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Visual Pattern Recognition

Taylor J. Meek

October 22, 2009

Physiology

Patterns



Features



Difference Detectors and Visual Aftereffects

Finding the Feature Detectors

Building Feature Detector Systems

PHYSIOLOGICAL VISUAL SYSTEM

Physiology

Patterns



Features

Difference Detectors

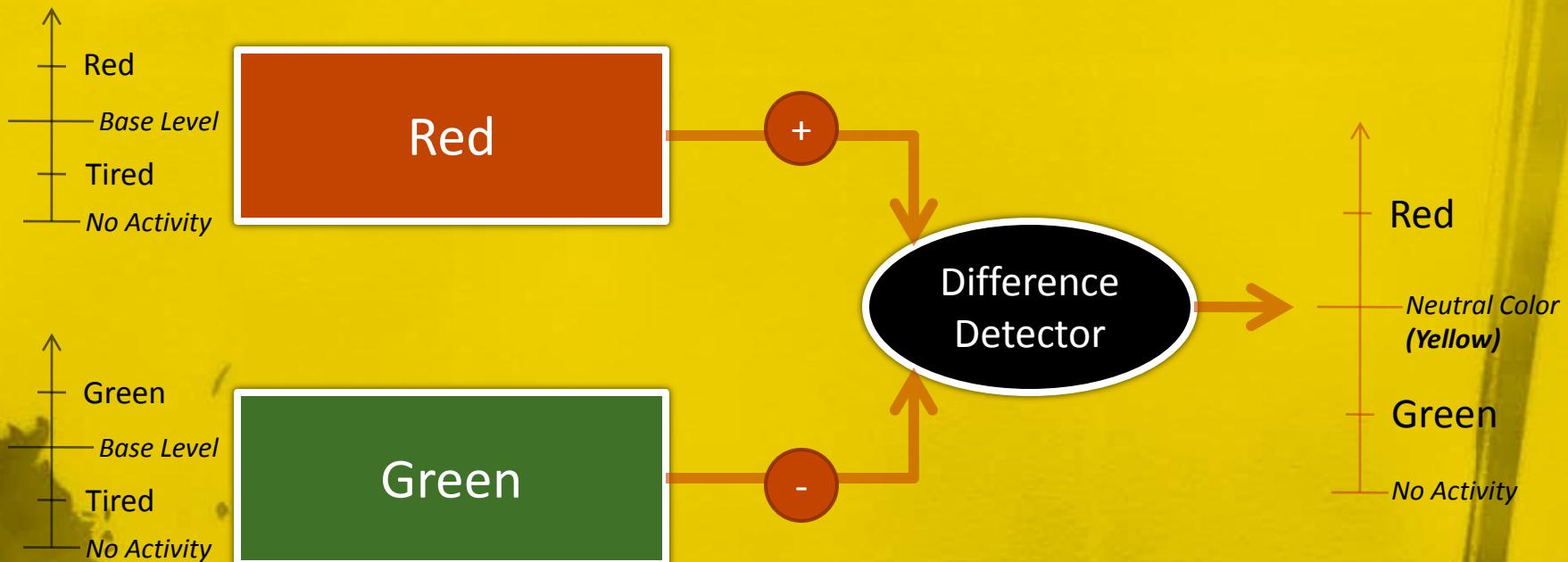


Physiology

Patterns

Features

Difference Detectors

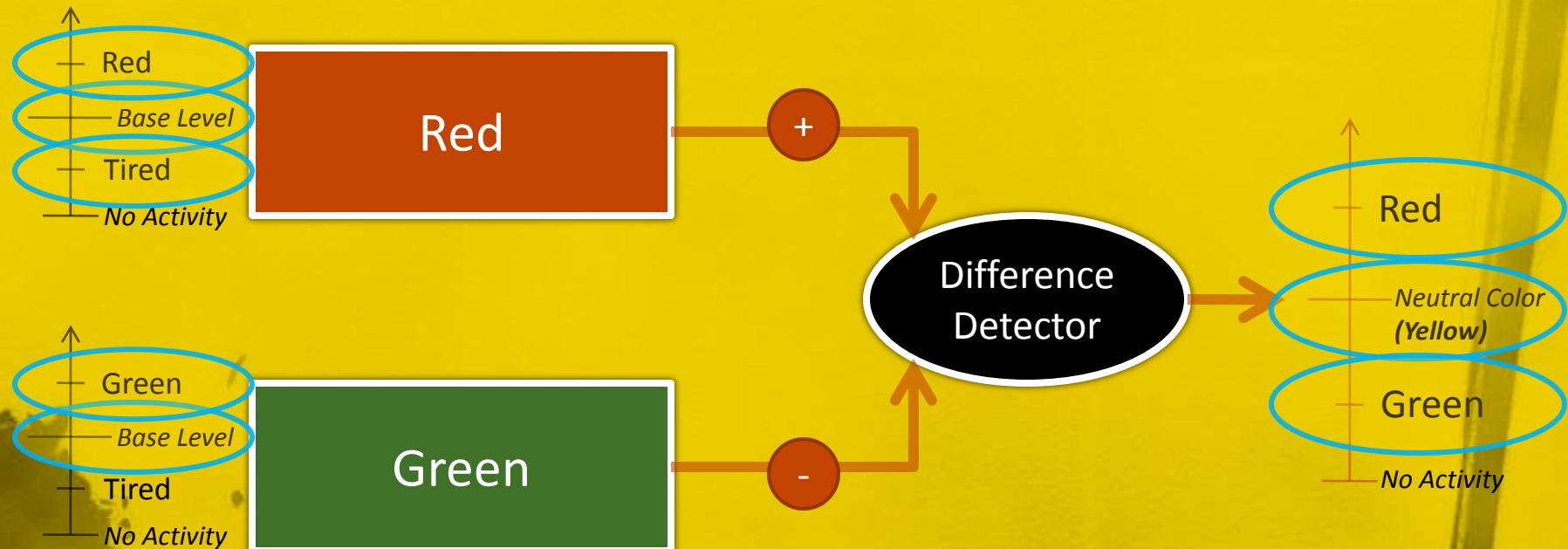


Physiology

Patterns

Features

Difference Detectors



Physiology

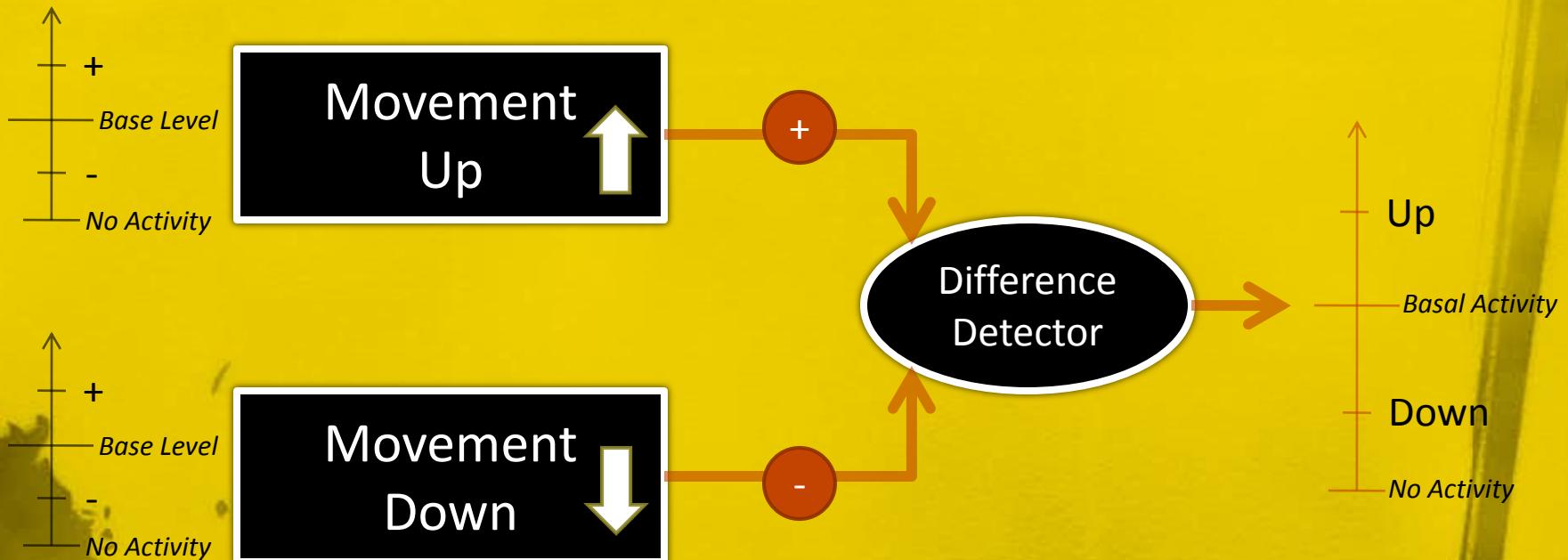
Patterns



Features



Difference Detectors



Physiology

Patterns



Features

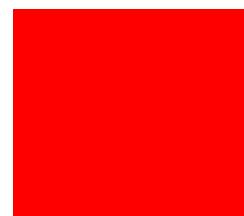
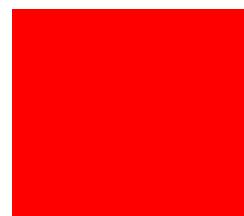
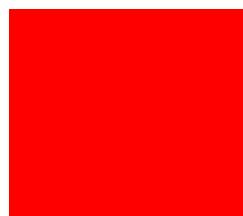
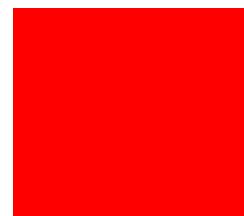
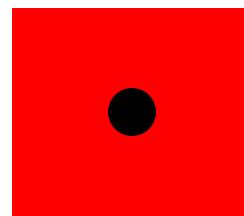
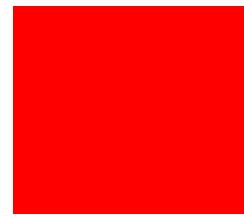
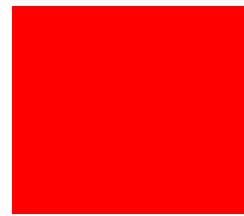
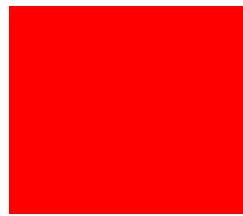


