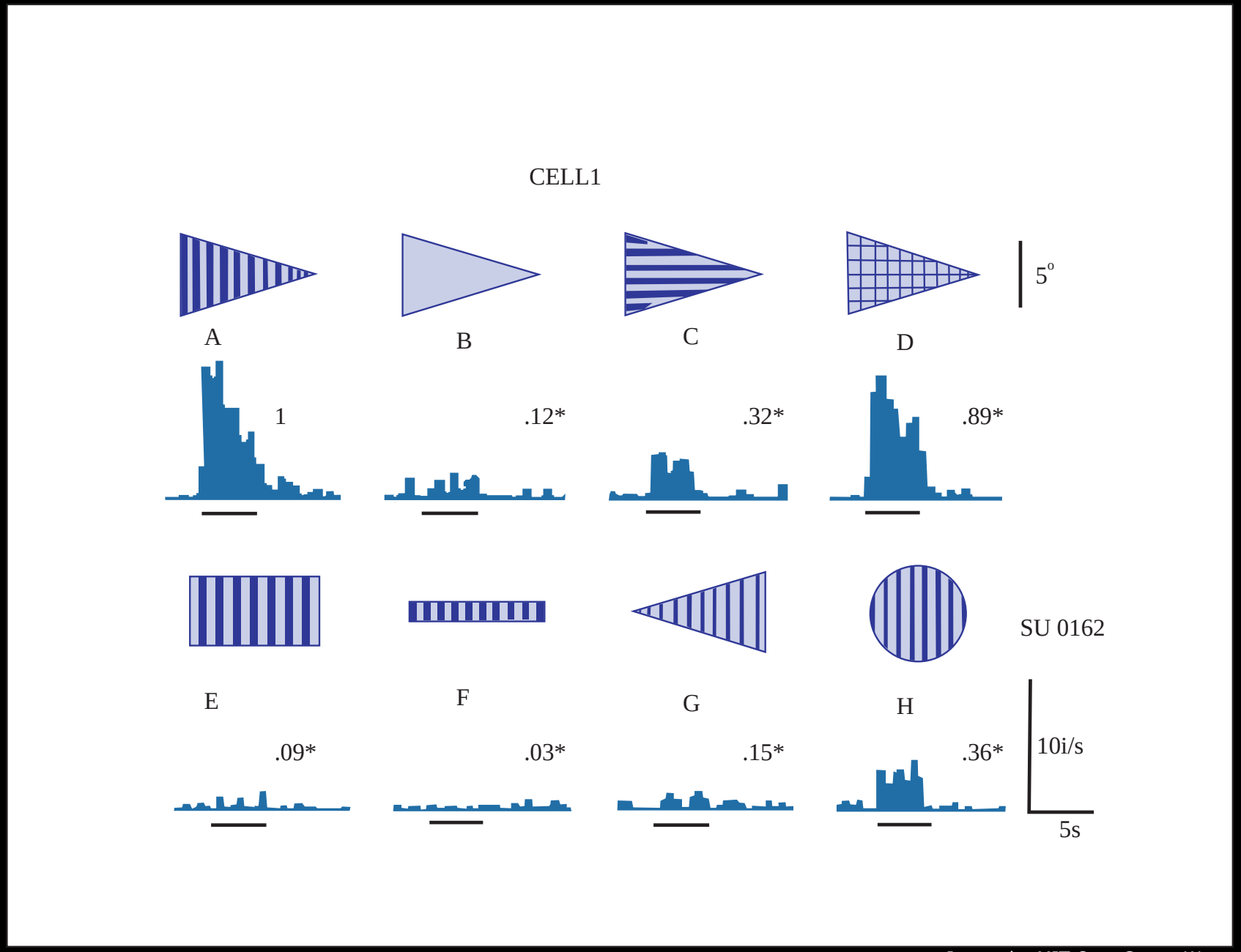
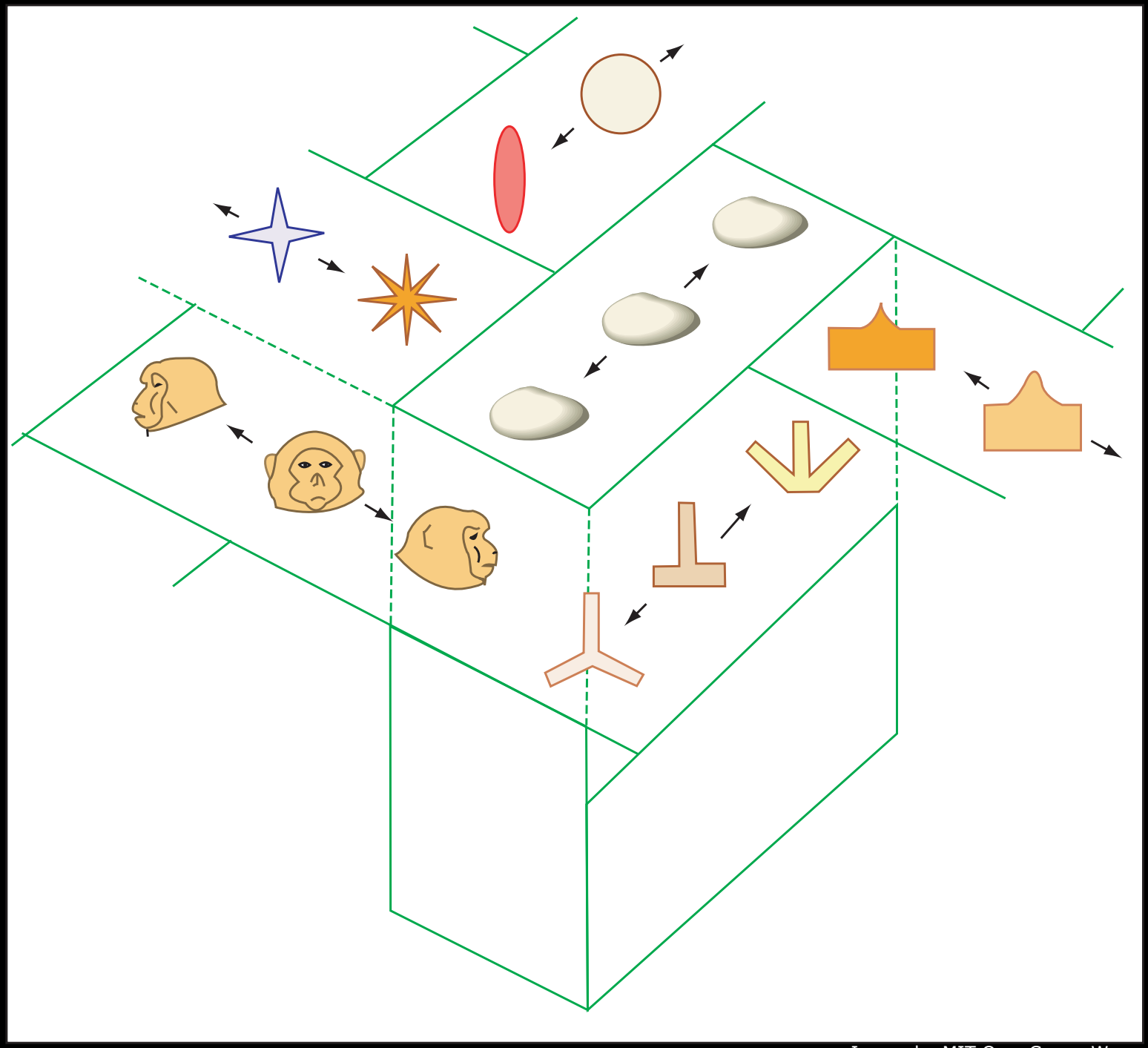


Image by MIT OpenCourseWare.



