

Perceptual Organization and Pattern Recognition

Lecture 15

Gibson's "Ecological View"

Direct Perception



- All information needed for perception is supplied by the stimulus
- Perceptual systems evolved to extract the stimulation relevant for perception
- Perception is Determined by the Stimulus
 - The whole pattern of proximal stimulus information available in the environment

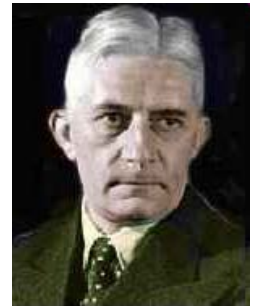
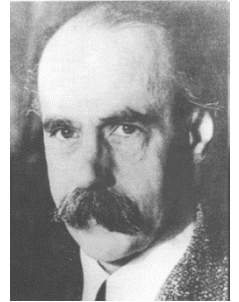
Problems for Ecological Perception

- Conceptual Problem
 - Availability vs. Utilization
- Empirical Problems
 - Organization
 - Pattern Recognition
 - Perceptual Constancies
 - Ambiguous (Reversible) Figures
 - Perceptual Illusions
 - Cultural Differences
 - Perceptual Problem-Solving

Gestalt Principles of Perception

Max Wertheimer (1925); Wolfgang Kohler (1929) ; Kurt Koffka (1935)

- Critique of Structuralism
 - Atomism and the Chemical Analogy
- Holism
 - Emergent Properties



“The whole is *something else*
than the sum of its parts”

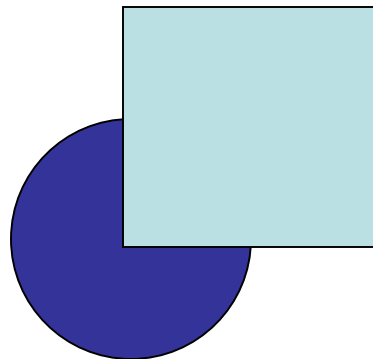
Koffka (1935)

The Law of *Prägnanz* (The Minimum Principle)

Hochberg (1974, 1978)

Perception will be as good
as stimulus conditions allow.

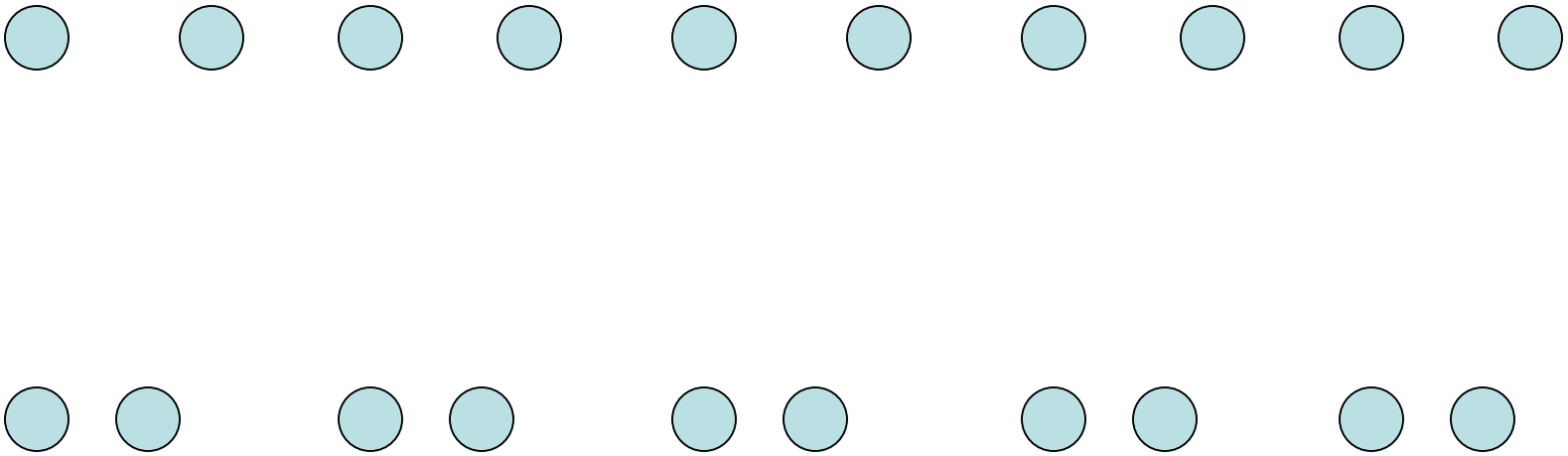
We perceive the simplest or most homogeneous
organization that will fit the sensory pattern



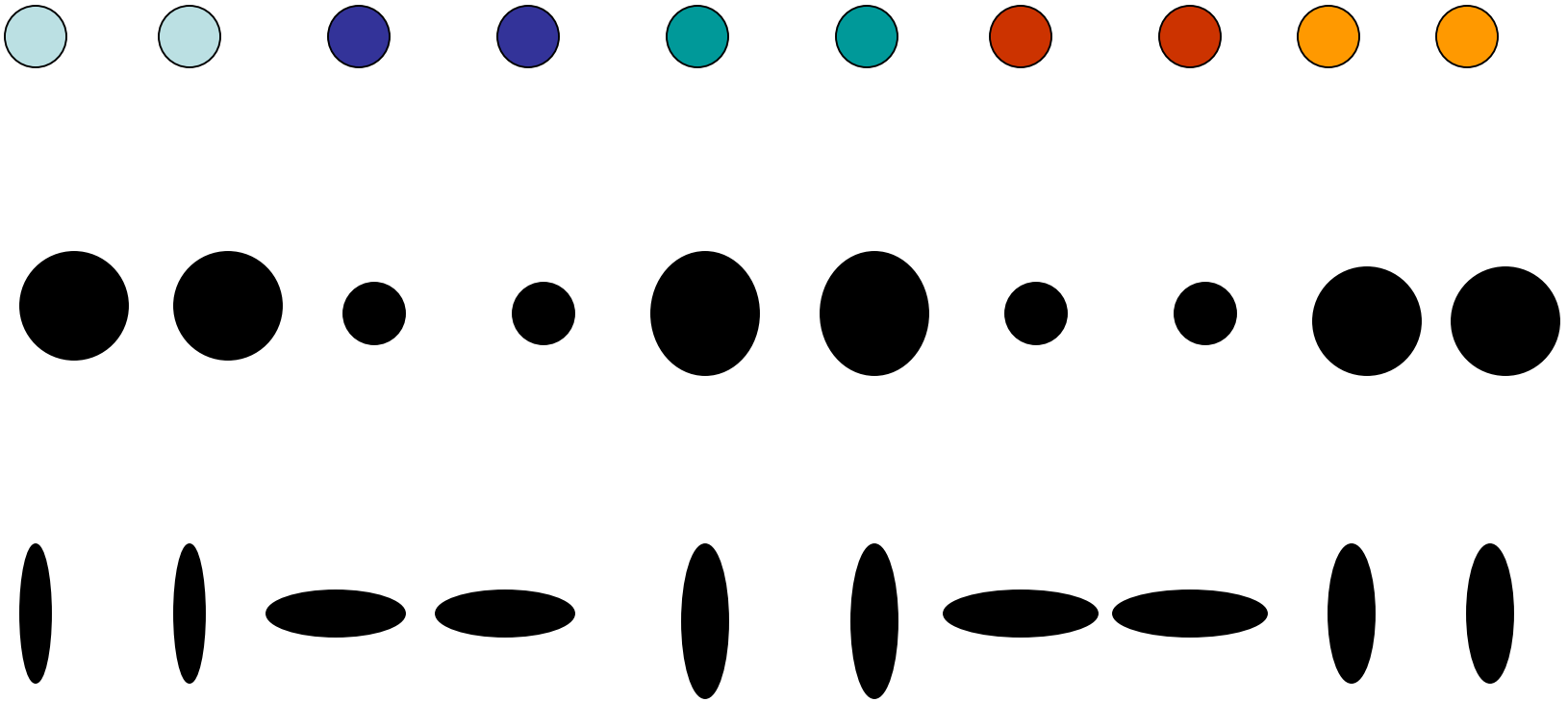
Classical Gestalt Principles of Perception

