

Computer Vision

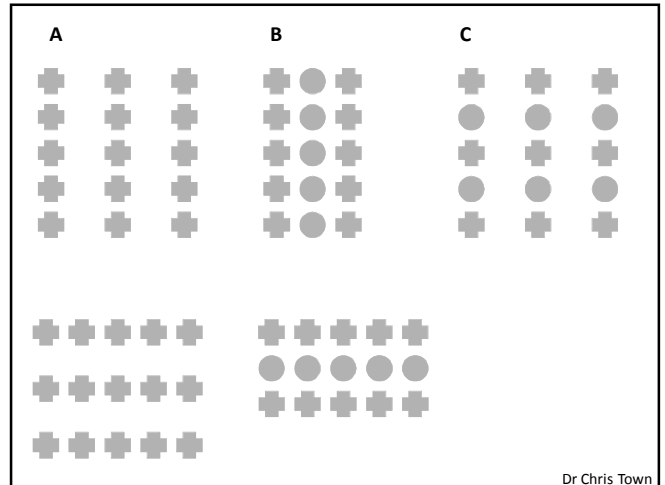
Computer Science Tripos Part II

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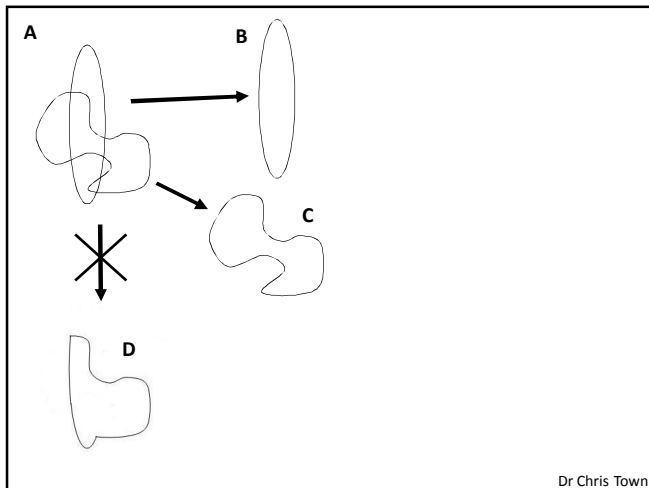
9. Perceptual psychology and visual cognition. Visual illusions.



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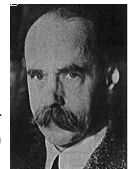
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Gestalt Theory

- Gestalt: a meaningful “whole” or “group”
 - Whole is greater than the sum of its parts
 - Relationships among parts can yield new properties/features
- Psychologists identified a series of principles (laws) of perceptual organisation

“I stand at the window and see a house, trees, sky. Theoretically I might say there were 327 brightnesses and nuances of colour. Do I have “327”? No. I have sky, house, and trees.”

Max Wertheimer
(1880-1943)

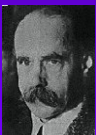


<http://psy.ed.asu.edu/~classics/Wertheimer/Forms/forms.htm>

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Gestaltism


Perception results from the interaction between the intrinsic structure of the stimulus and the intrinsic structure of the brain.



Max
Wertheimer



Wolfgang
Köhler



Kurt
Koffka

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Gestaltism

Principles of Gestalt Theory

Holism:
The whole is different from the sum of its parts.

Prägnanz: (saliency, conciseness)
The percept will be as “good” as the prevailing conditions allow, i.e. simplest explanation

Nativism:
Not a total rejection of learning, but rejection of its primacy.

Gestaltism

Holism: The whole is different from the sum of its parts.

Emergent properties:
Features of a configuration that are not features of its components, e.g.:

- length
- orientation
- curvature
- closure
- connectedness

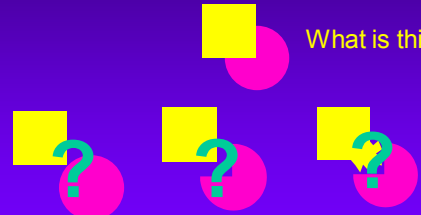


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Gestaltism

Prägnanz: the percept will be as "good" as the prevailing conditions allow

What is this?



square & circle? square & pacman? squigit & pacman? etc....