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Intermediate level vision

Basic visual capacities

color

brightness

pattern

texture

motion

depth

Intermediate visual capacities

constancy

selection

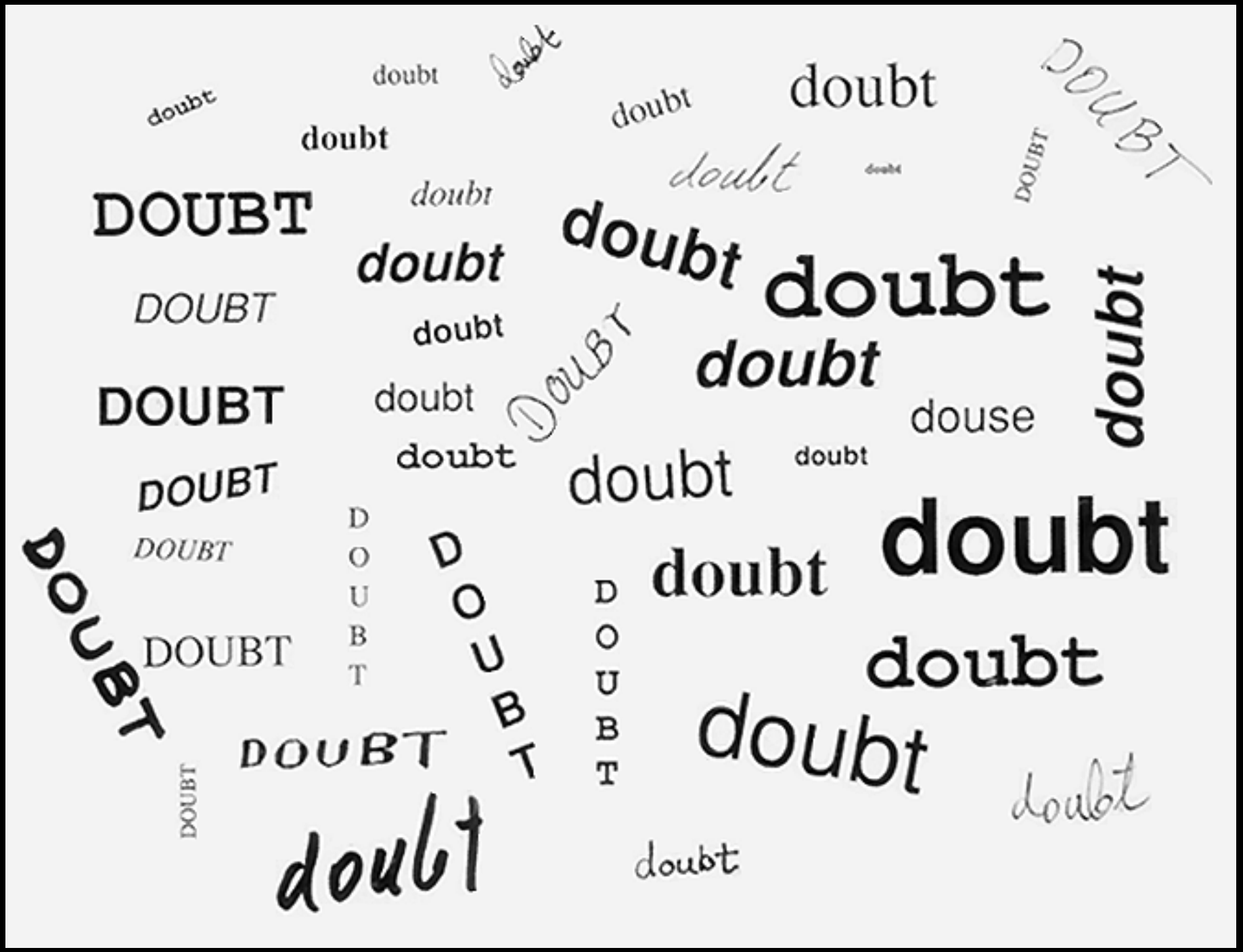
recognition

transposition and invariance

comparison

location

Transposition and invariance



Hirschfeld

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Image removed due to copyright restrictions.

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Voltaire, 18th French Enlightment writer of more than 2,000 books and pamphlets