- Proximity
- Similarity
 - Color, Size, Orientation
- Common Fate
- Symmetry
- Parallelism
- Good Continuation
- Closure

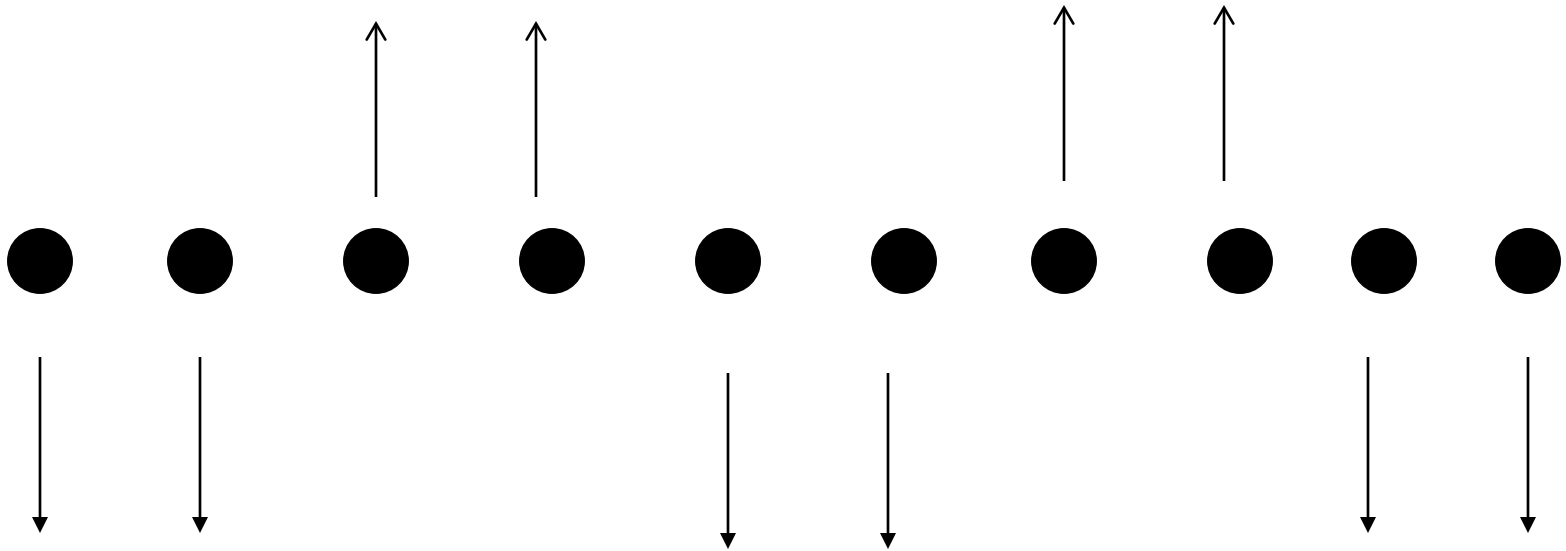
Proximity



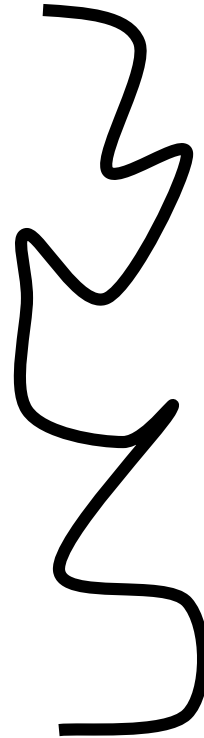
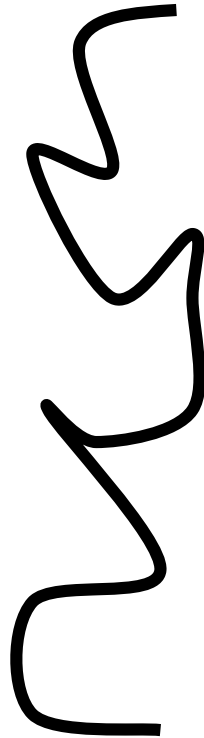
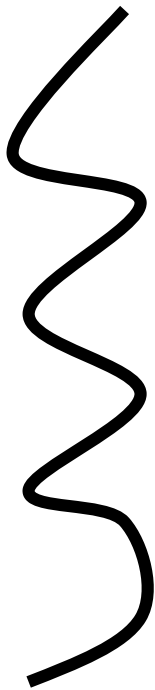
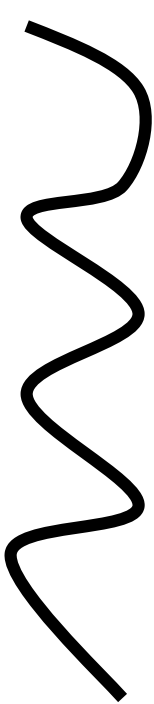
Similarity