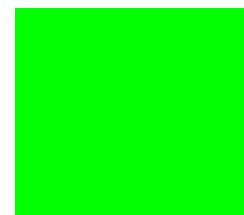
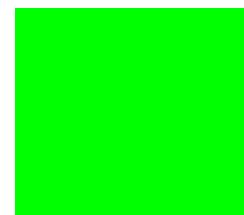
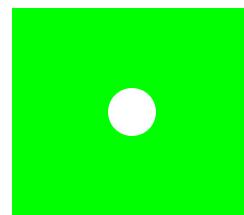
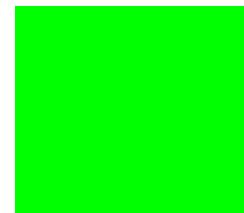
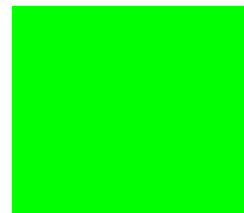
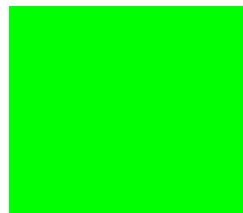
Aftereffects

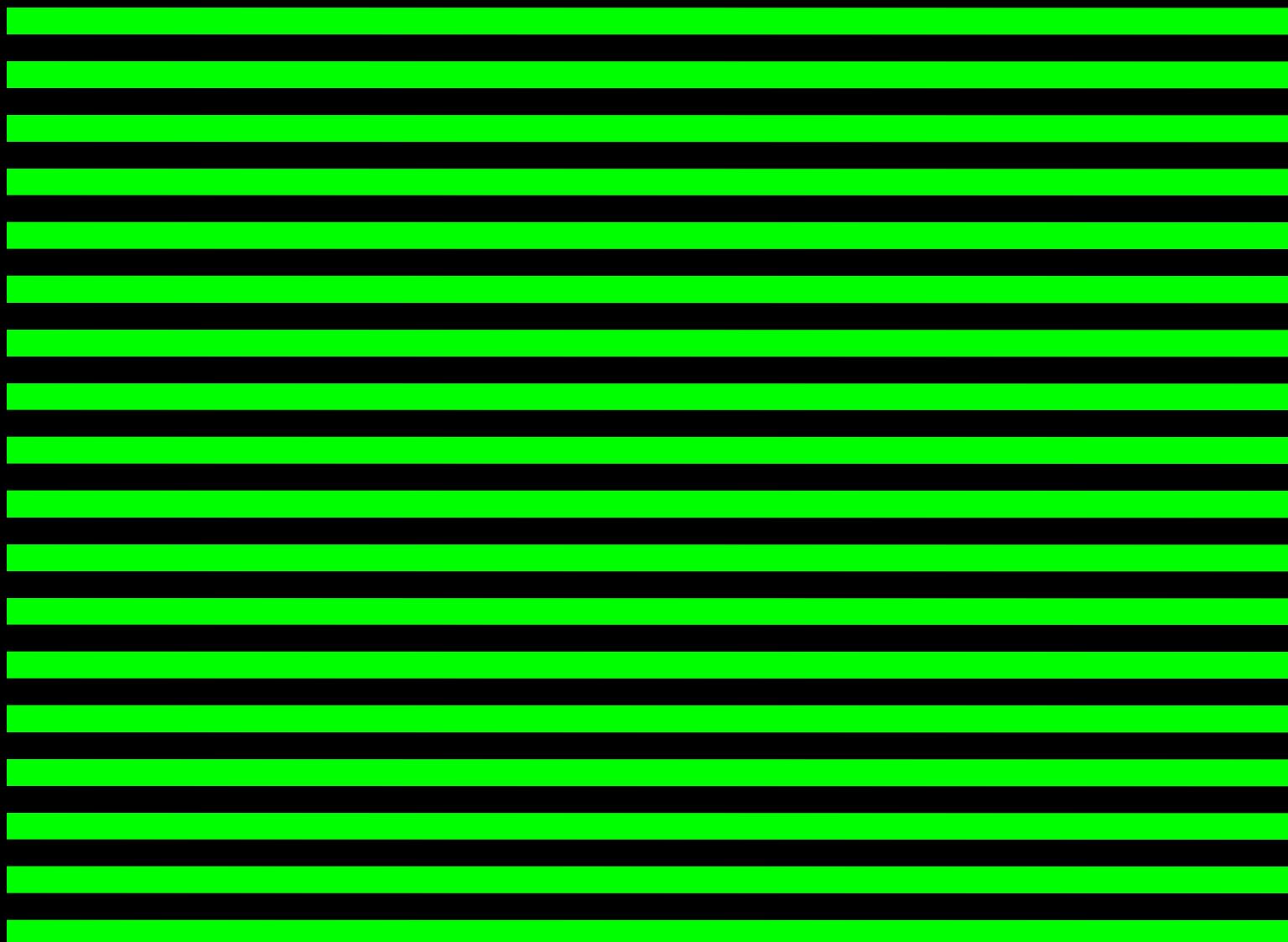
Complementary Color Photoreceptors

Something More Abstract

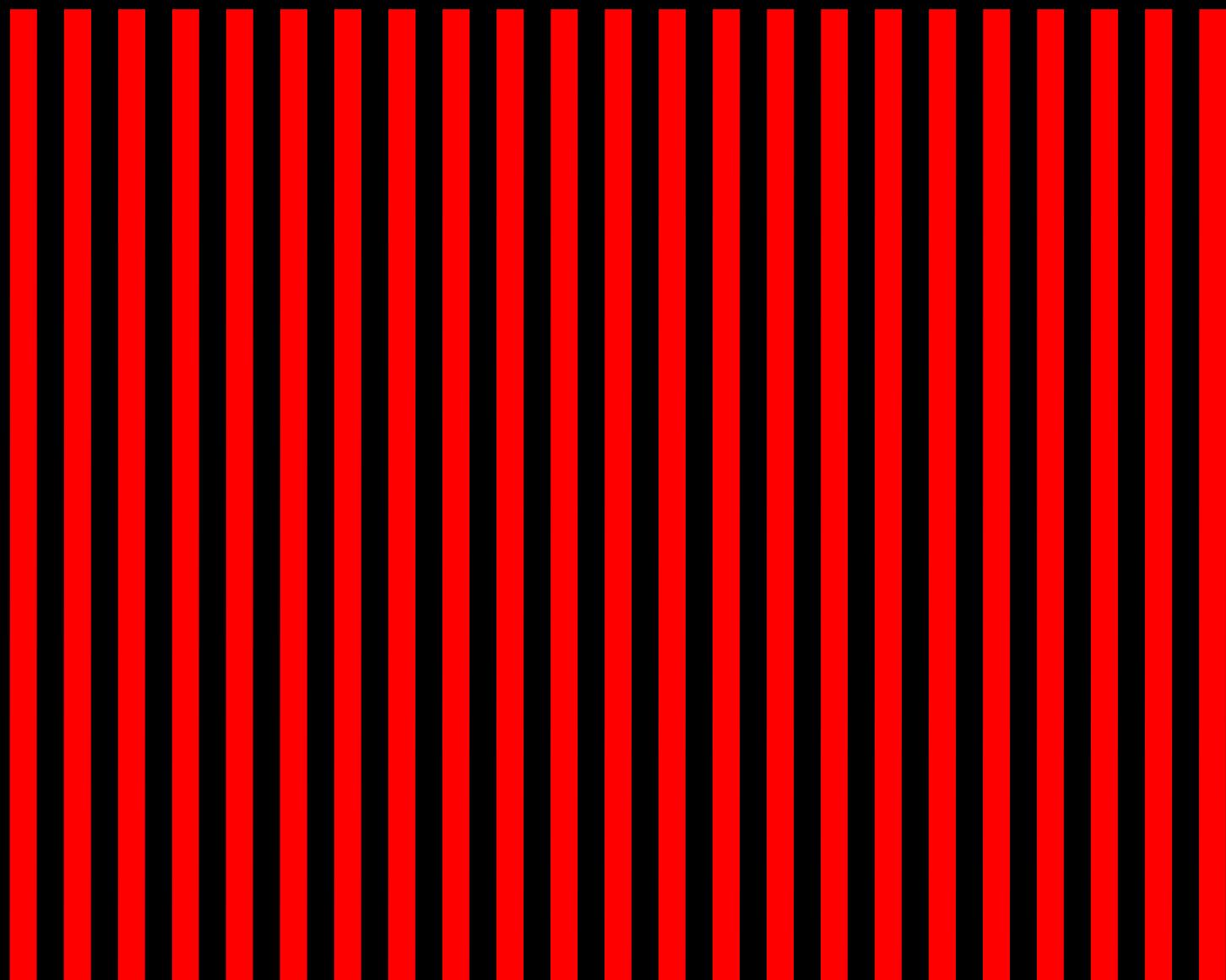
“The McCollough Effect”