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Principles of Perceptual Organisation









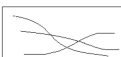

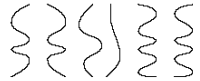
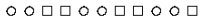



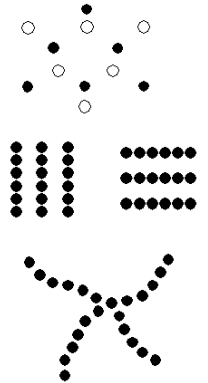
<ul style="list-style-type: none">  Not grouped  Proximity  Similarity  Similarity  Common Fate  Common Region 	<ul style="list-style-type: none">  Parallelism  Symmetry  Continuity  Closure
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Image source: Forsyth & Ponce Dr Chris Town

<ul style="list-style-type: none"> (a)  Symmetry (b)  Similarity (c)  Proximity (d)  Closure (e)  Smoothness 	
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Gestalt Theory

Koffka noted in 1935:


"...to apply the Gestalt category means to find out which parts of nature belong as parts to functional wholes, to discover their position in these wholes, their degree of relative independence, and the articulation of larger wholes into sub-wholes."

Max Wertheimer


"There are wholes, the behaviour of which is not determined by that of their individual elements, but where the part-processes are themselves determined by the intrinsic nature of the whole (...). This problem cannot be solved by listing possibilities for systematisation, classification, and arrangement. If it is to be attacked at all, we must be guided by the spirit of the new method and by the concrete nature of the things themselves which we are studying, and set ourselves to penetrate to that which is really given by nature."

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Influences of grouping



a



b



c

Grouping influences other perceptual mechanisms such as lightness perception

<http://web.mit.edu/people/adebon/publications/gazzanoni/koffka.html> Dr Chris Town

The importance of context

12
13
14

A B C

12
A B C
14

12
A B C
14

12
A B C
14

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The importance of context

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PRINCIPLE OF NON-ACCIDENTALNESS: Critical information is unlikely to be a consequence of an accident of viewpoint.

Three Space Inference from Image Features

2-D Relation	3-D Inference	Examples
1. Collinearity of points or lines	Collinearity in 3-Space	
2. Curvilinearity of points of force	Curvilinearity in 3-Space	
3. Symmetry (Skew Symmetry?)	Symmetry in 3-Space	
4. Parallel Curves (Over Small Visual Angles)	Curves are parallel in 3-Space	
5. Vertices—two or more terminations of a common point	Curves terminate at a common point in 3-Space	 "L" "Fork" "Arrow"

Figure 4. Five nonaccidental relations. (From Figure 5.2, *Perceptual organization and visual recognition* [p. 77] by David Lowe, Unpublished doctoral dissertation, Stanford University. Adapted by permission.)

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Some Nonaccidental Differences Between a Brick and a Cylinder

Brick

Cylinder

The high speed and accuracy of determining a given **non-accidental** relation (e.g., whether some pattern is symmetrical) should be contrasted with performance in making absolute quantitative judgments of variations in a single physical attribute, such as length of a segment or degree of tilt or curvature.

Object recognition is performed by humans in around 100ms or less.

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Locus of Deletion

Proportion Contour Deleted	At Midsegment	At Vertex
25%		
45%		
65%		
	Recoverable	Unrecoverable

"If contours are deleted at a vertex they can be restored, as long as there is no accidental filling-in. The greater disruption from vertex deletion is expected on the basis of their importance as diagnostic image features for the components."

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Figure 7. The first row depicts the final parts comprising Layer II obtained for (a) Clipsarts and (b) Abstracts. The variances of position distributions of parts, relative to the central part, are depicted in the middle. The feature probabilities are listed in the last row.

Figure 8. (a) Examples of Layer 3 parts, (b) variances of positions of the surrounding subparts.

Fidler & Leonardis, CVPR'02; Fidler, Boben & Leonardis, CVRR 2008

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Constructivism

Tilted room illusion

A. Actual Situation

B. Perceived Situation

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Constructivism

Unconscious Inference: the process of recovering environmental information by logically combining retinal information with heuristic assumptions.

Tilted room illusion: If you assume that the walls and floor of the room are vertical and horizontal, then you must be tilted —and you feel that way!