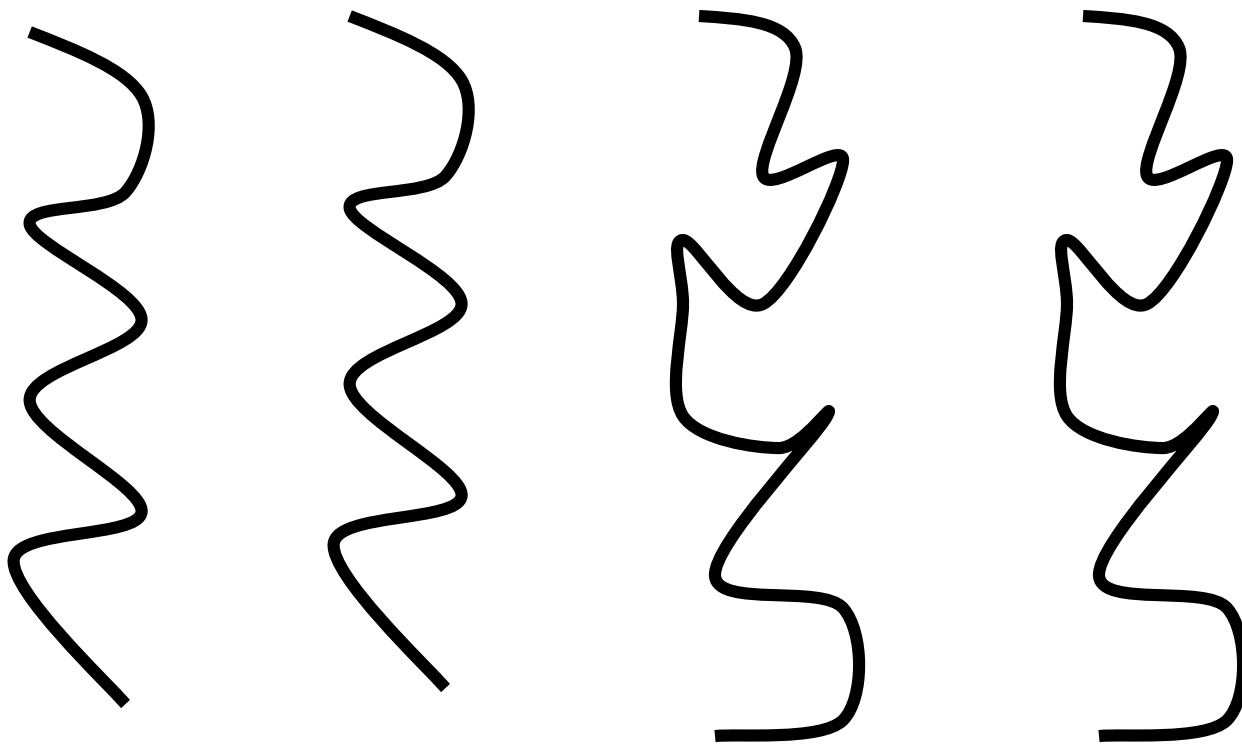
Common Fate



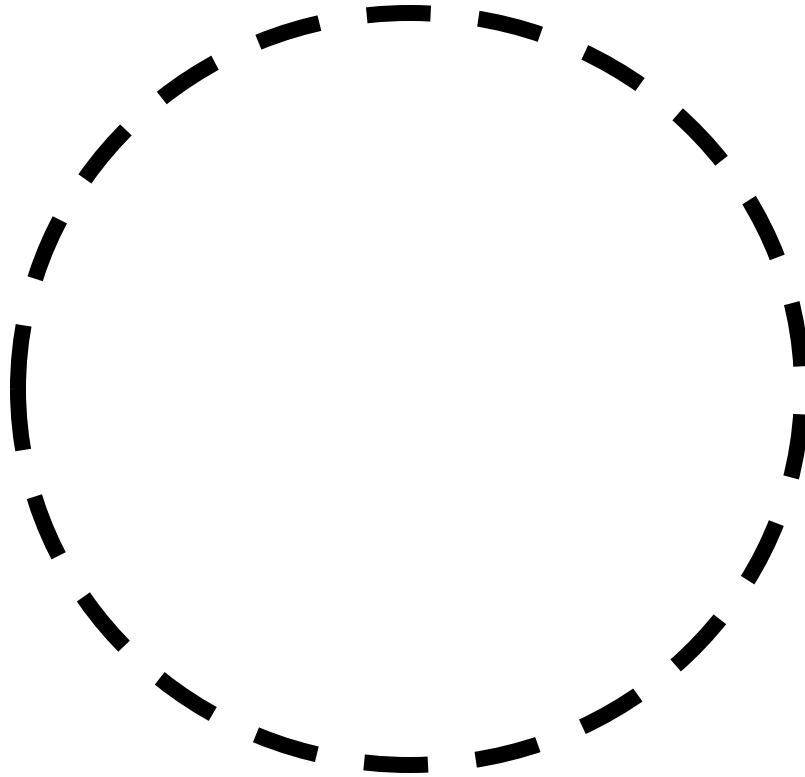
Symmetry



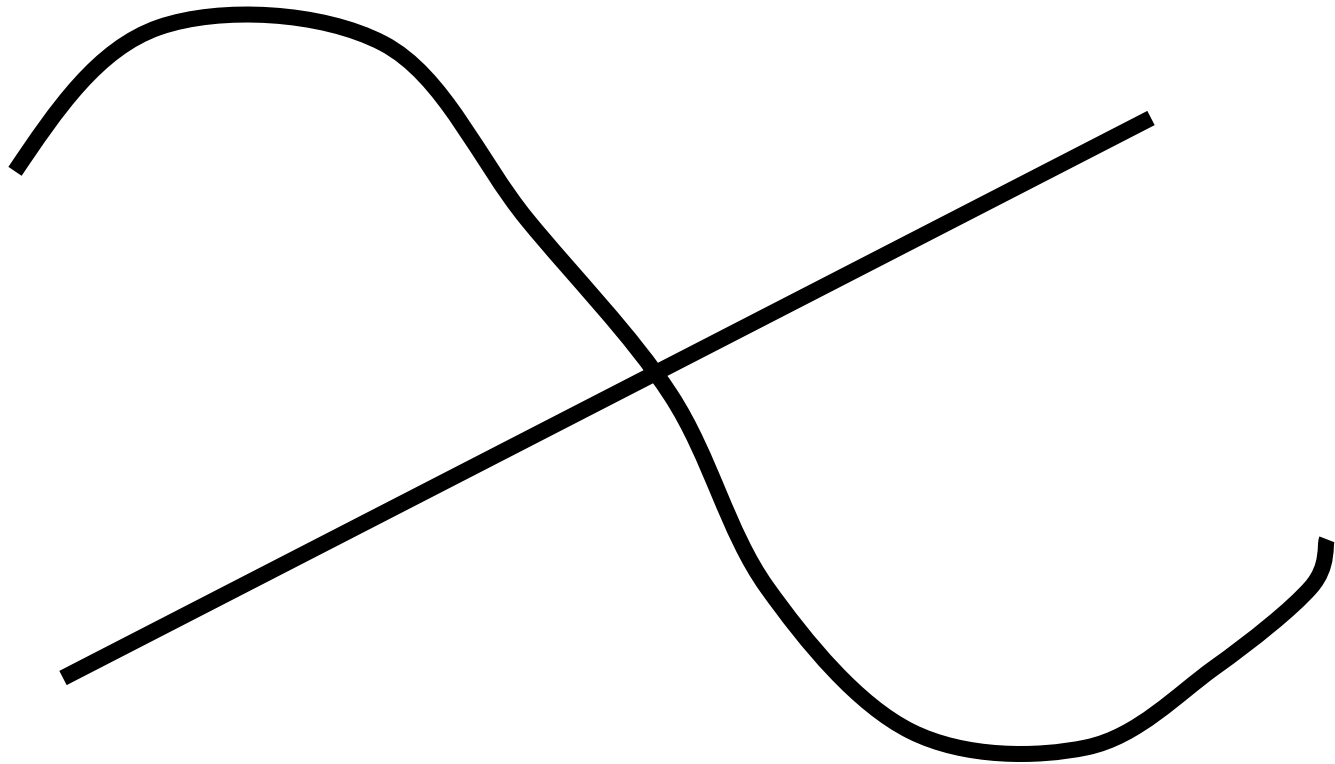
Parallelism



Closure



Good Continuation