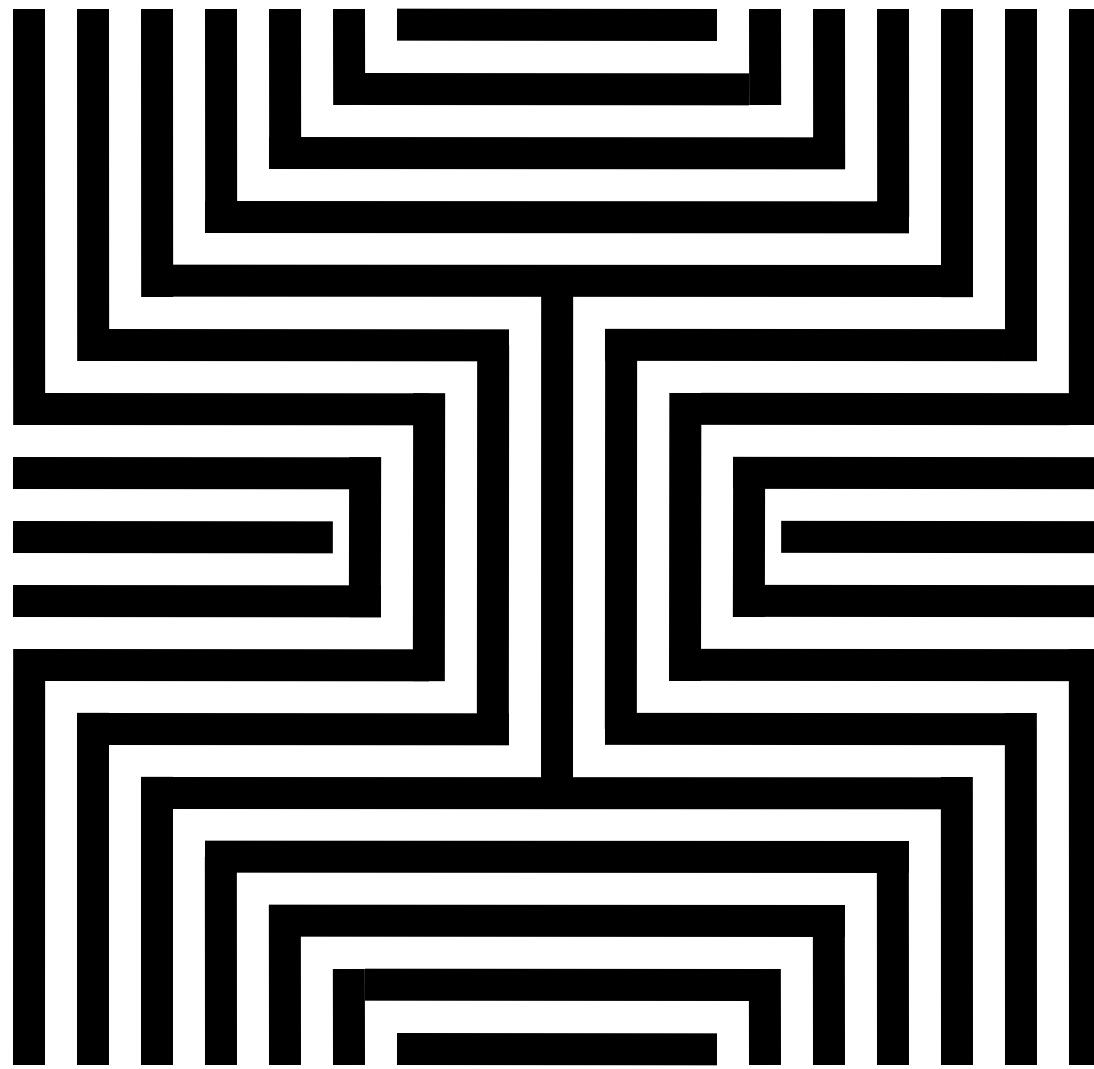




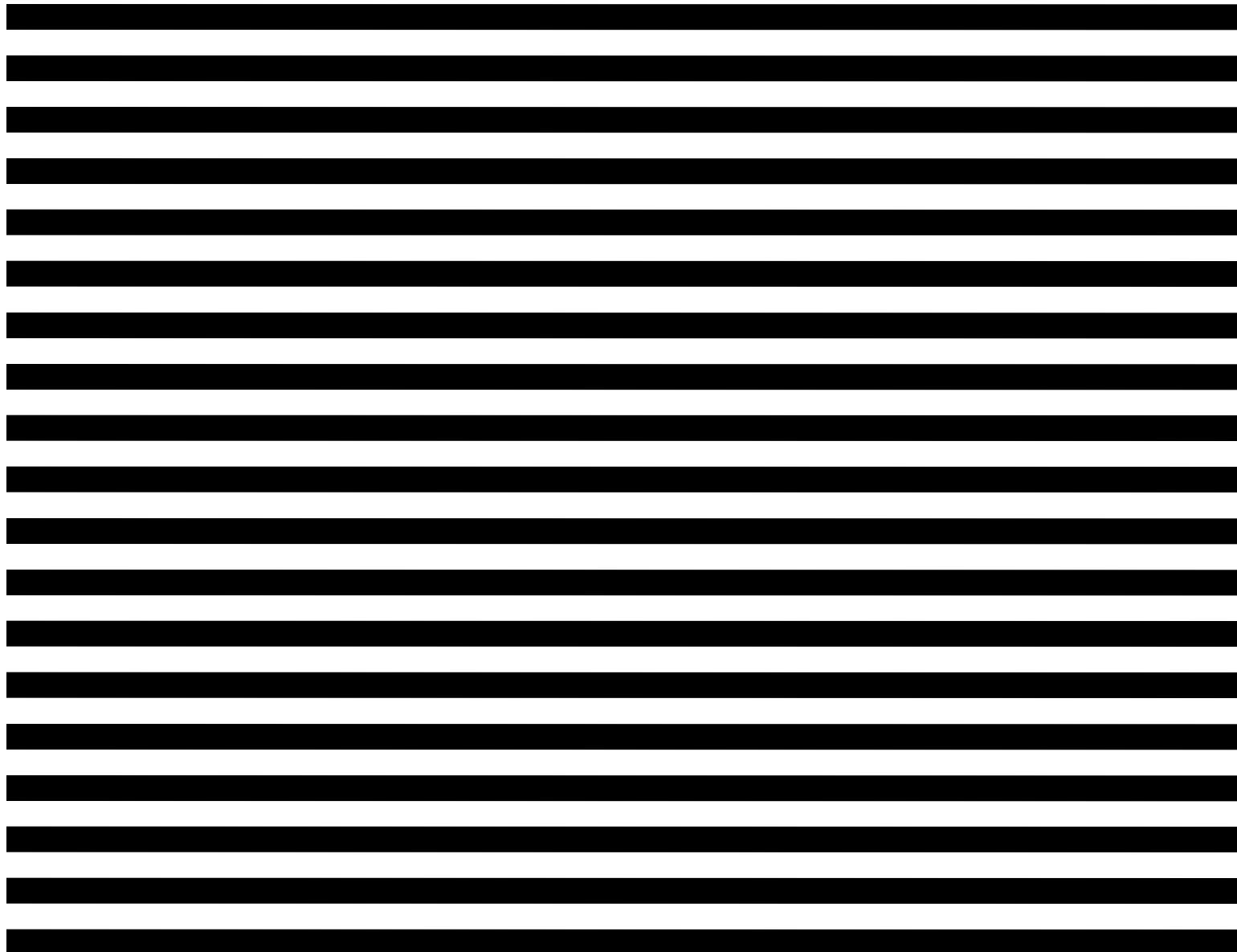
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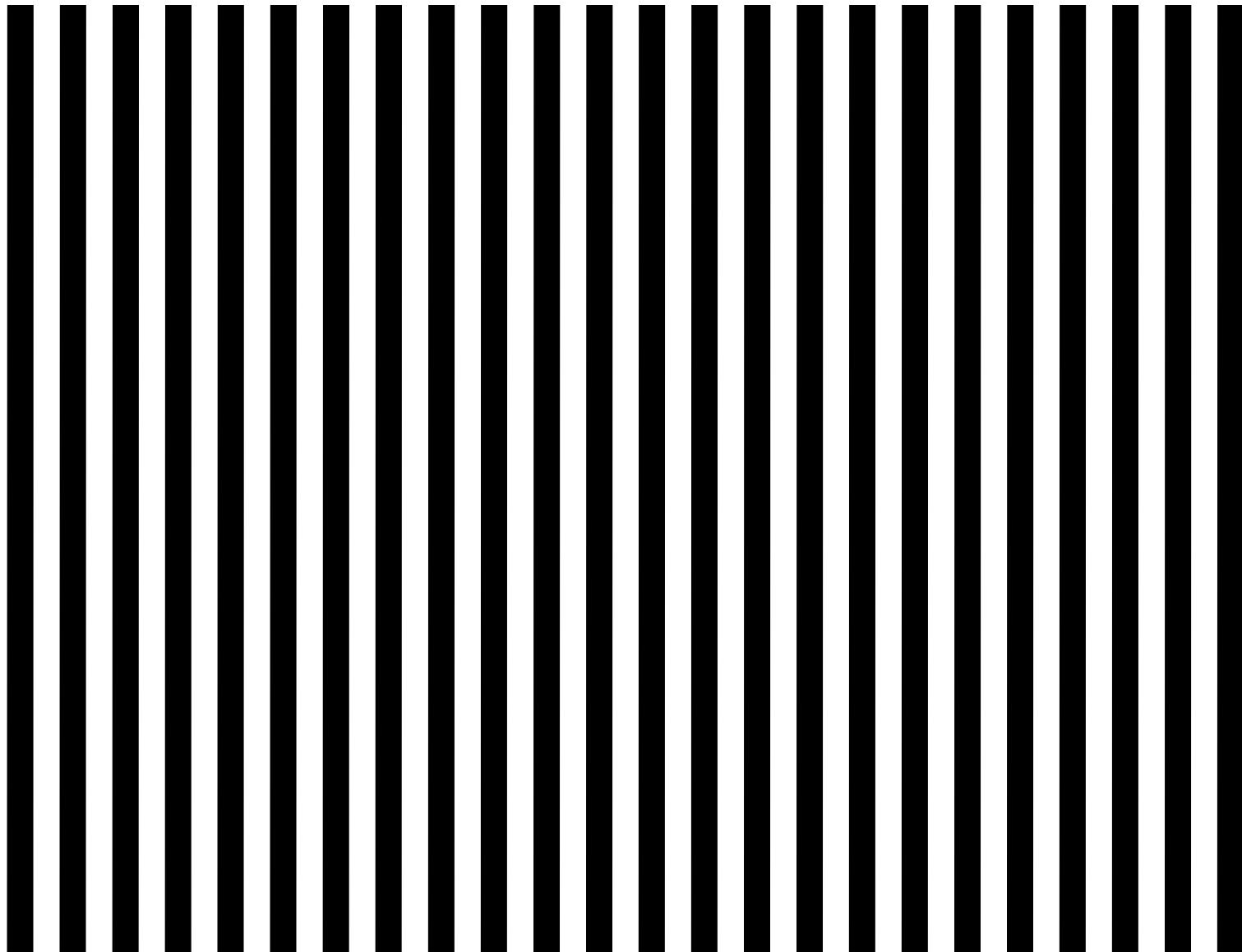