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- **Likelihood Principle:** “we will perceive the object that is most likely to be the cause of our sensory stimulation” (Helmholtz)
- **Hypothesis Testing:** “we may think of sensory stimulation as providing data for hypotheses concerning the state of the external world” (Richard Gregory)

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“The intelligent eye”: Richard Gregory

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Vision as a Cycle of Perception

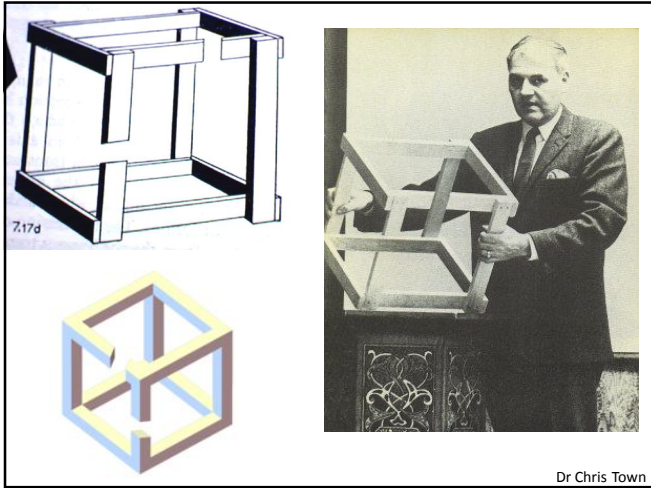
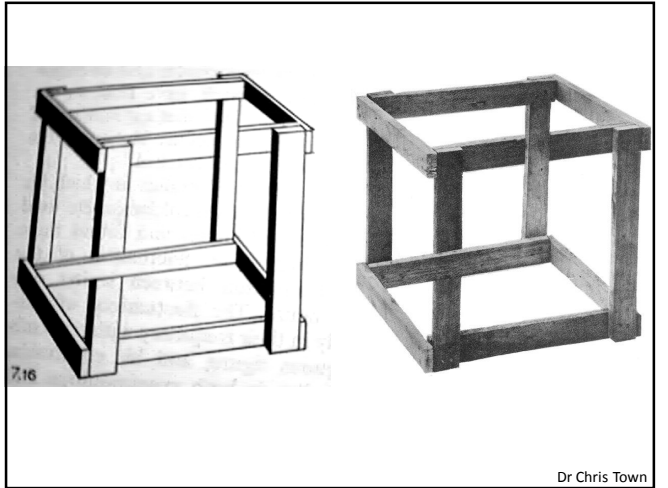
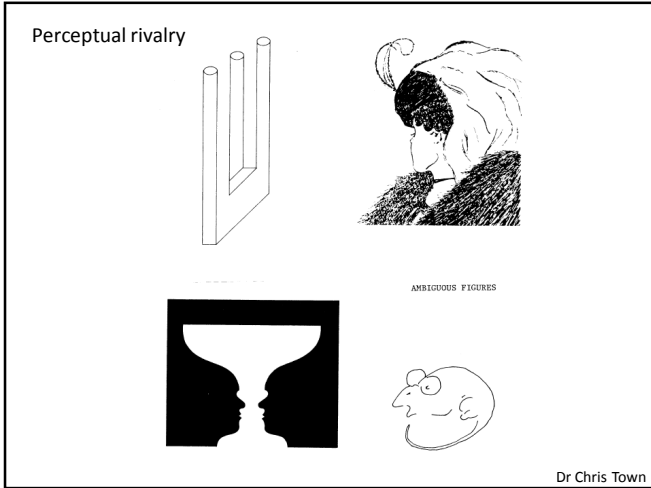
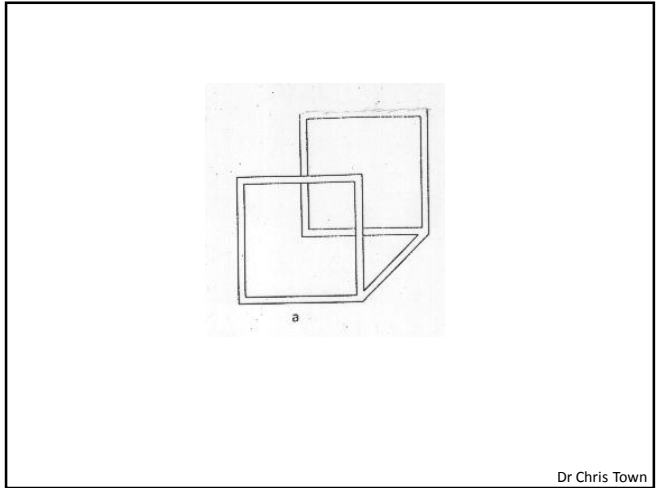
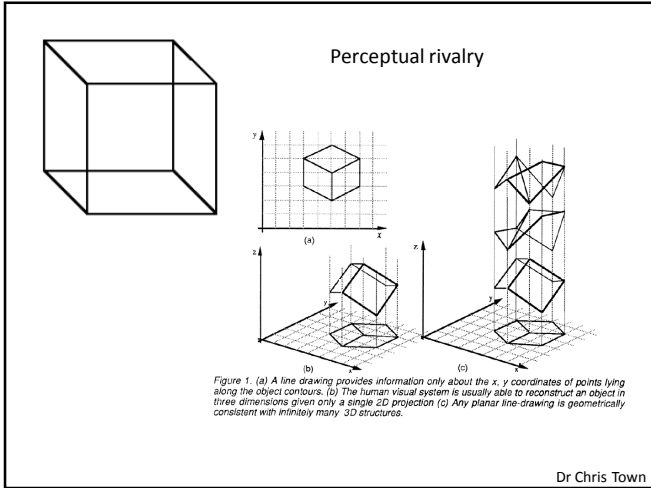
The **Hermeneutical cycle** for iterative interpretation in a generative (hypothesis and test) approach.