New

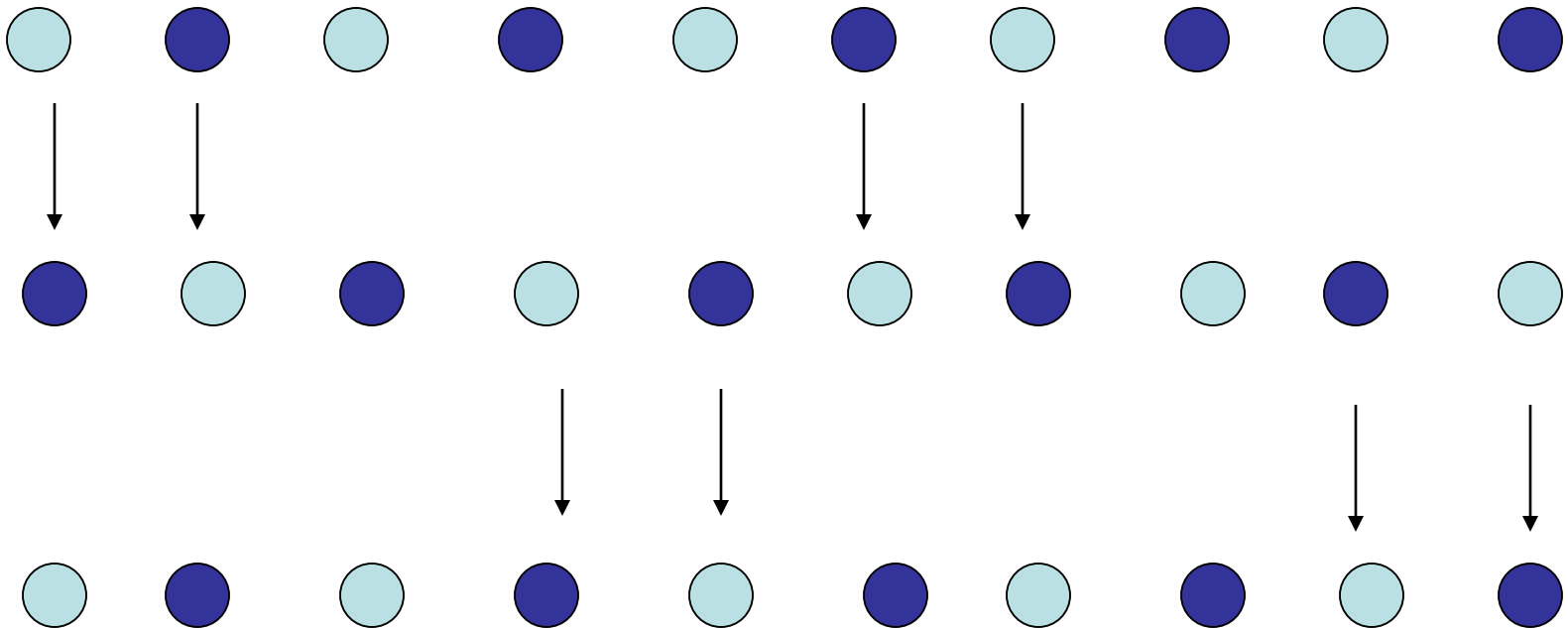
Gestalt Principles of Perception

Palmer (1999)

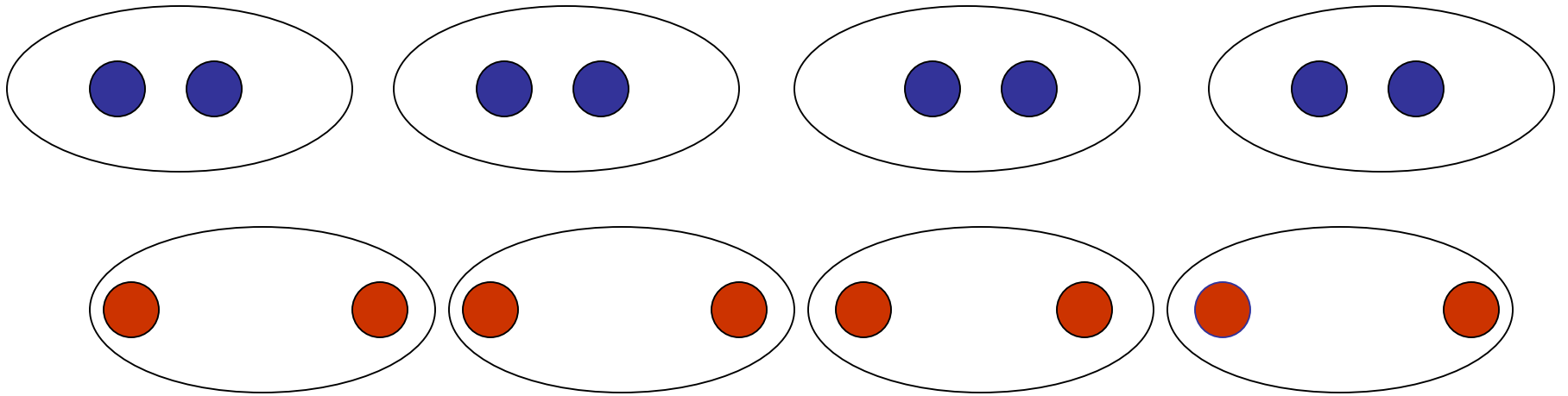
- Synchrony
- Common Region
- Connectedness