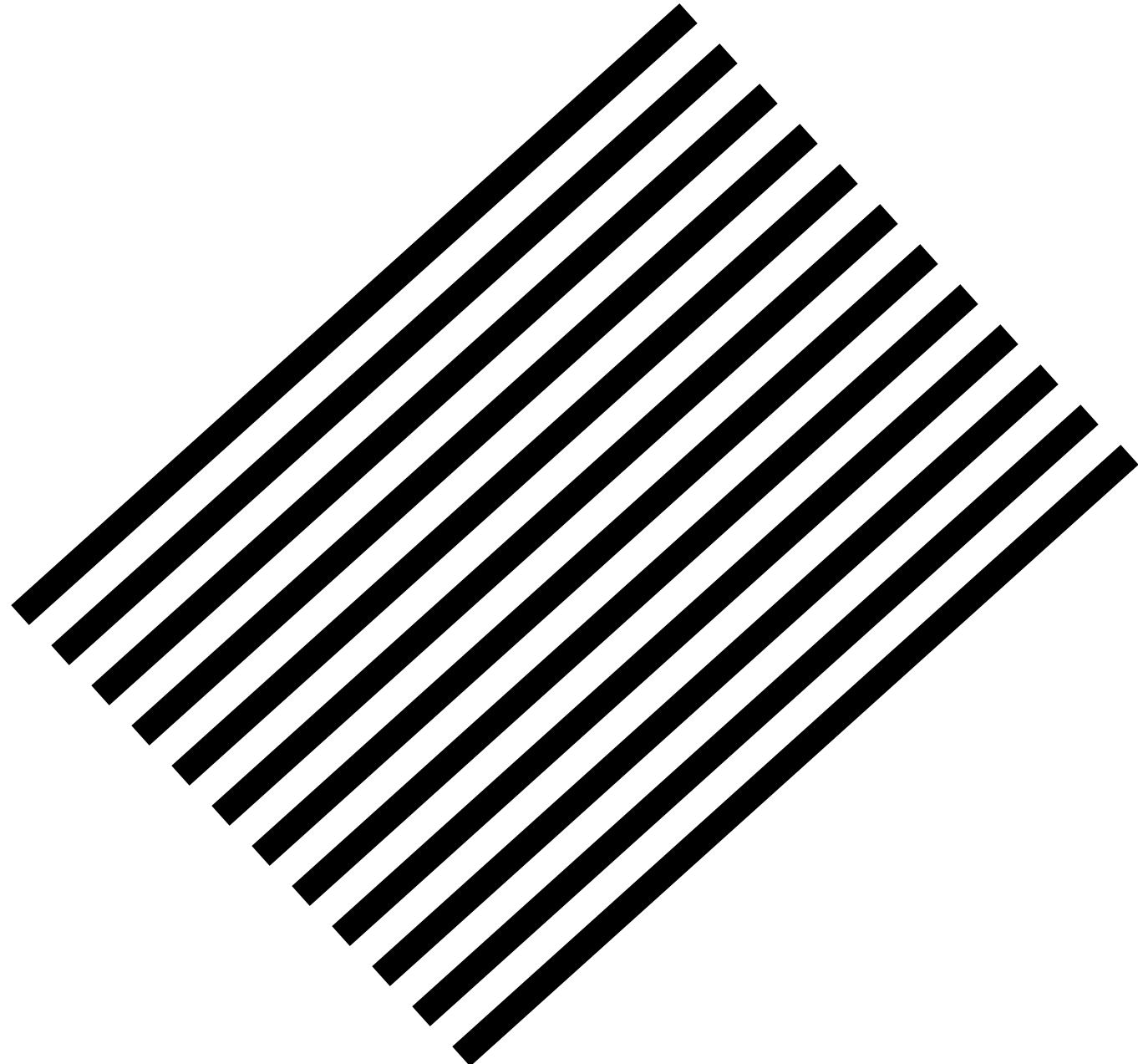
(Gibson & Harris 1968 in Lindsay & Norman 1977)



(Gibson & Harris 1968 in Lindsay & Norman 1977)







Difference Detectors

So what?

Eye Transfer

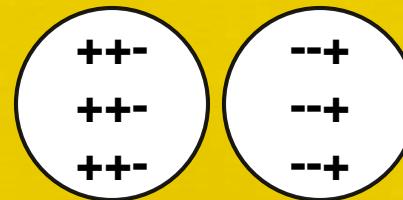
Color Desensitization

Motion Detector Desensitization

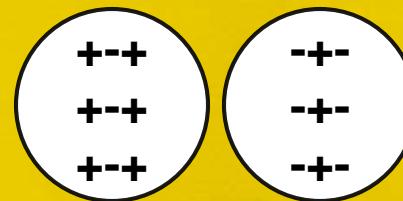
Orientation-specific Line Detectors

Feature Detectors

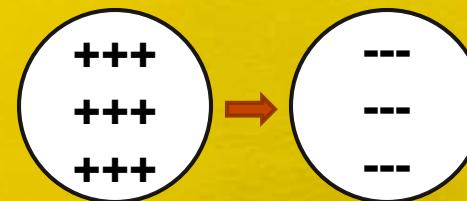
Edge



Slit/Line

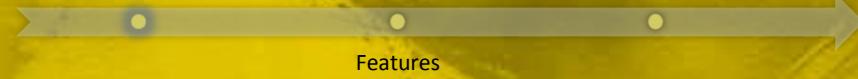


Dimness



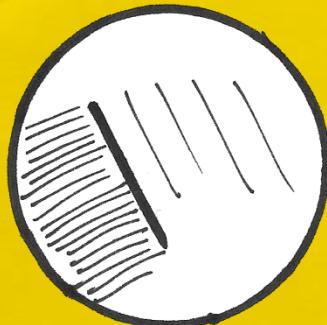
Physiology

Patterns

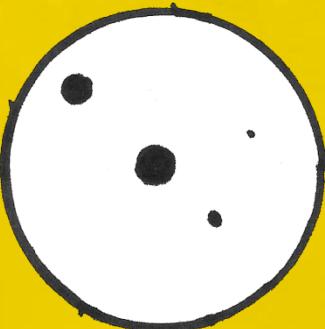


Features

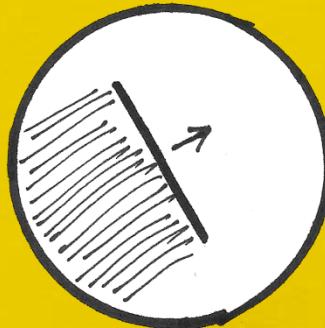
Physiological Feature Detectors



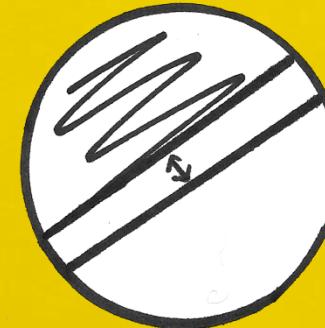
Edge



Convex
Edge



Moving
Contrast
(Edge)



Dimness



<http://flickr.com/photos/thomashawk/90125879/>
Toad by Thomas Hawk, under CC License

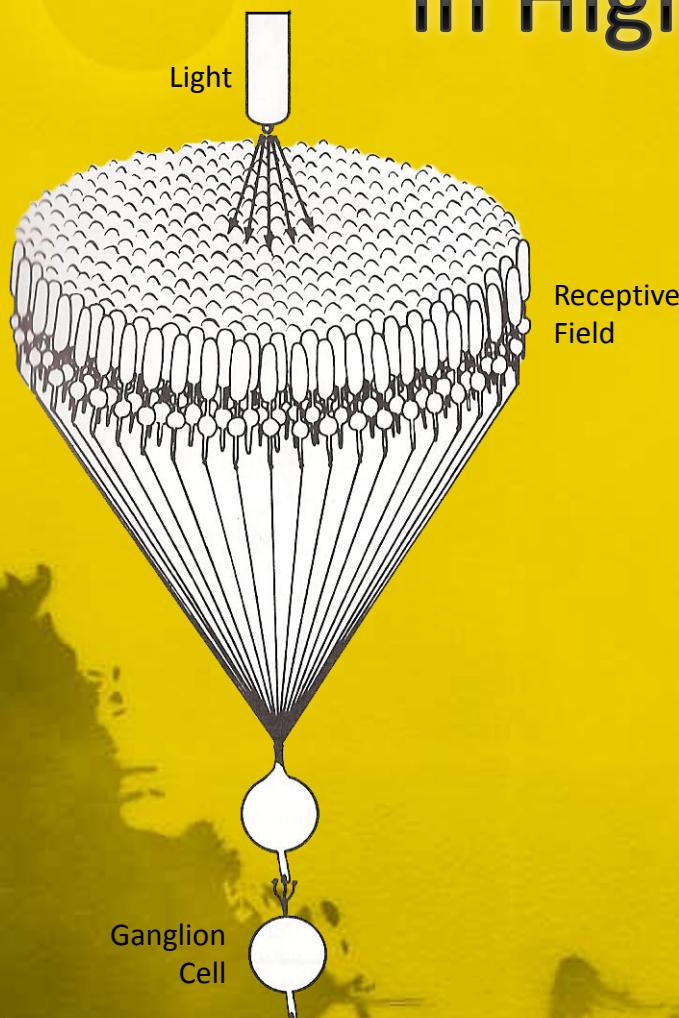
Physiology



Features

Patterns

Feature Detectors in Higher-Order Species



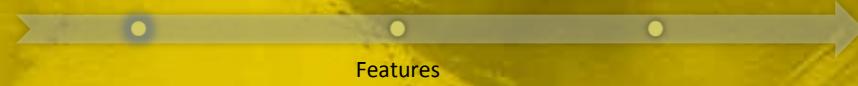
Ganglion & Bi-Polar Cells

- On-Center, Off-Surround
- Off-Center, On-Surround
- Light Onset, Extinction
- Peculiar Receptive Fields
- Color Specificity, Contrast
- Movement (Directional)