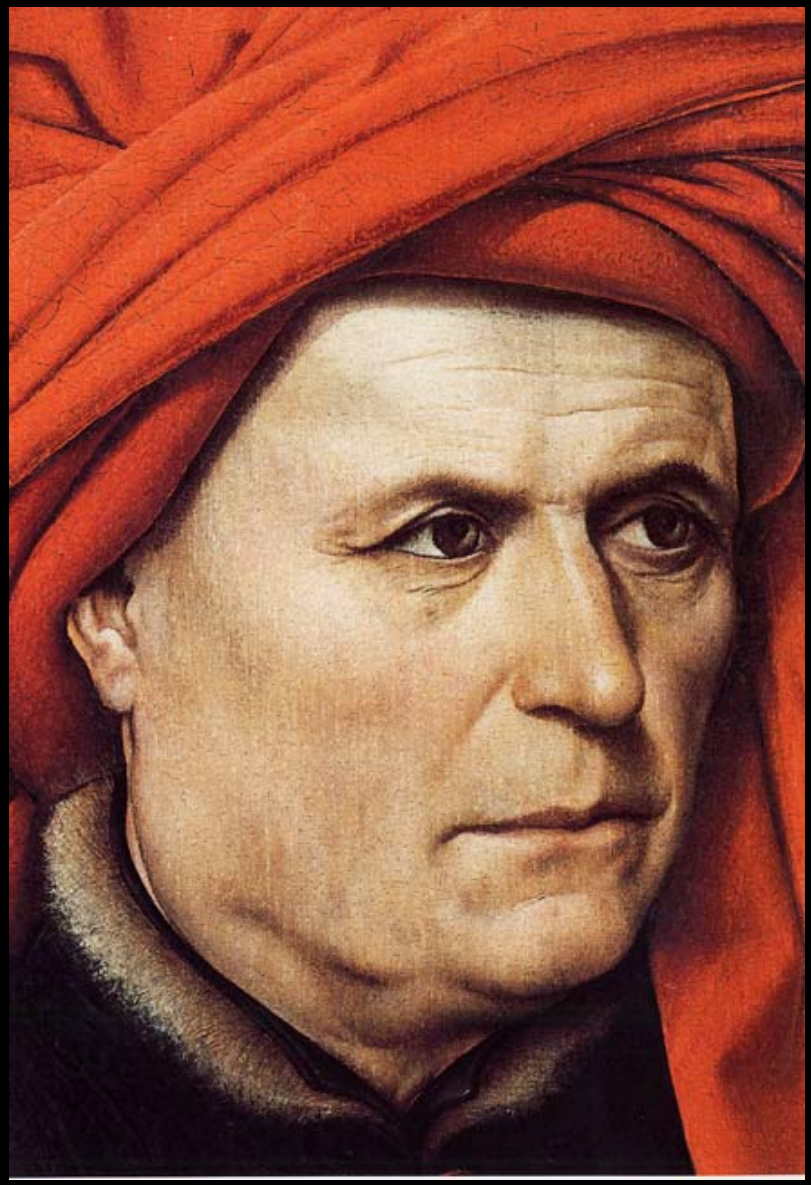
The Art World

Secret Knowledge

by

David Hockney

Masolino da Panicale, 1425



Robert Campin, 1430

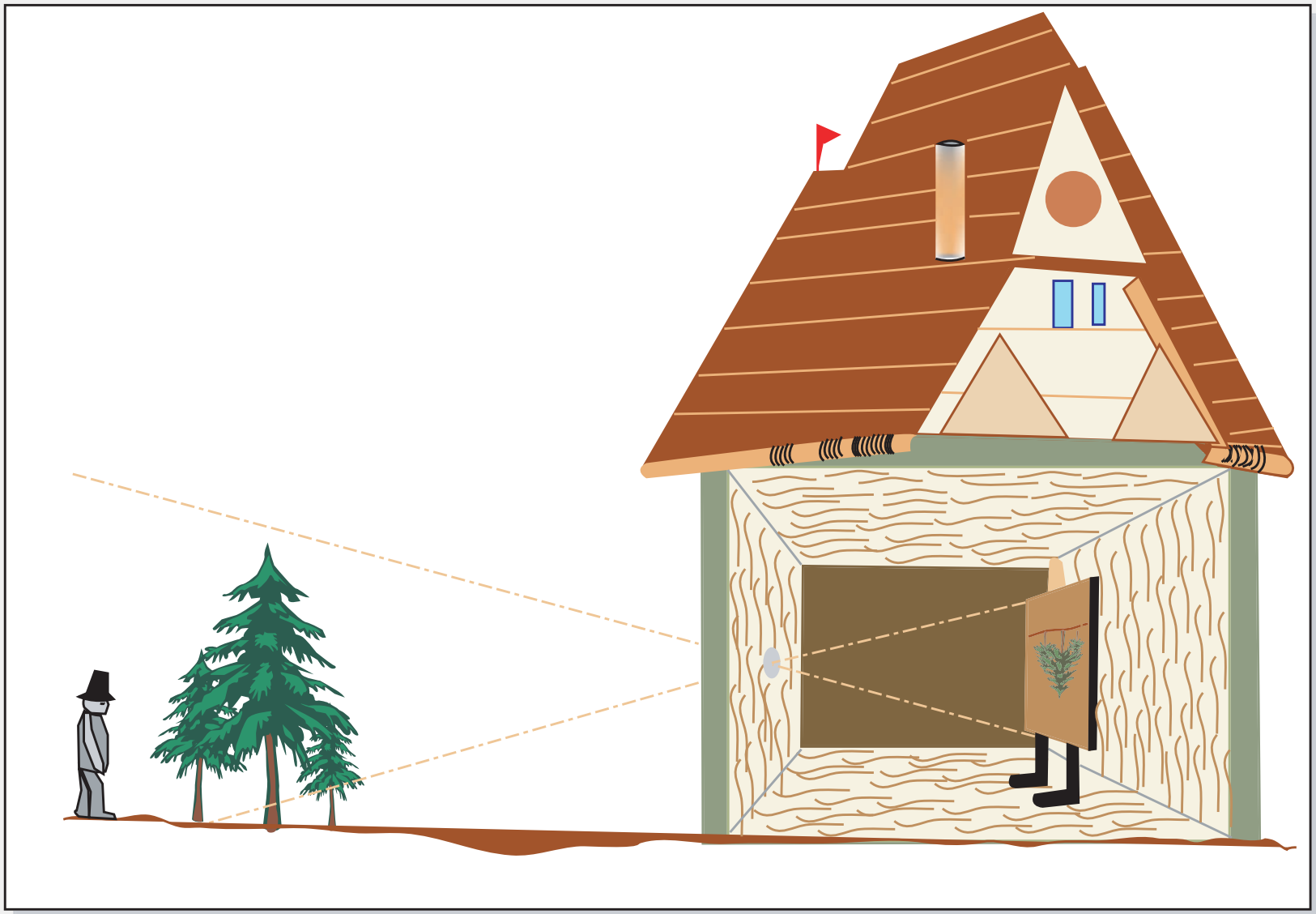


Image by MIT OpenCourseWare.

Camera obscura

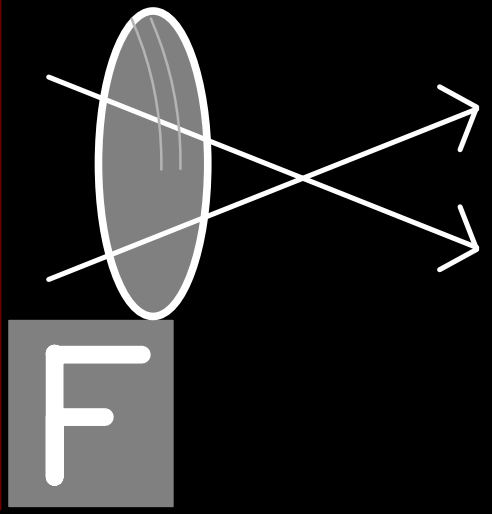
Jan van Eyck
1436

Painting is in public domain.

Bacchus, c1597
by Caravaggio

Camera obscura???
David Hockney

original image



camera obscura image

rotated camera obscura image

Painting is in public domain.