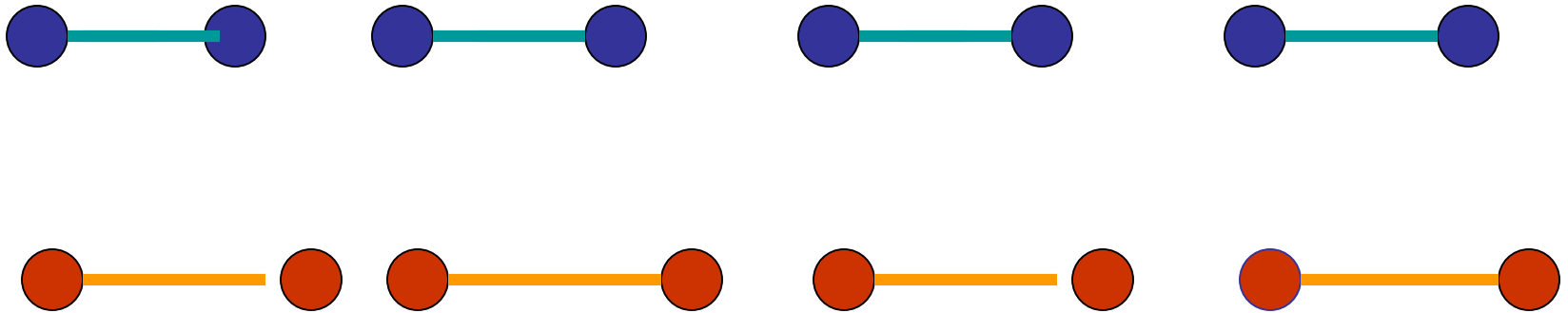
Synchrony



Common Region

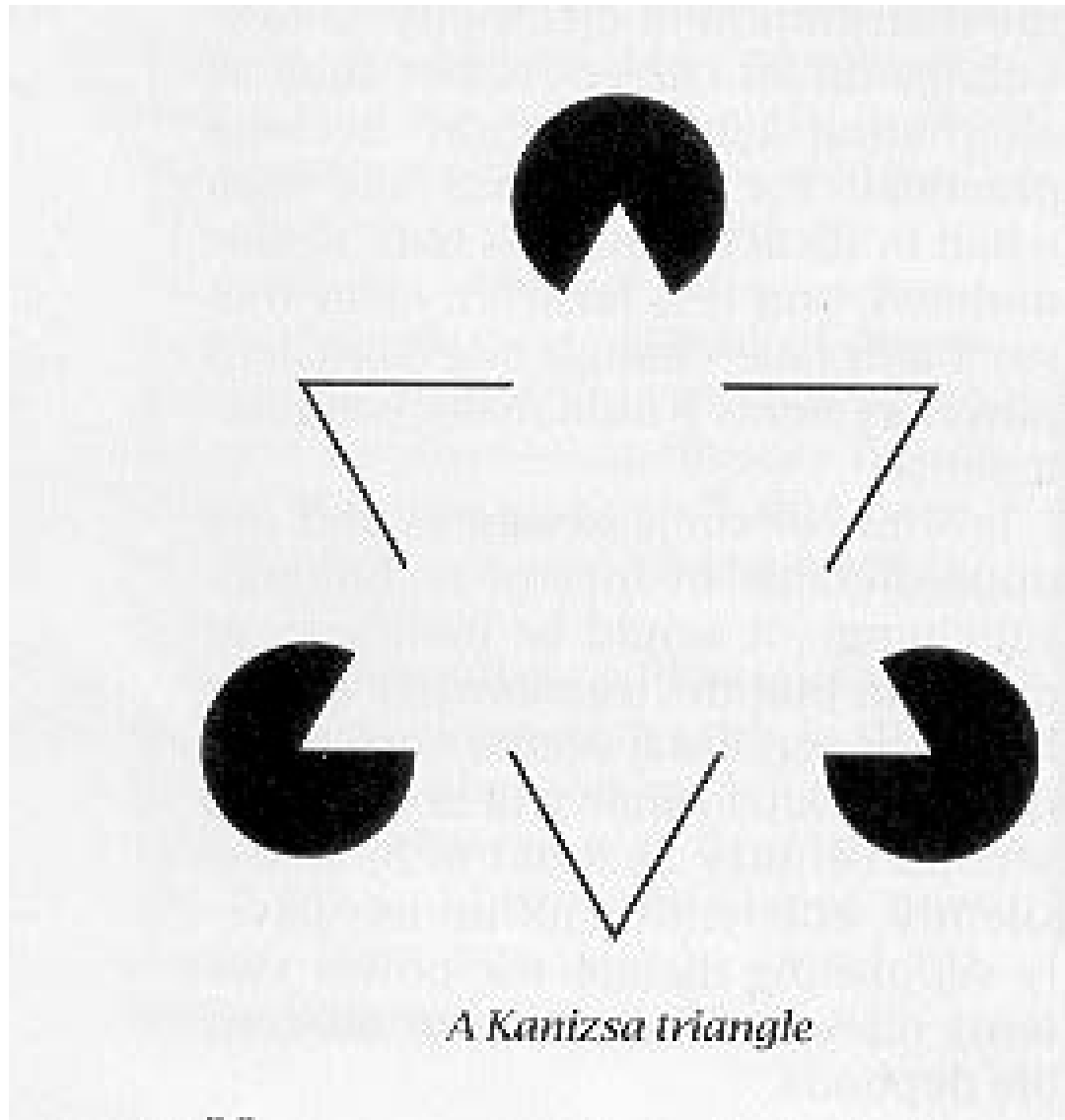


Connectedness



Subjective Contours

Kanizsa (1976)



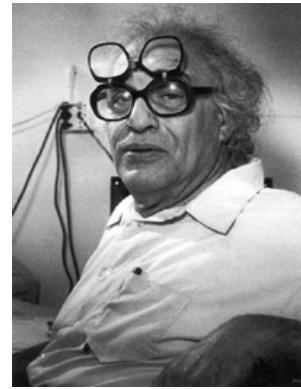
Information-Processing View of Perception

Selfridge (1957); Lindsay & Norman (1977)

- Feature Detection
 - Analyze Stimulus
 - Extract Elementary Features
- Pattern Recognition
 - Synthesize Mental Representation
 - Familiar, Meaningful Configurations

“What the Frog’s Eye Tells the Frog’s Brain”

Lettvin et al. (1959)



- Present Visual Stimulus
- Record Activity in Optic Nerve
 - Single Fiber (or Very Small Bundle)
- Detector Types
 - Sustained Contrast
 - Net Convexity
 - Moving Edge
 - Net Dimming
- “Grandmother Cells”?

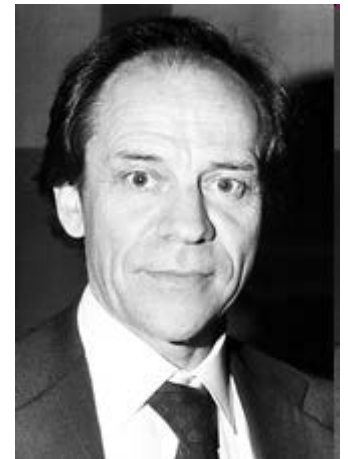


TheFrog.org

Feature Detectors in Visual Cortex

Hubel & Wiesel (1959, 1962)

- Present Stimuli in Visual Field
- Record Activity in Visual Cortex
 - Single Neurons (or Small Bundle)
- Stimulus Features
 - Points of Light/Darkness
 - Edges
 - Bars
 - Angle of Orientation
 - Movement vs. Stability
 - Direction of Movement



Hierarchical Organization of Feature Detectors

Hubel & Wiesel (1959, 1962)

- Simple
 - Location of Feature
- Complex
 - Presence of Feature
- “Hypercomplex”
 - Combinations of Features

English Orthography

- Elementary Features
 - Vertical, Horizontal, Oblique *Lines*
 - Right, Acute *Angles*
 - Continuous, Discontinuous *Curves*

A B O R

German Orthography

B

ß

(*sisset*)

Greek Orthography

Γ “gamma”

Π “pi”

Θ “theta”

Φ “phi”

Ψ “psi”

Ω “omega”

Russian Orthography

Ж “zhe”

Ц “tse”

Ш “sha”

Щ “shcha”