(Lindsay & Norman 1977, p.215)

Physiology

Patterns

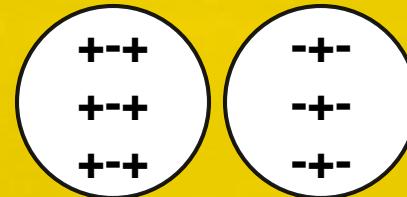


Features

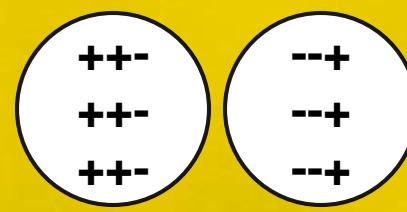
Simple Feature Detector Cells in Higher-Order Species

Selective to:
Location
Type
Orientation/direction
Width

Slit and Line



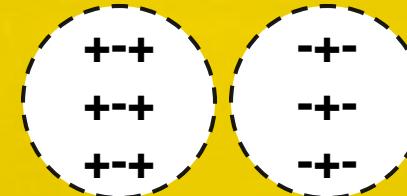
Edge



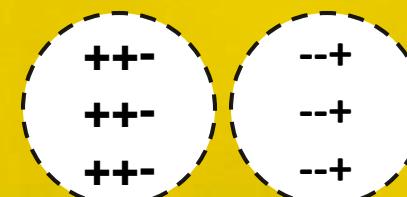
Complex Feature Detector Cells in Higher-Order Species

Selective to:
~~Location~~
Type
Orientation/direction
Width

Slit and Line



Edge



Hyper-Complex Feature Detector Cells in Higher-Order Species

Size/Endpoint Termination

Movement (Axial Bidirectional)

Angle

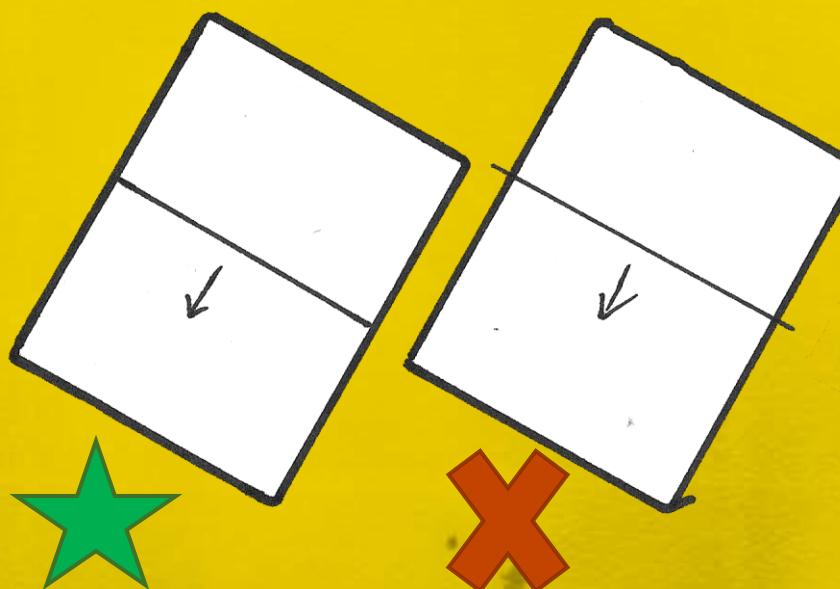
Physiology

Patterns



Hyper-Complex Feature Detector Cells in Higher-Order Species

Size/Endpoint Termination



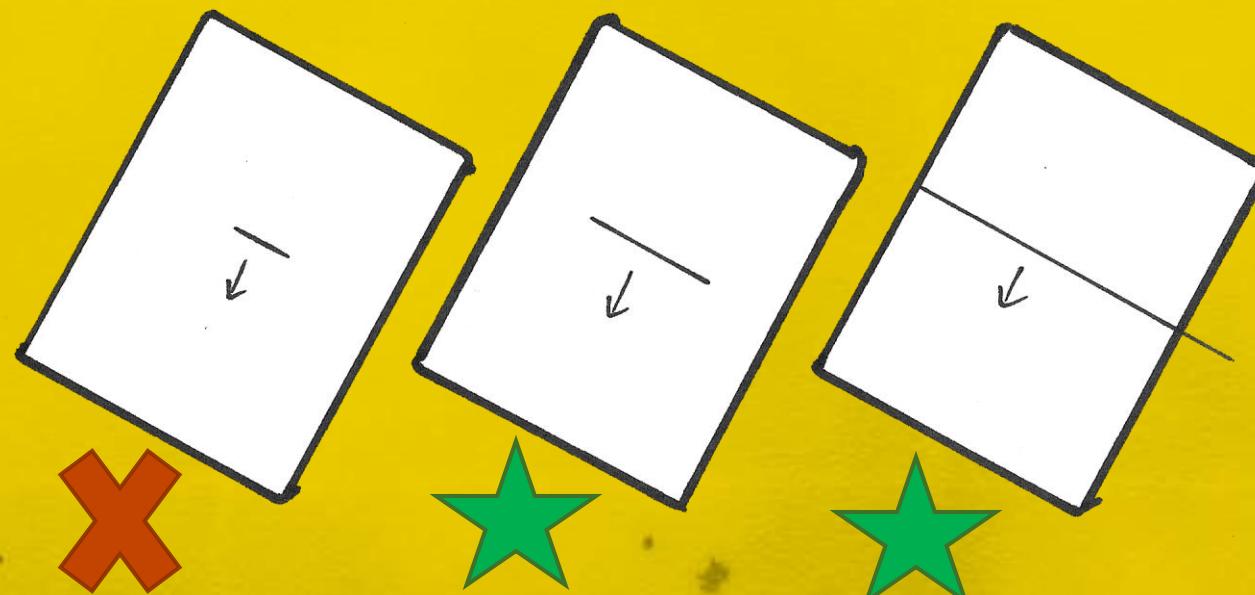
Physiology

Patterns



Hyper-Complex Feature Detector Cells in Higher-Order Species

Size/Endpoint Termination



Physiology

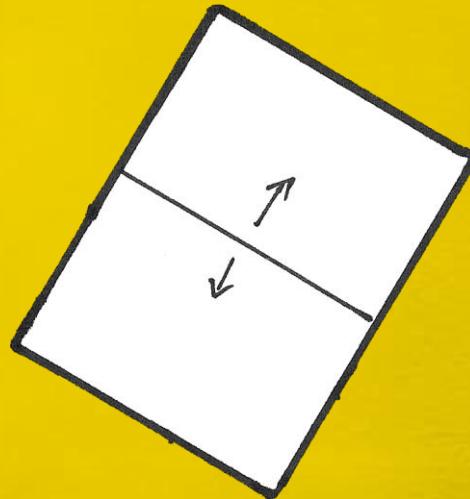
Patterns



Features

Hyper-Complex Feature Detector Cells in Higher-Order Species

Movement (Bidirectional)