The marriage of Giovanni Arnolfini
with Giovanna Cenami
Jan van Eyck, 1434

C4amera obscura??? David Hockney

The recognition of faces

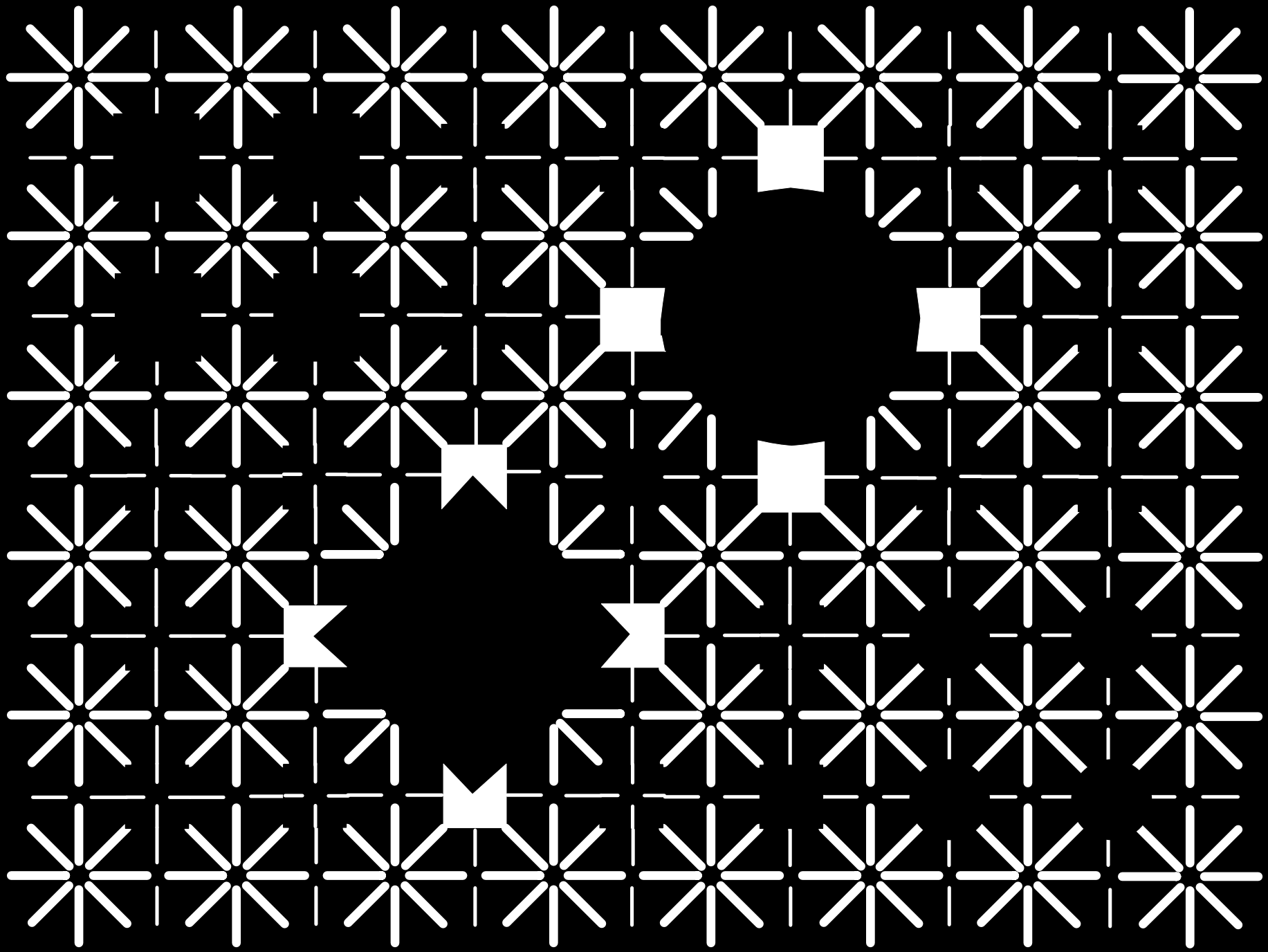
The recognition of faces

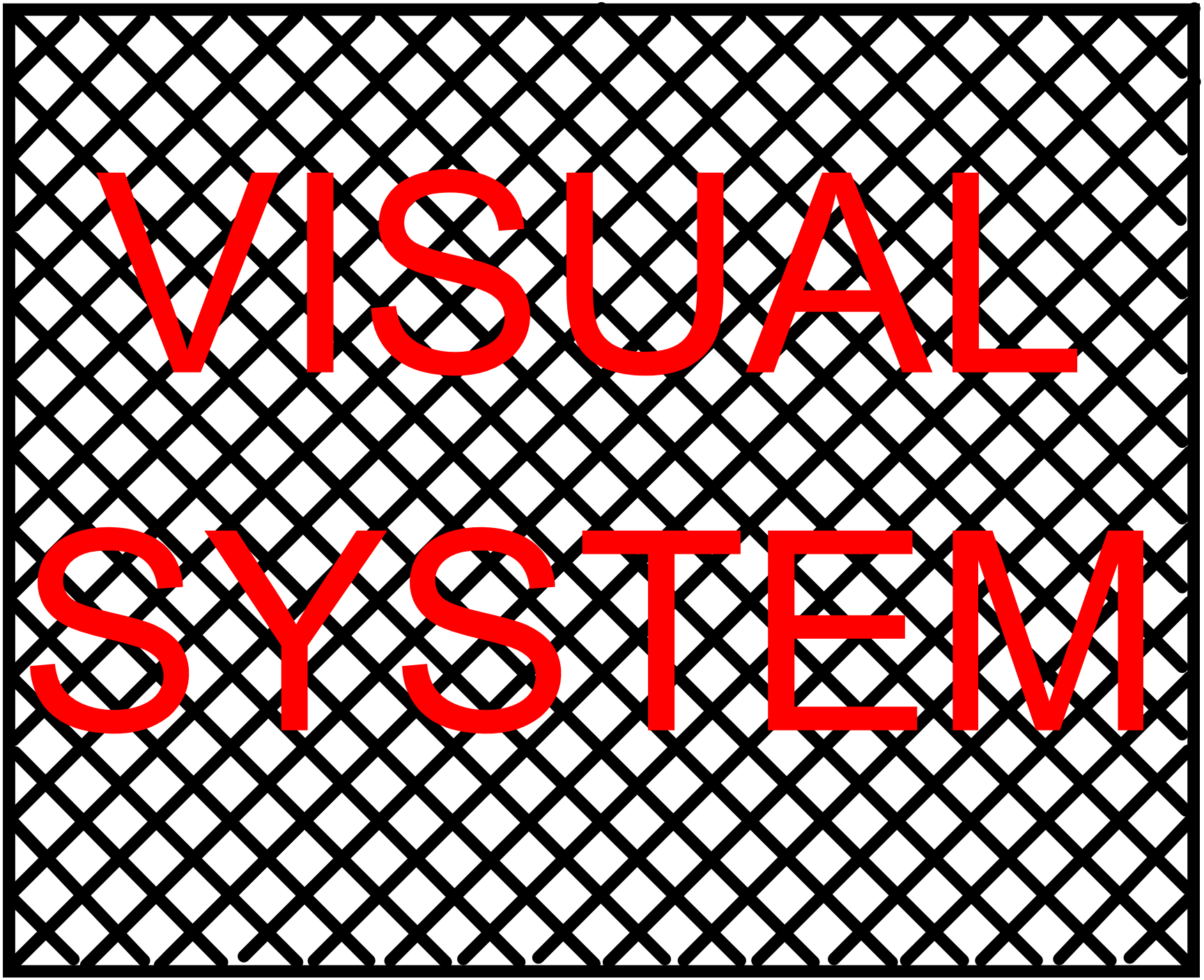
Photos removed due to copyright restrictions.

The recognition of faces

Photos removed due to copyright restrictions.

The perception of subjective contours




VISUAL
SYSTEM

A

Subjective contours at high contrast

B

Subjective contours at isoluminance

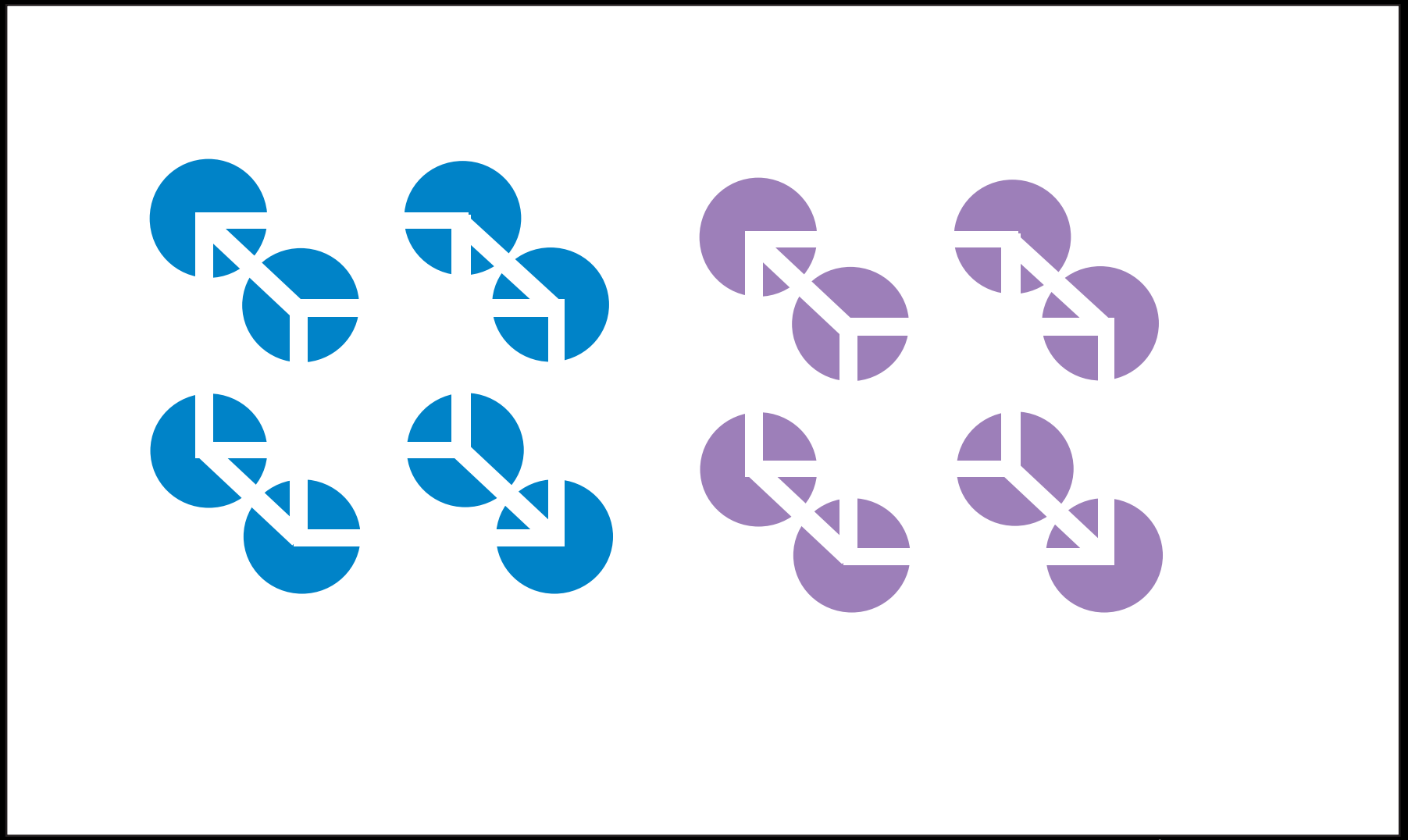


Image by MIT OpenCourseWare.