Ы “ee”

Я “ya”

Hebrew Orthography

א “alef”

ב “bet”

ג “nun”

ד “dalet”

ק “qof”

ש “shin”

Arabic Orthography

ا

“alef”

ب

“beh”

ت

“teh”

ث

“theh”

س

“seen”

ش

“sheen”

Hierarchical Coding of Input in Reading

Graphemic Information



I S R Q P

- Feature Detectors
- Letter Codes
- Spelling-Pattern Codes
- Word Codes
- Word-Group Codes
- Innate, Automatic
- Learned
 - Initially Effortful
 - Automated via Practice

Articulatory Features in English

Types of Articulation

- Plosives
- Nasals
- Fricatives
- Laterals
- Trills

PA vs. BA

TA vs. DA

MA vs. NA

W vs. FA vs. VA

Positions of Articulation

- Bilabial
- Labiodental
- Dental
- Alveolar
- Alveopalatal
- Palatal
- Velar
- Glottal

Sample Language Differences in Phonology

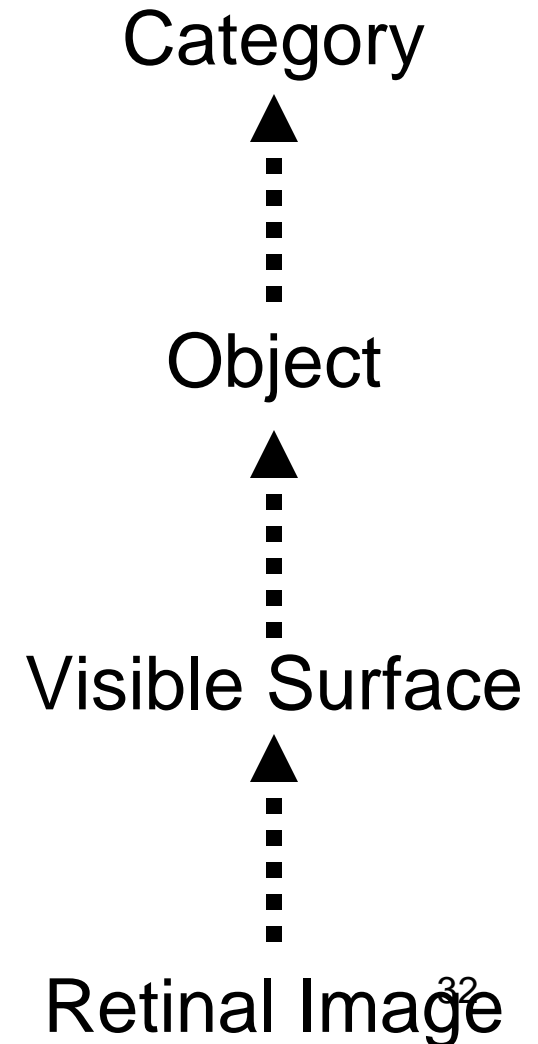
- English: 40 phonemes
- Hawaiian: 14 phonemes
 - “glottal stop”
 - *humuhumunukunukuapua'a*
 - Hawai'i, Kaua'i
- German: **ch** as in *Ach!* or *Bach*
- Russian: **Щ**, *shcha*
- Khoisan: **!** and **ǀ**, “click”



“Bottom-Up” Processing in Perception

After Marr (1982)

- Bottom-Up Processing
 - Data-Driven
 - Perceptually Driven
 - Input: Low-Level Representation
 - Output: Higher-Level Representation



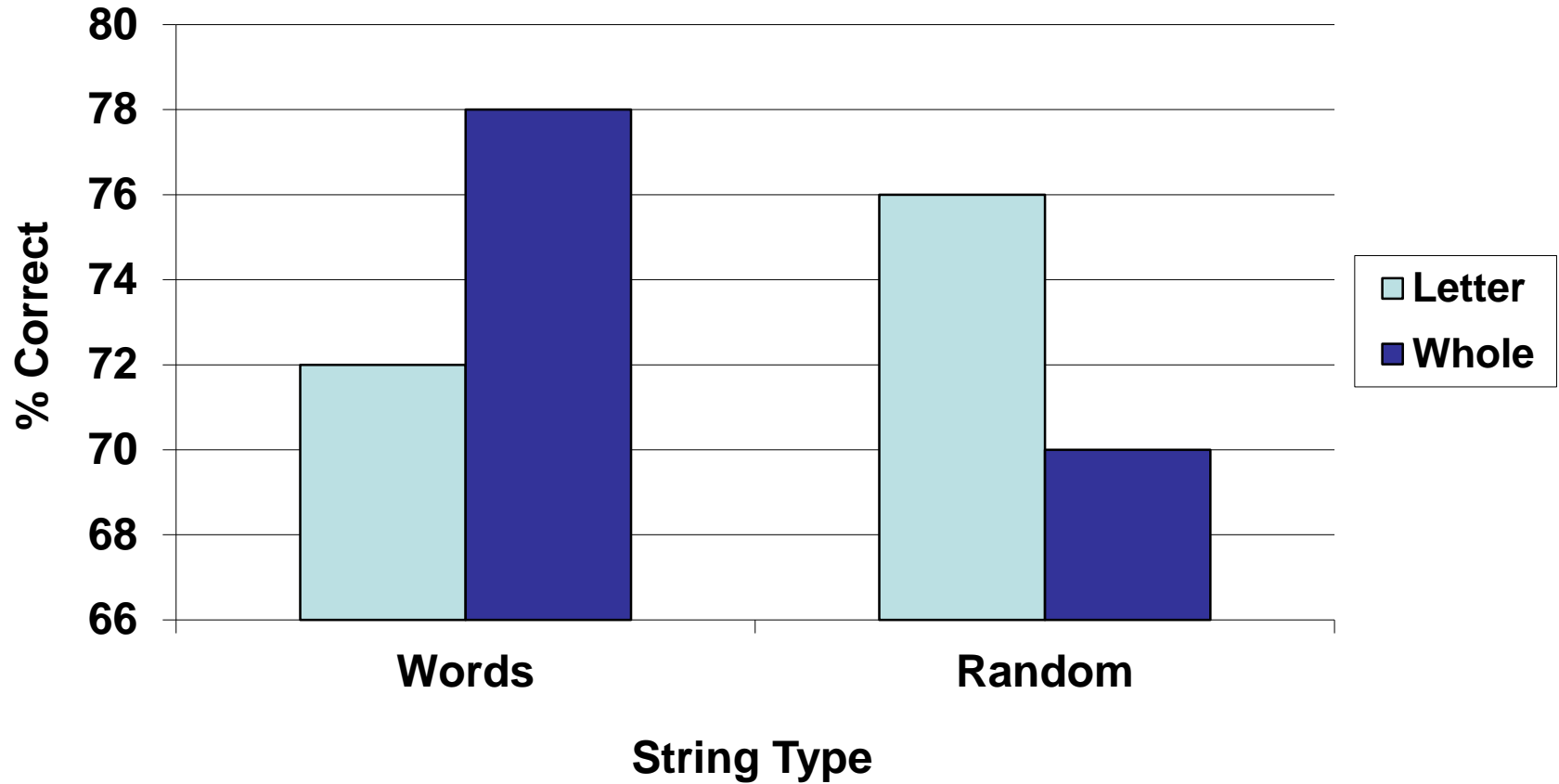
The Word-Letter Phenomenon

Johnston & McClelland (1974), after Reicher (1969), Wheeler (1970)