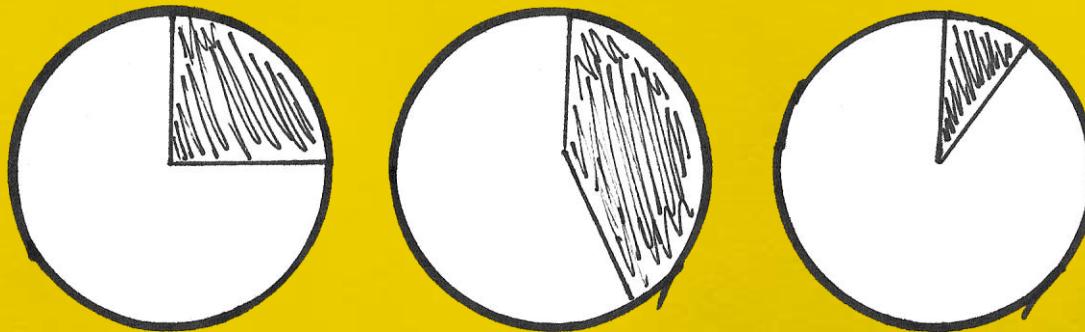
Physiology

Patterns



Hyper-Complex Feature Detector Cells in Higher-Order Species

Angle

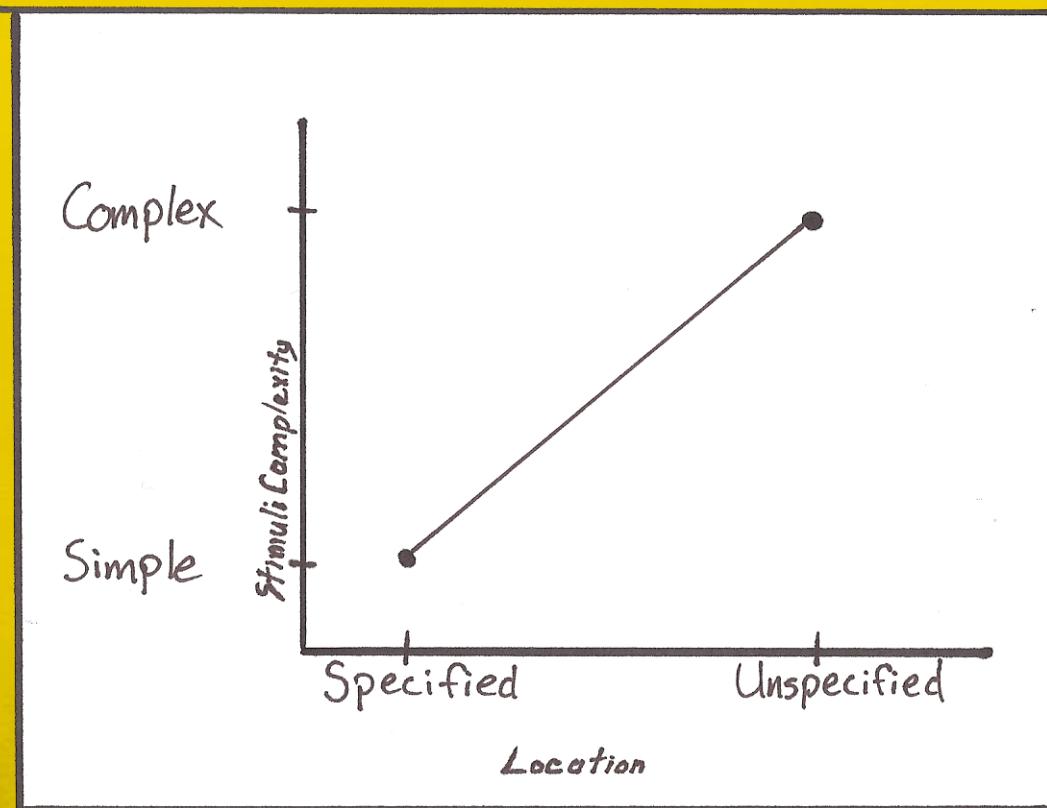


Physiology

Patterns



Higher-Level Feature Detector Cells in Higher-Order Species



Physiology

Patterns

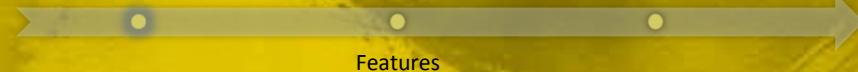
Features

Higher-Level Feature Detector Cells in Higher-Order Species



<http://flickr.com/photos/crowolf/205180735/>
The Monkey Paw by John "Jay" Glenn, under CC License

Physiology



Higher-Level Feature Detector Cells in Higher-Order Species

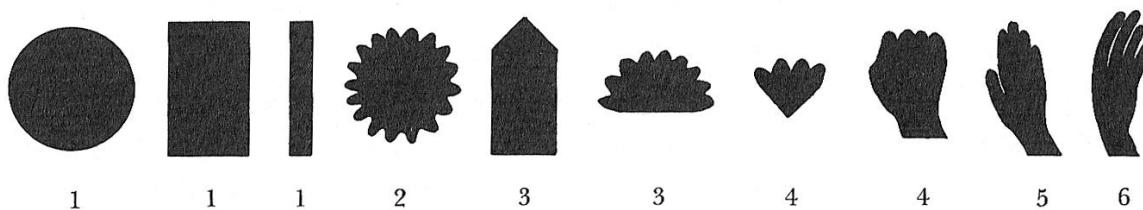
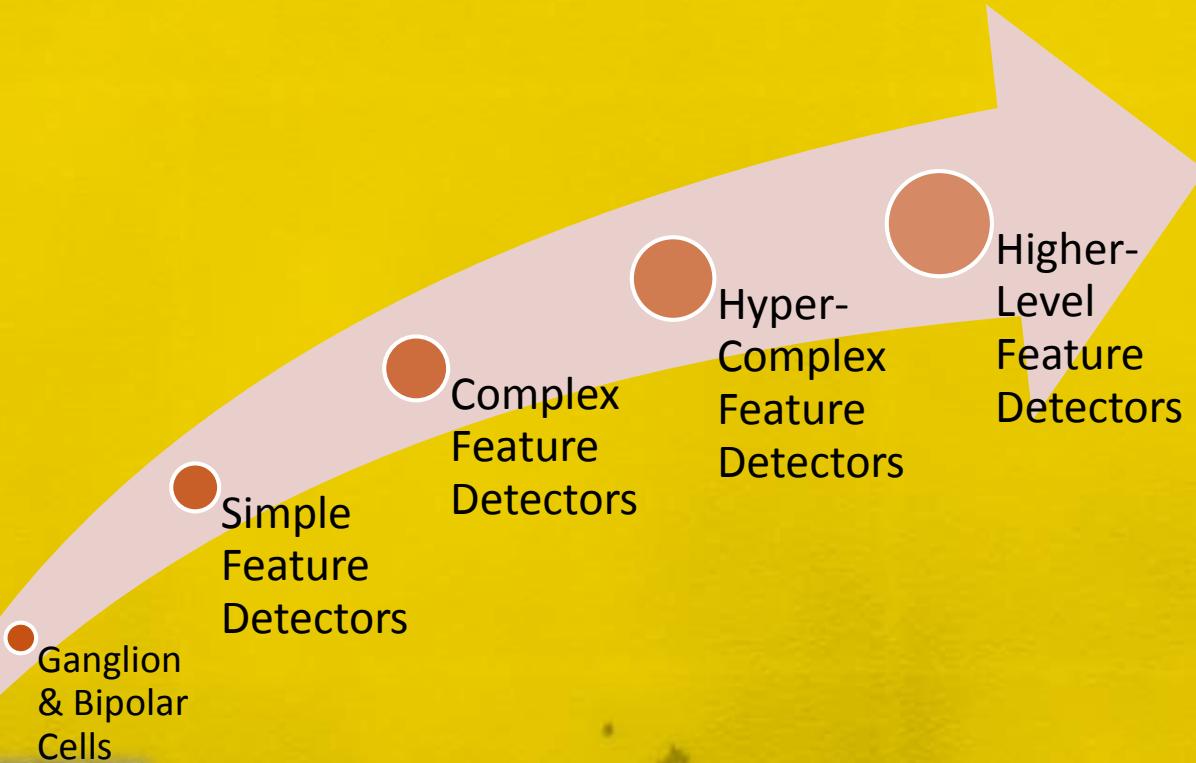


FIGURE 6-45 *Examples of shapes used to stimulate an inferotemporal unit apparently having very complex trigger features. The stimuli are arranged from left to right in order of increasing ability to drive the neuron from none (1) or little (2 and 3) to maximum (6). (From Gross et al., 1971, reproduced from Gross, 1973.)*

Building Up Complex Feature Detectors



<http://flickr.com/photos/residae/386508456/>
Father of the Eye by Desirae, under CC license