Response to subjective contours in V2

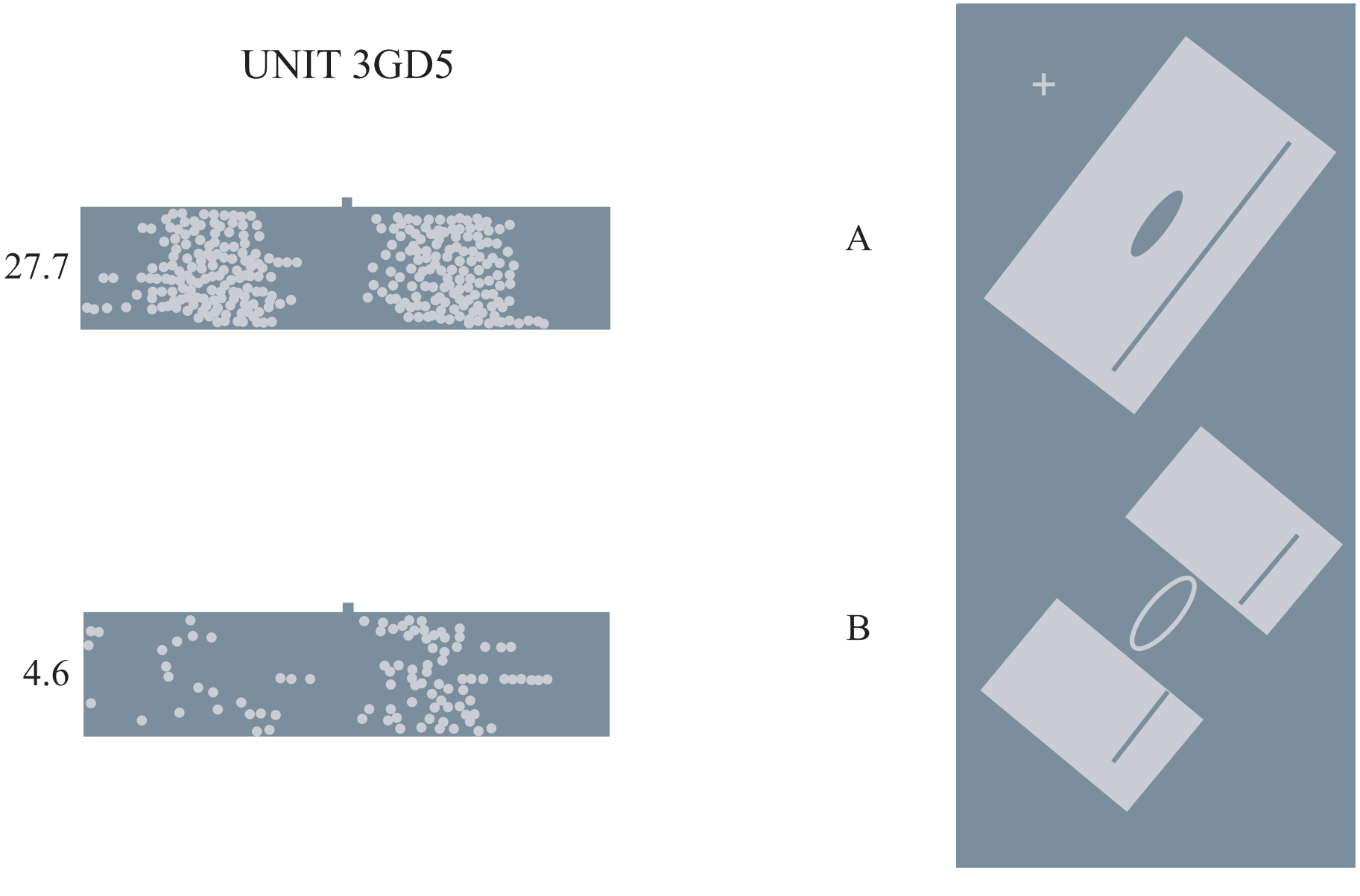


Image by MIT OpenCourseWare.

Response to subjective contours in V2

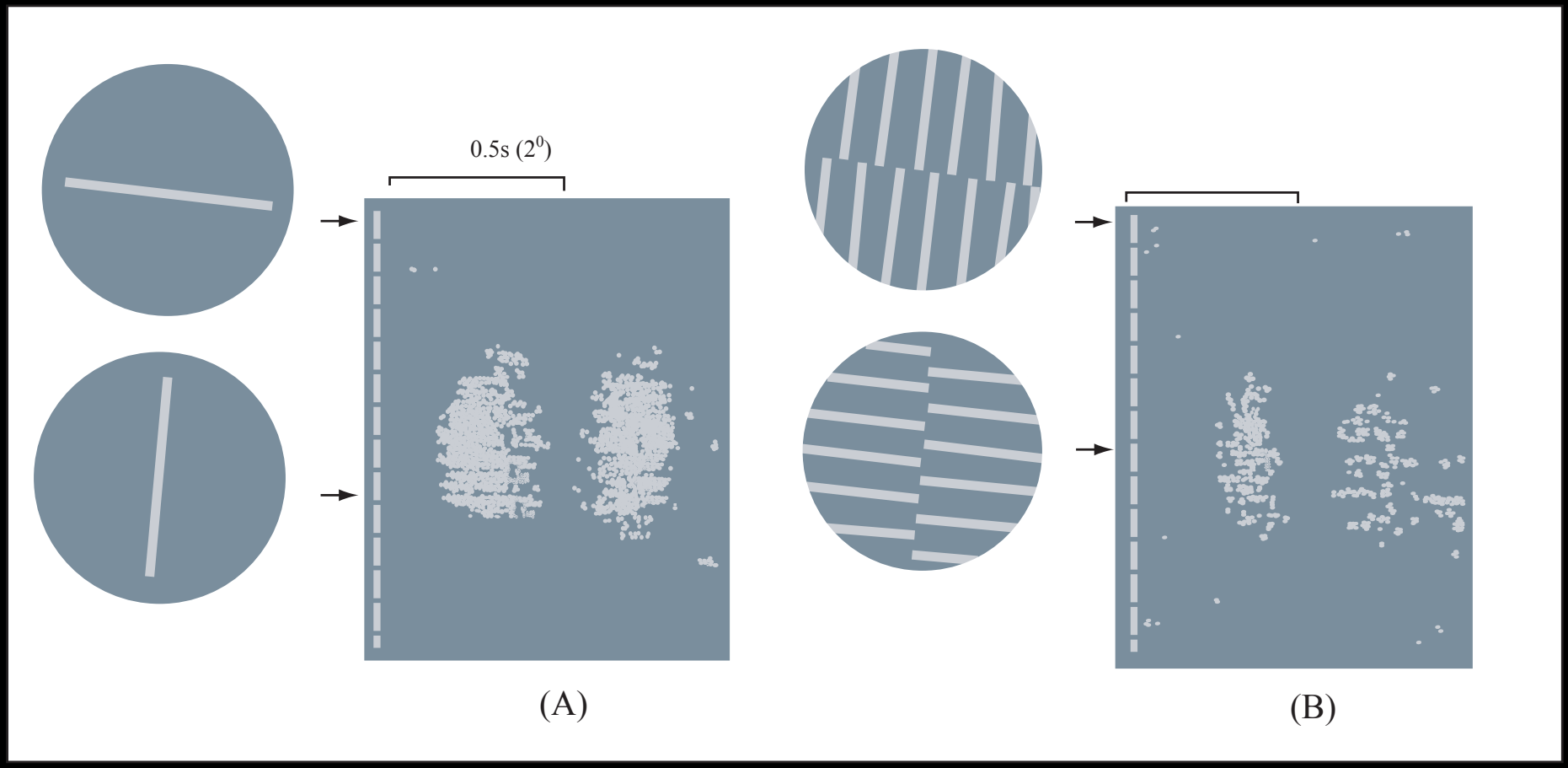
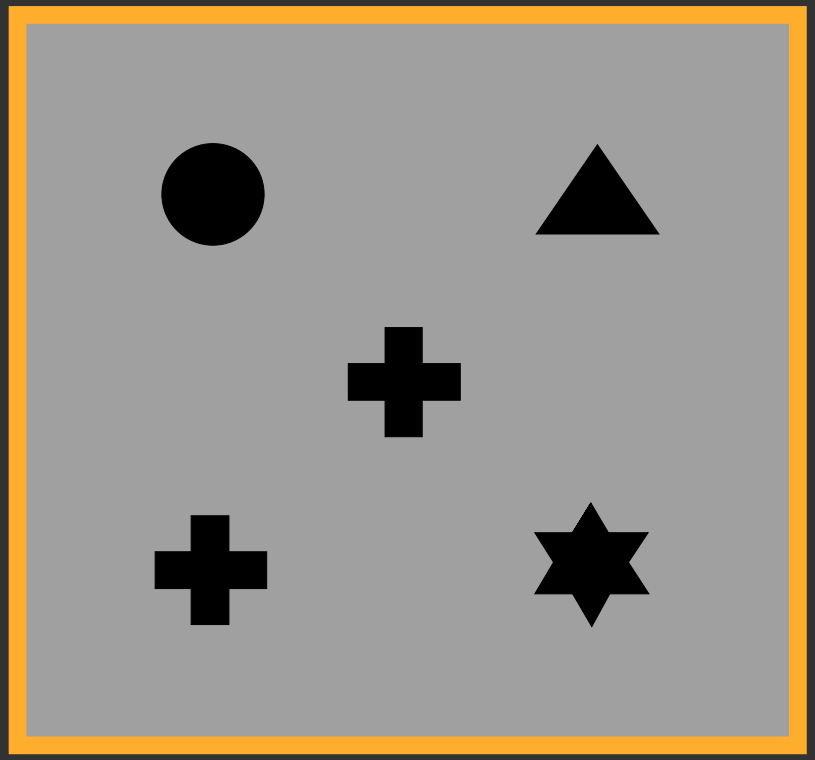


Image by MIT OpenCourseWare.