- Word Superiority Effect
 - COIN vs. JOIN > C vs. J
- Detect Letter in 4-Letter String
 - Words (COIN) vs. Random Strings (CPRD)
- Instructional Conditions
 - “Try to see the whole word”
 - “Fixate on particular letter position”

The Word-Letter Phenomenon

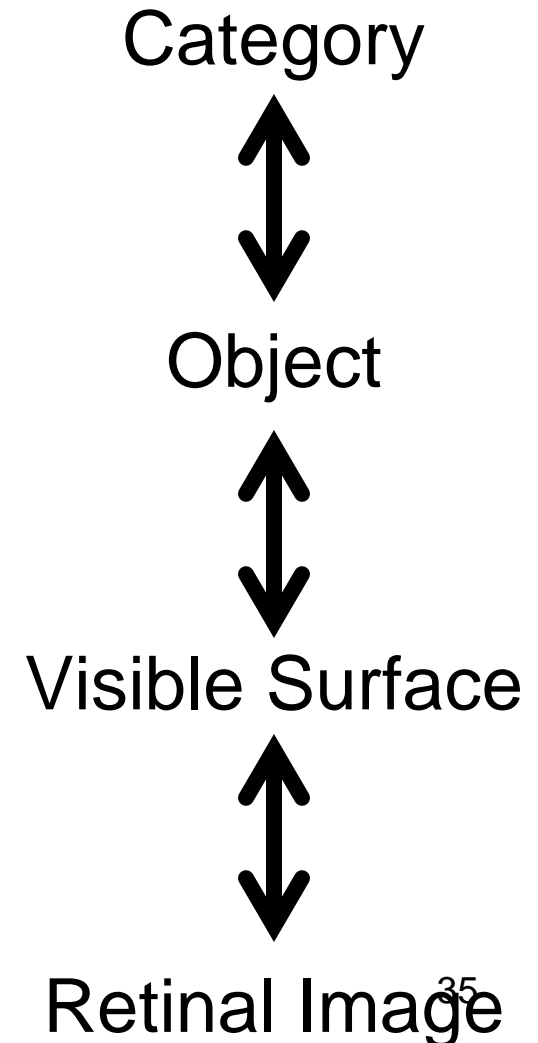
Johnston & McClelland (1974), after Reicher (1969), Wheeler (1970)



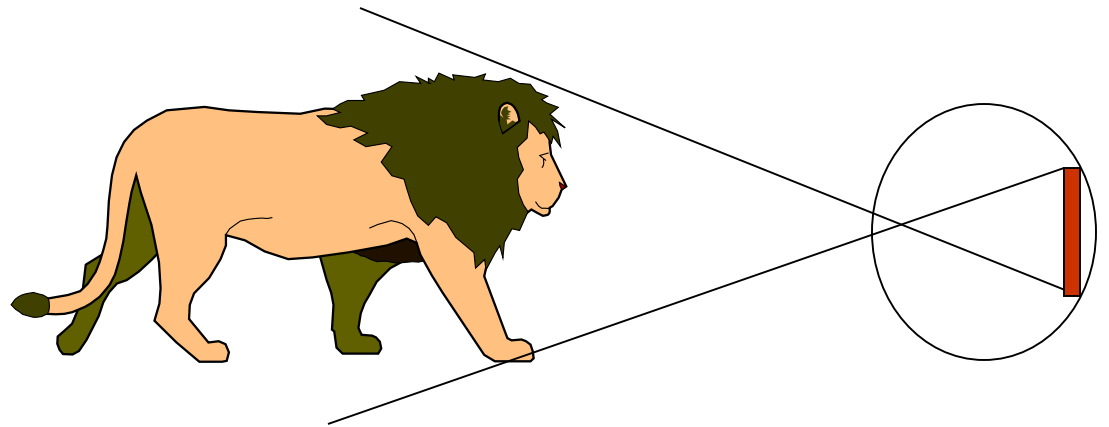
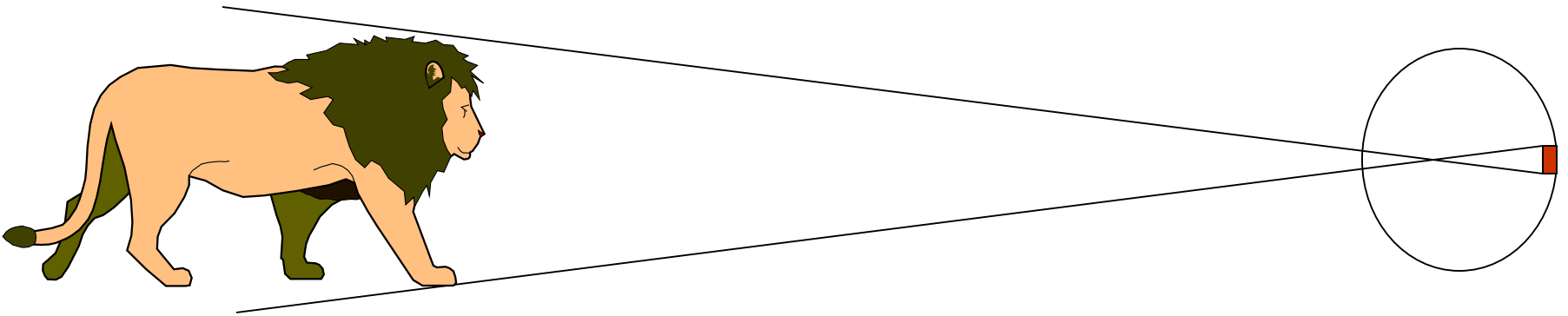
“Top-Down” vs. “Bottom-Up” Processing in Perception

After Marr (1982)