Physiology

Patterns

Features



Features and Grouping
Geon Theory

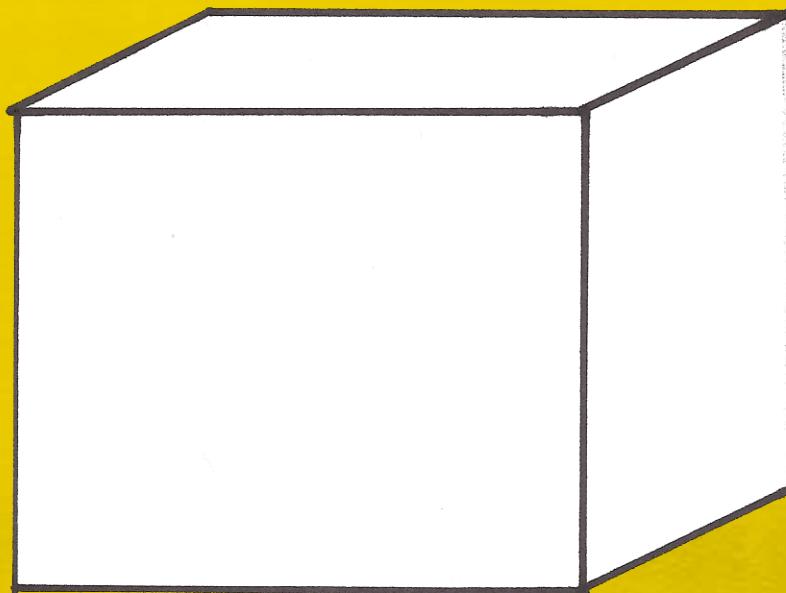
COGNITIVE FEATURE DETECTION

Physiology

Patterns

Features

Features and Objects



Physiological Nystagmus

Jiggly Eye Movements

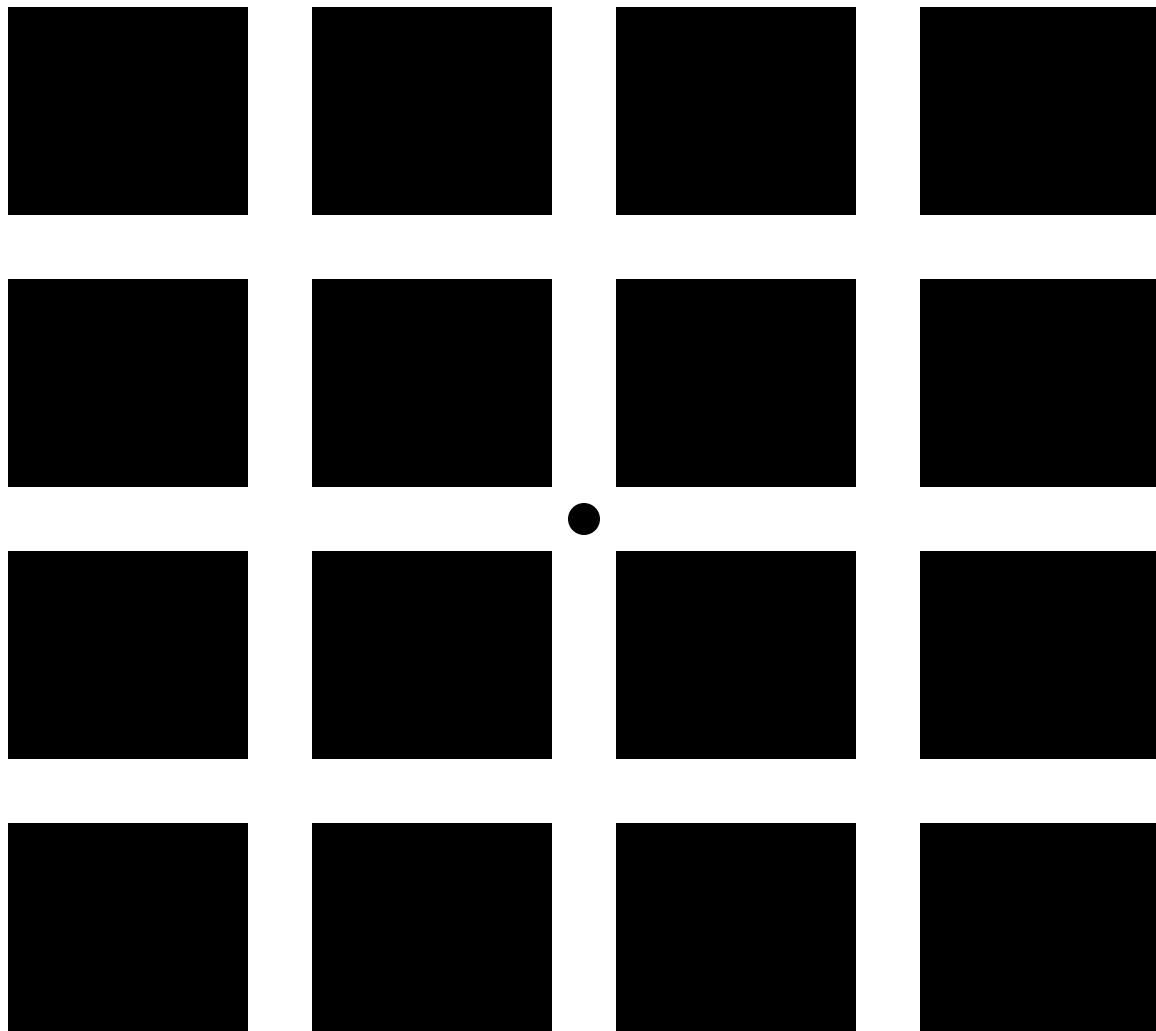


http://en.wikipedia.org/wiki/Image:Optokinetic_nystagmus.gif
Available under GNU Free Documentation License,
http://commons.wikimedia.org/wiki/Commons:GNU_Free_Documentation_License

Physiology

Patterns

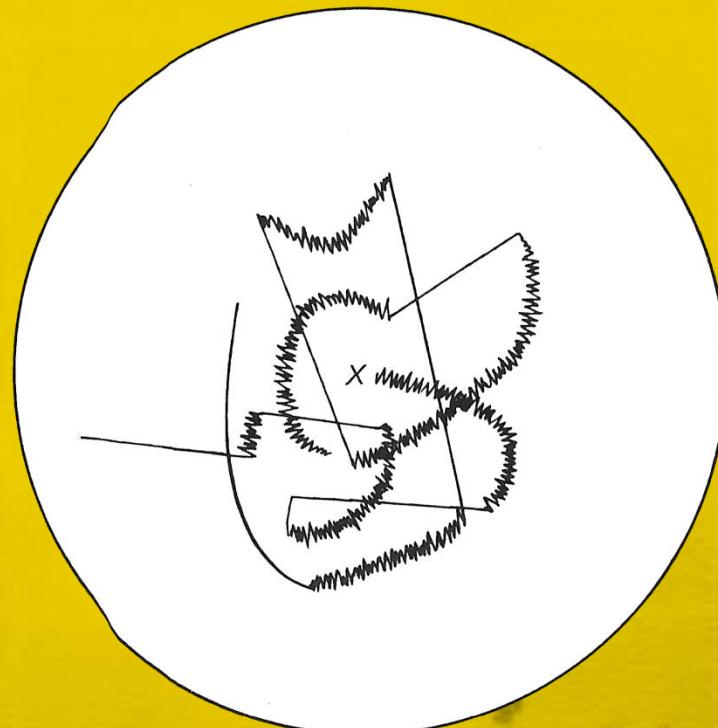
Features



(Verheijen 1961 in Lindsay & Norman 1977)

Physiological Nystagmus

Jiggly Eye Movements



Physiology

Patterns

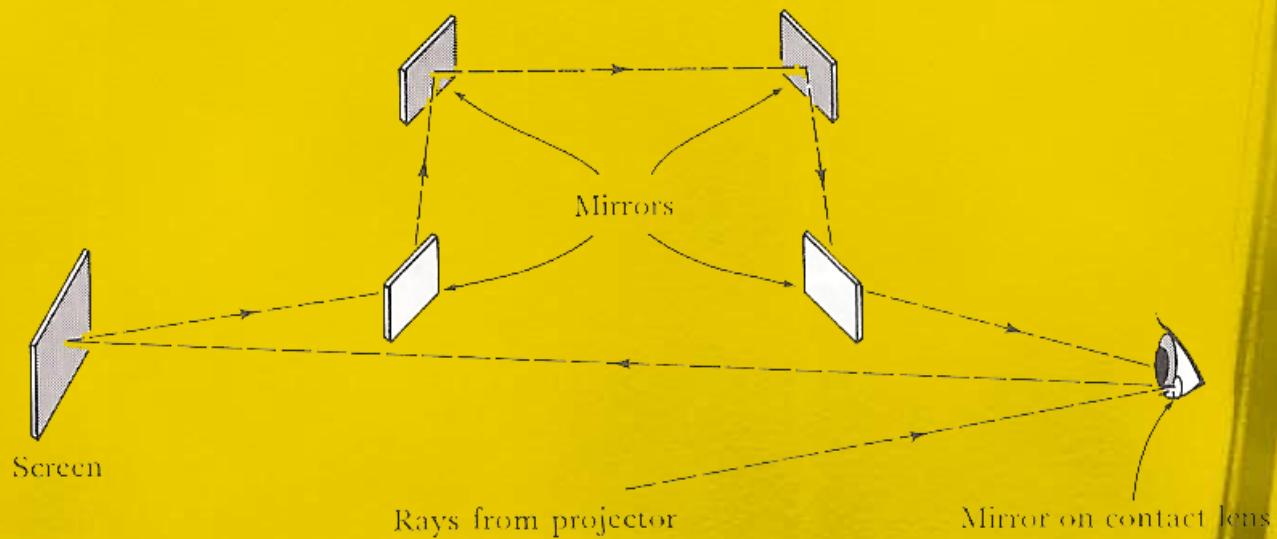
Features

Physiological Nystagmus

Jiggly Eye Movements

FIGURE 1-42

From Riggs, Ratliff,
Cornsweet, and Corn-
sweet (1953).