The effects of V4 and MT lesions on intermediate vision

Match to sample task



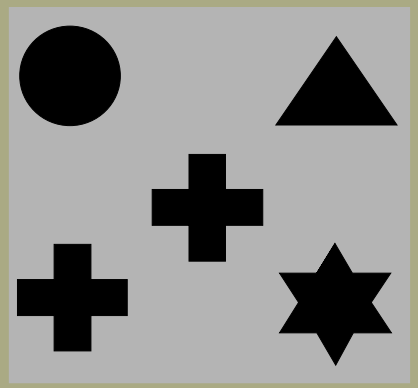
The effect of V4 lesions on object matching

Figure removed due to copyright restrictions.

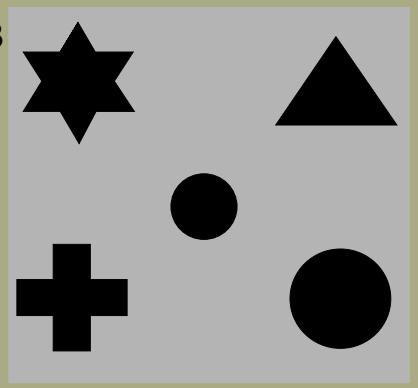
Intermediate vision tasks

SIZE

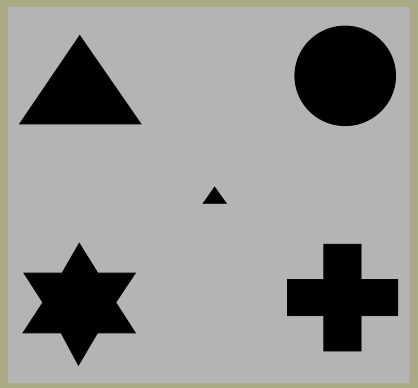
A



B

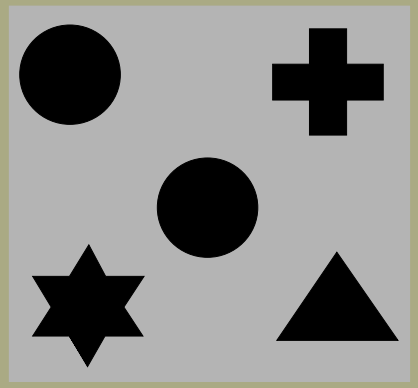


C



OCCLUSION

A



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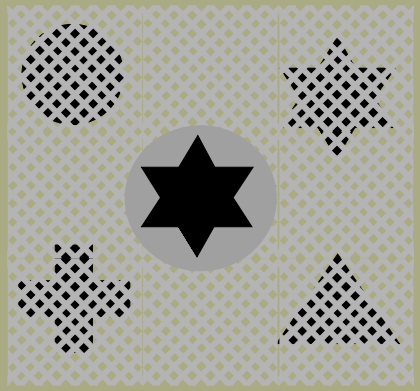
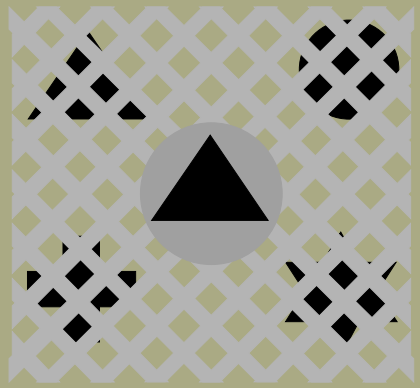
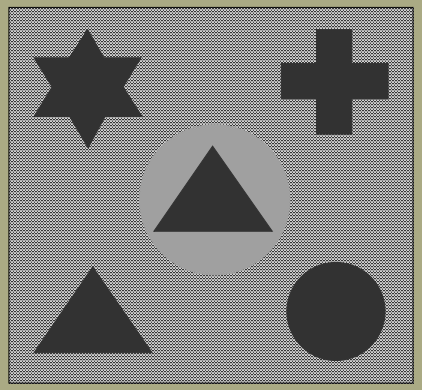


C

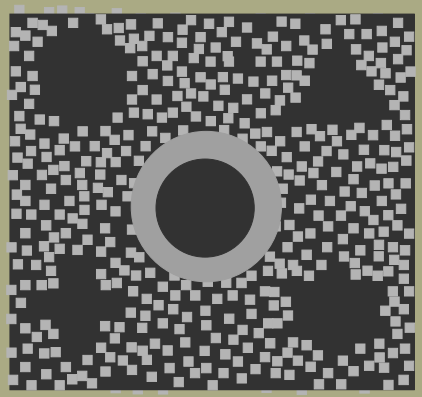


CONTOUR

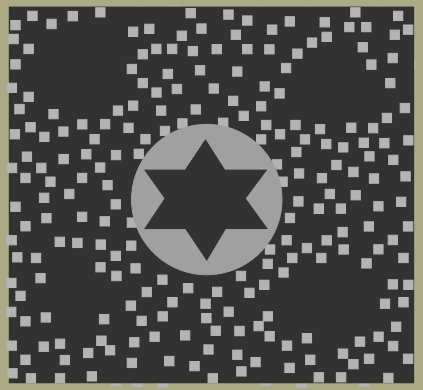
A



B



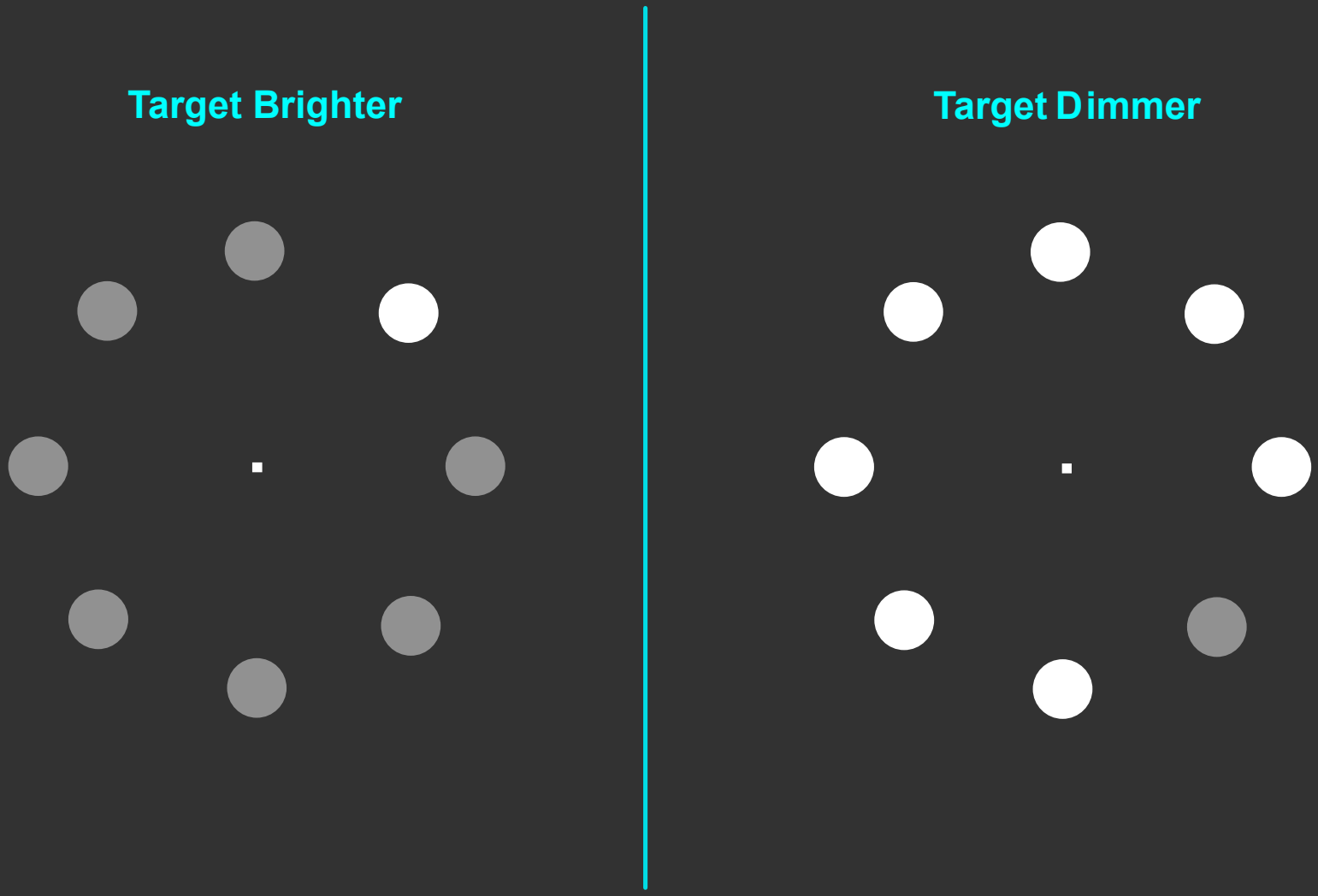
C



The effect of V4 lesions on object transformations

Figure removed due to copyright restrictions.