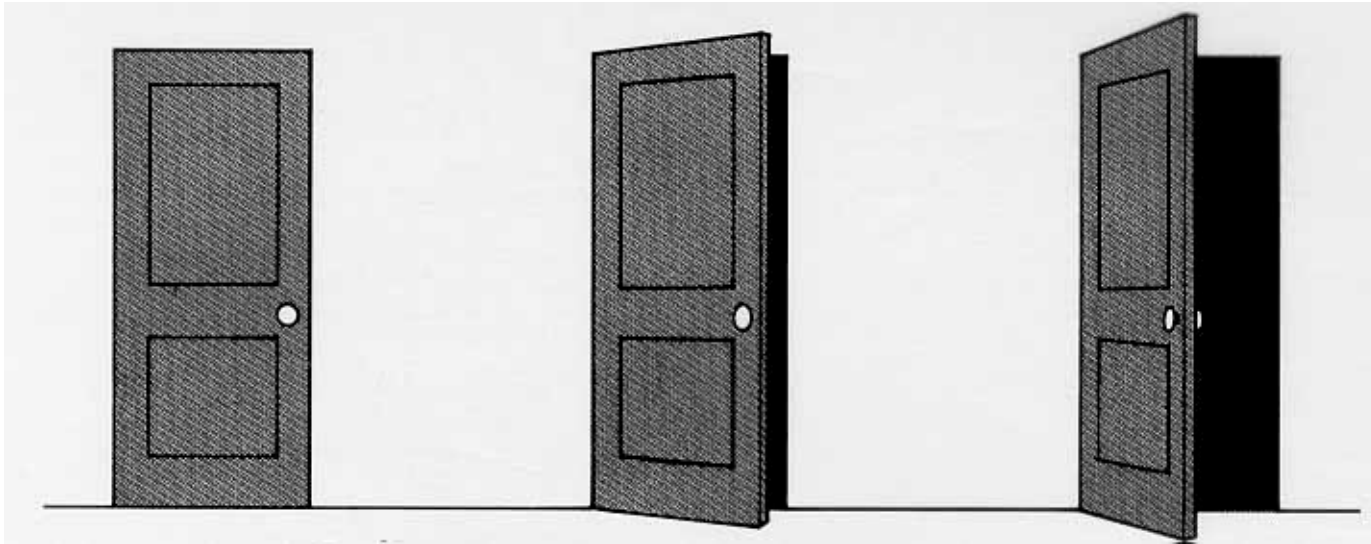
- Bottom-Up Processing
 - Data-Driven
 - Perceptually Driven
 - Input: Low-Level Representation
 - Output: Higher-Level Representation
- Top-Down Processing
 - Conceptually Driven
 - Hypothesis-Driven
 - Expectation Driven
 - Input: Higher-Level Representation
 - Output: Lower-Level Representation



Size Constancy



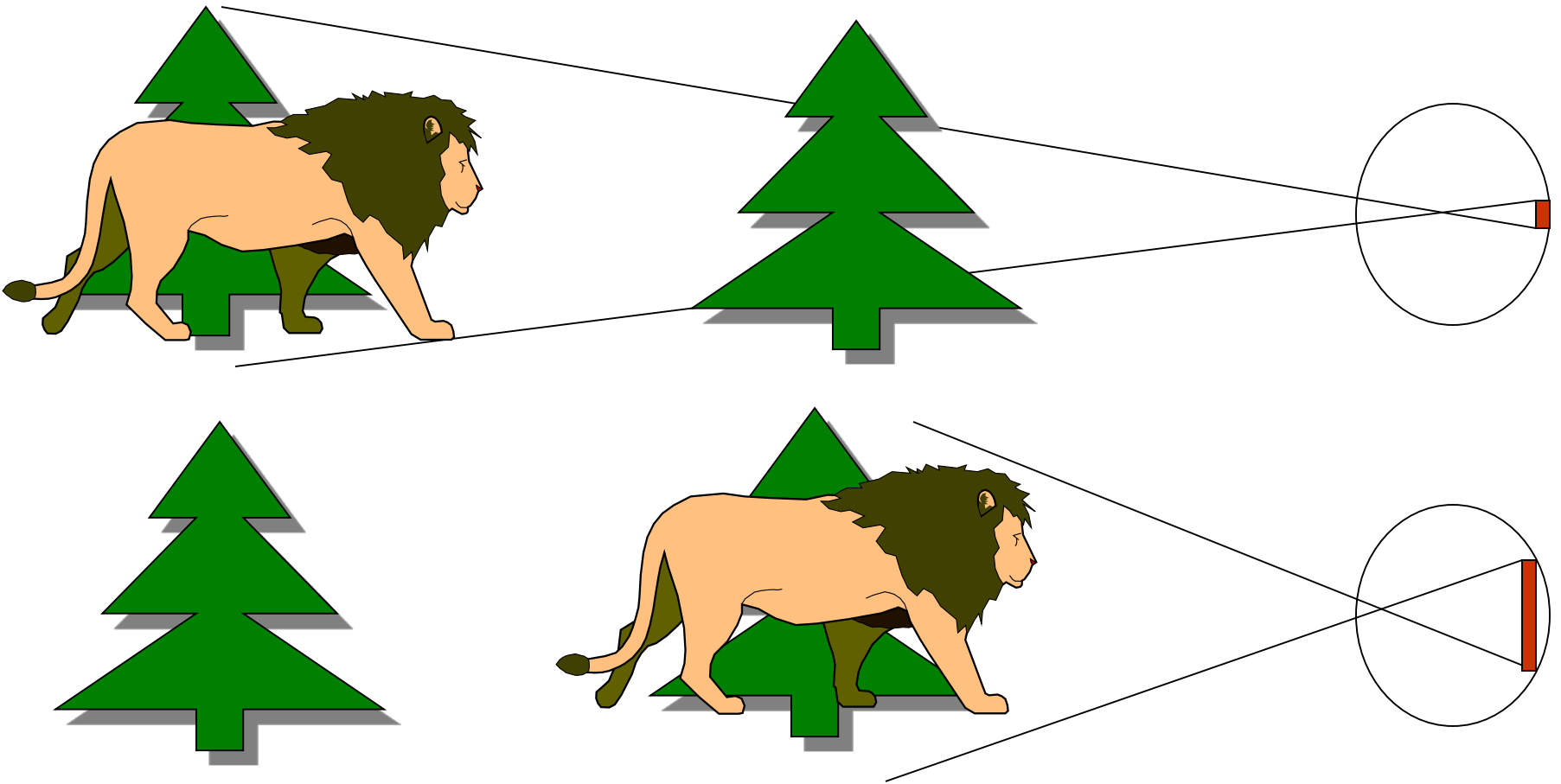
Shape Constancy



Perceptual Constancies

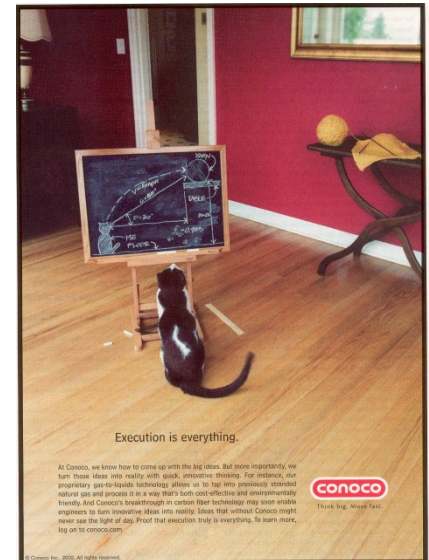
- Pattern of proximal stimulation changes
 - Retinal image gets larger
- Perception of distal stimulus is constant
 - Object perceived as getting closer
 - Perceived size stays the same

Figure and Ground in Size Constancy



Two Sources of Constancy

- Gibson: Ratios
 - Comparison of object with background
 - Consistent with ecological view
 - All information needed by stimulus



- Helmholtz: Unconscious Inferences
 - Unaware of Performing Calculations
 - Cannot Specify What They Are
 - Know operation only by inference