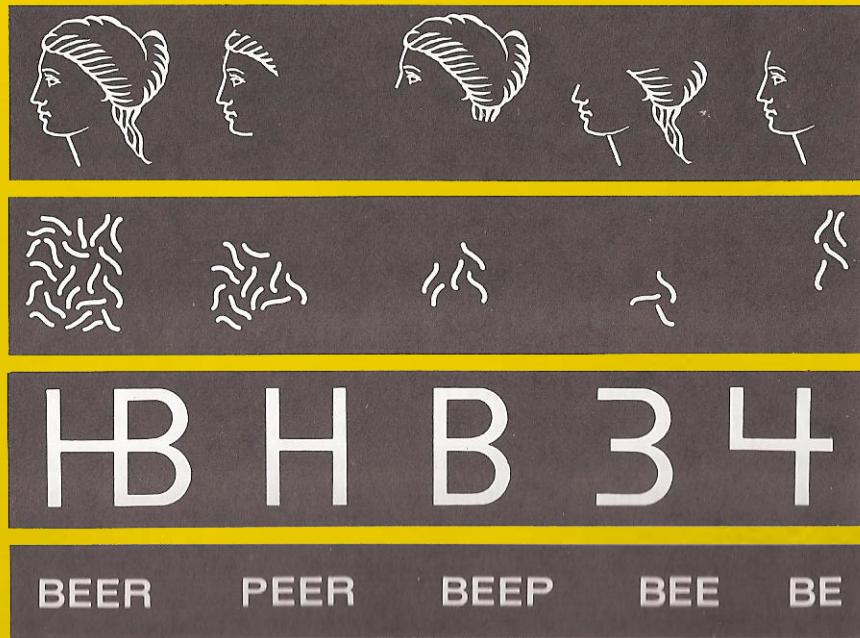


Physiology

Patterns

Features

Segmental Image Loss

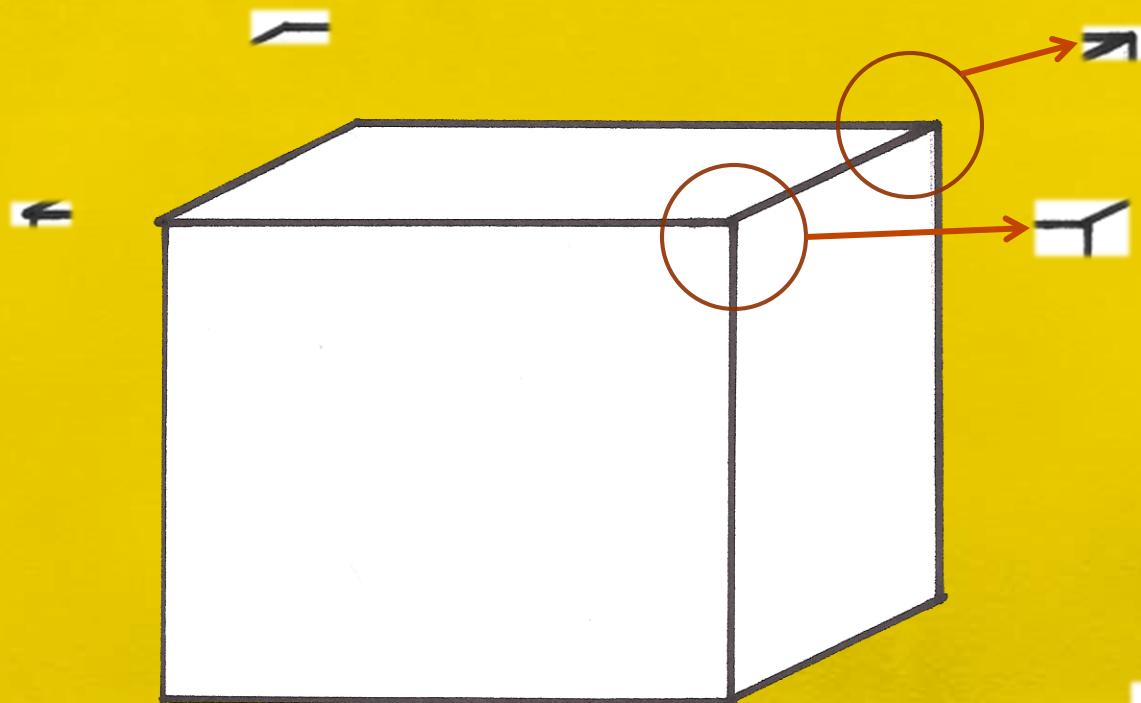


Physiology

Patterns

Features

Object Segmentation into Features

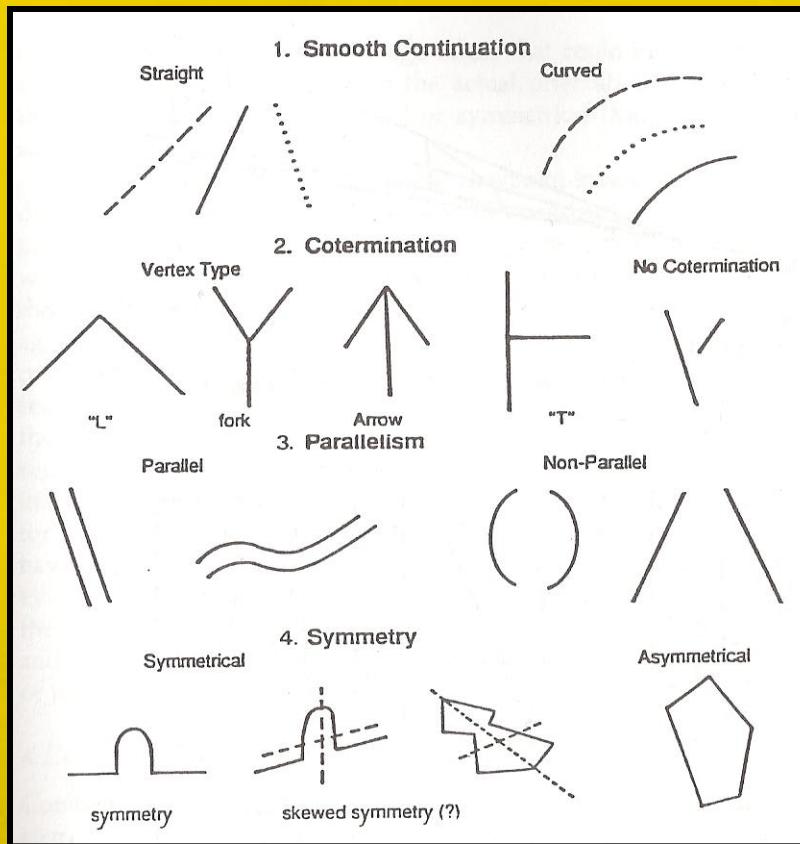


Physiology

Patterns



Feature Classes



Physiology

Patterns

Features

Feature Relation



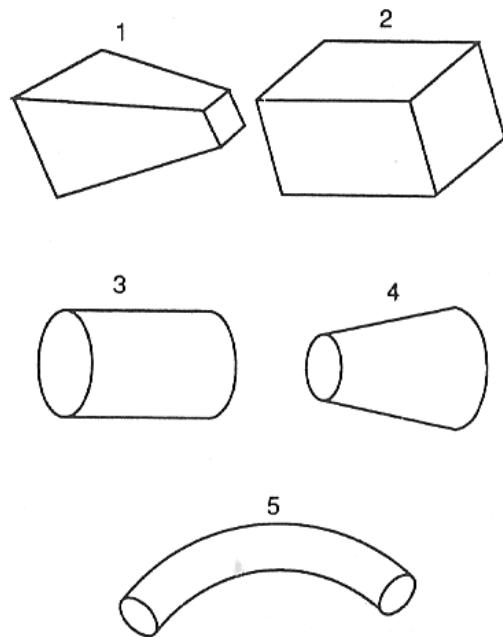
Physiology

Patterns

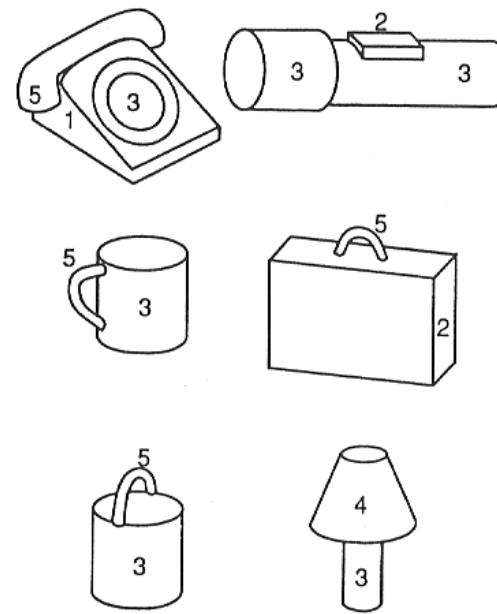
Features

Geons

Geons

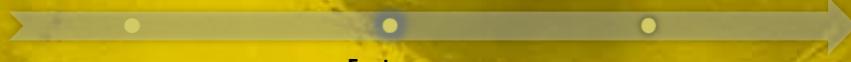


Objects



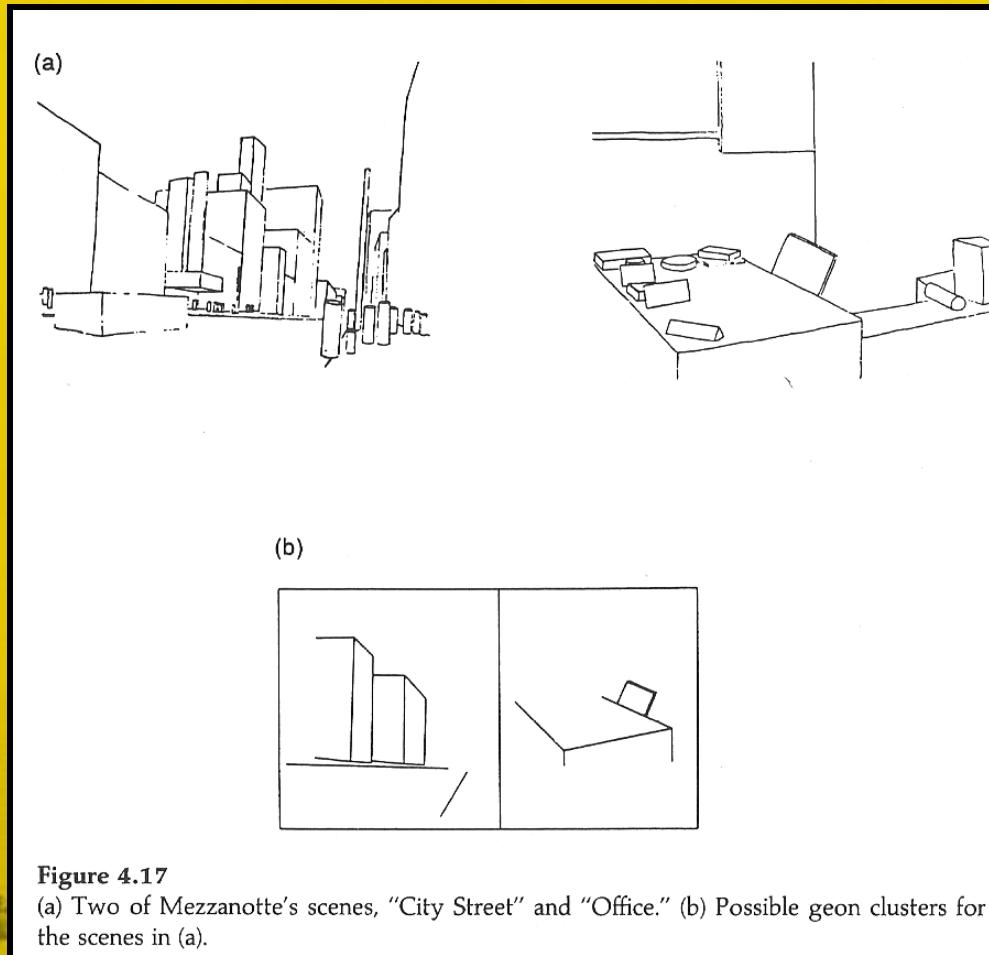
Physiology

Patterns



Features

Geons to Scenes



Physiology

Patterns



Features

Sensory Input

Physiological Features

Simple → Complex → Hypercomplex → Higher-Level

Feature Classes + Feature Relations

Object Segments

Objects

Pandemonium Revisited

PATTERN RECOGNITION

Physiology

Patterns

Features

Words make sense.

SIZE ^{doesn't matter}, orientation ^{nor orientation}, missing information,
~~Intference~~, Variety In Pattern...
and even if orientation turns you on your head.



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