Greater and lesser brightness discrimination



Brightness discrimination, greater and lesser targets

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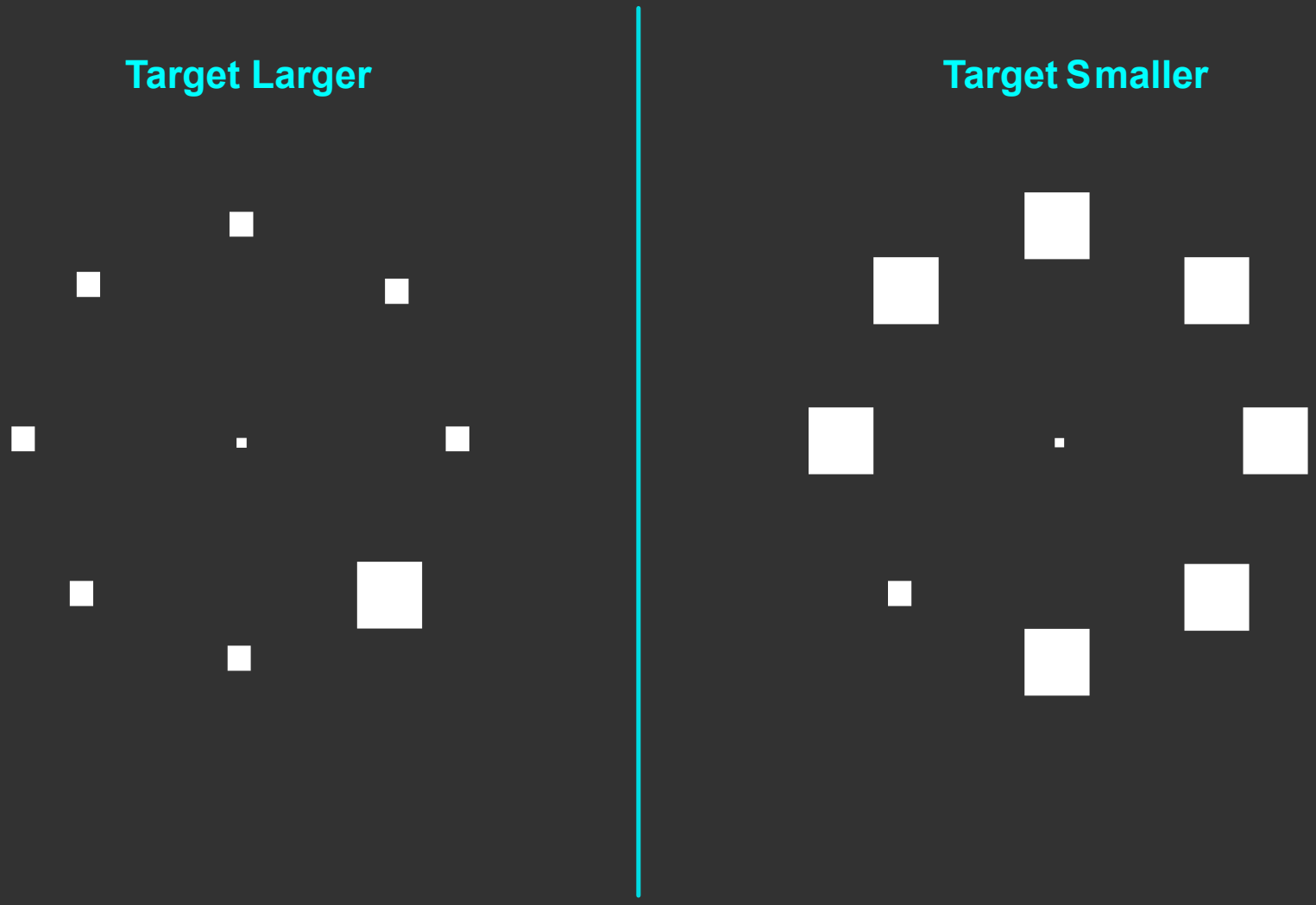
Greater and lesser size discrimination



Size discrimination, greater and lesser targets

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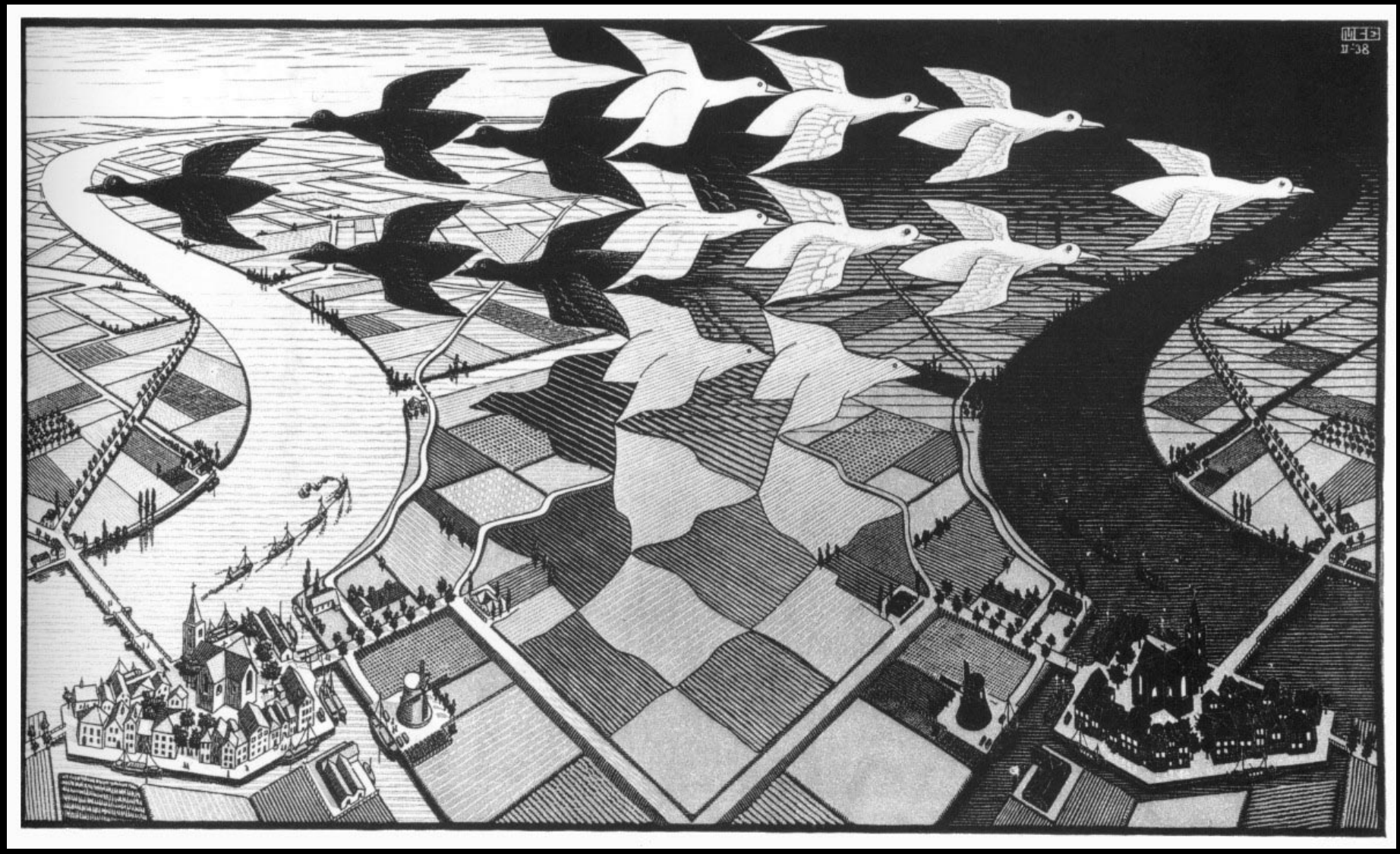
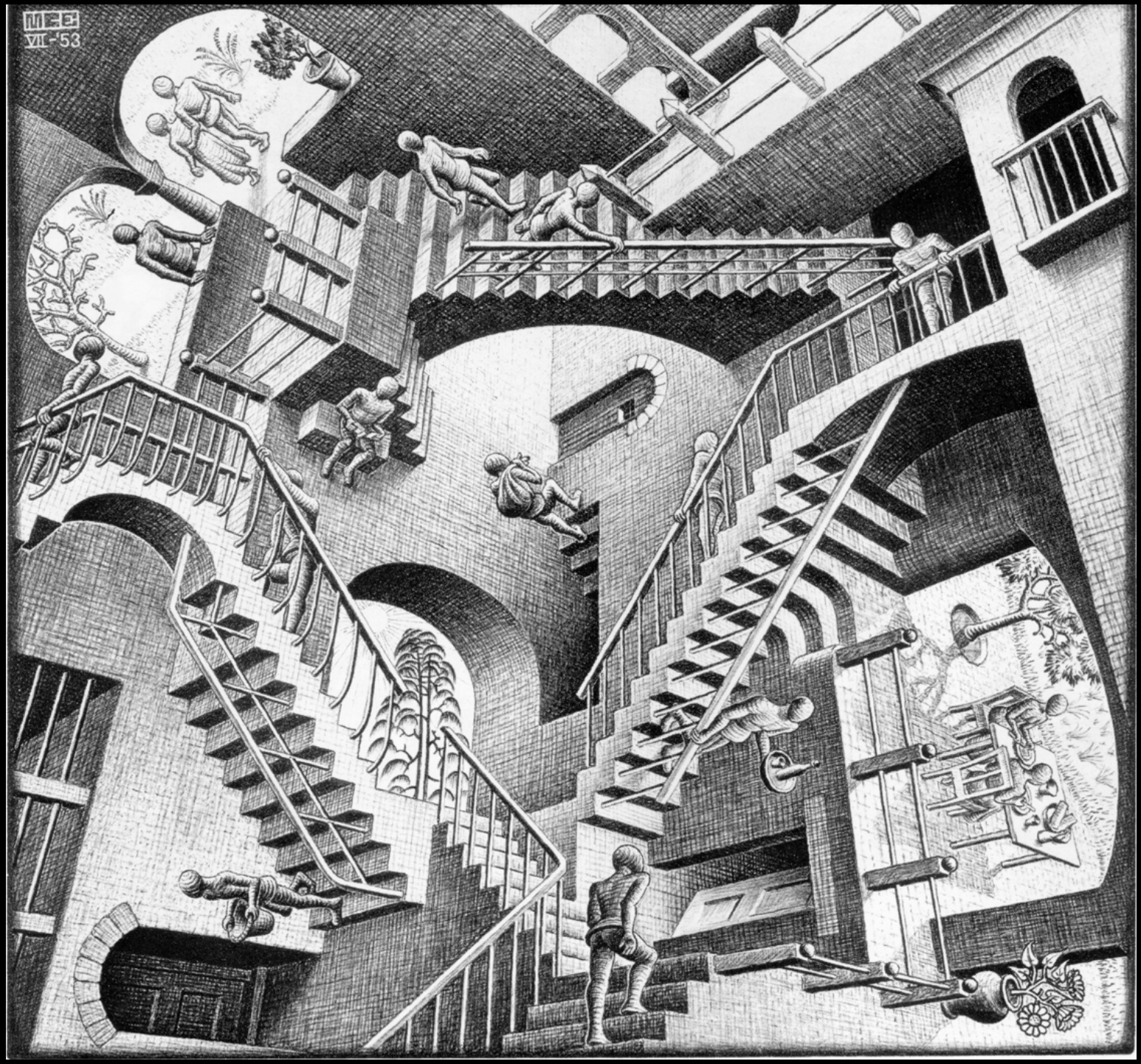
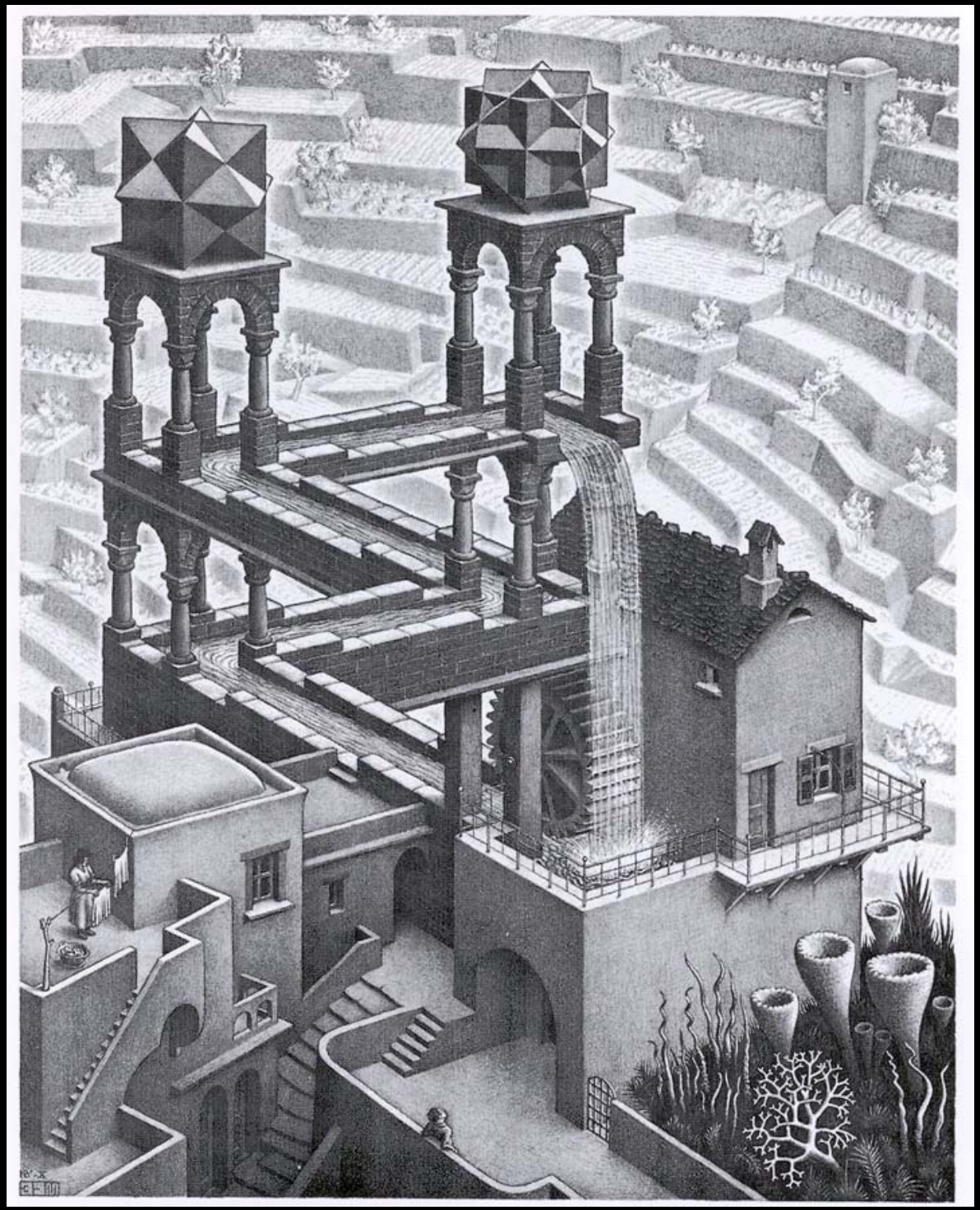
Confusing and interesting percepts created by great artists



Maurits Cornelis Escher (b. 1898)





Courtesy of The M. C. Escher Company, B. V. Used with permission.

Summary, form:

1. Three theories of form precessing in the brain are (a) analysis by orientation of line segmens, (b) spatial mapping onto a topographically organized brain region and (c) Fourier analysis.
2. Areas V2, V4 and IT play important roles in intermediate vision.
3. Neurons responding to subjective contours have been found in V2.
4. Recognition of objects transformed in various ways is compromised by V4 and IT lesions. V4 lesions also produce major deficits in visual learning and in selecting "lesser" stimuli.
5. Some IT neurons are selective for objects including faces, but most respond to a variety of objects whose recognition is based on the differential activity of a great many neurons.
6. How we process and deal with ambiguities in perception remains a mystery

9.04 Neural Basis of Vision and Audition

Fall 2013