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Vision as Graphics

Richard Gregory argues this sort of illusion happens because we are not used to seeing hollow faces, and therefore our beliefs and expectations are applied to make best sense of the data.
-> top-down rather than bottom-up (as in the Marr theory)

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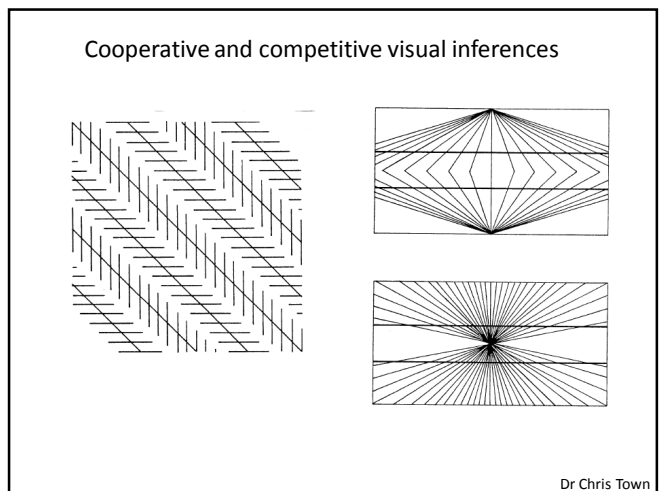
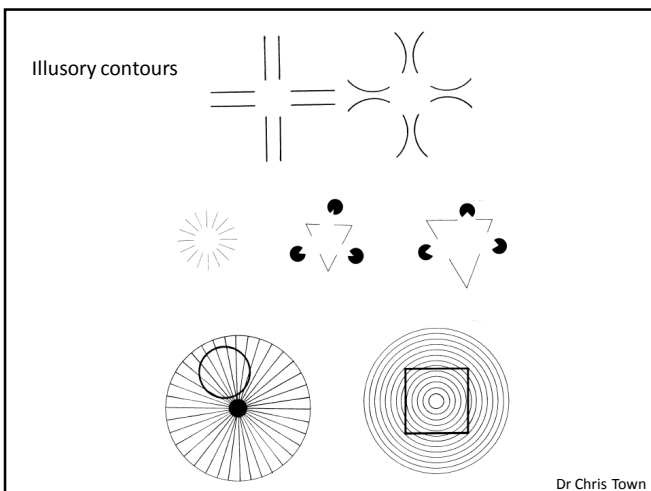
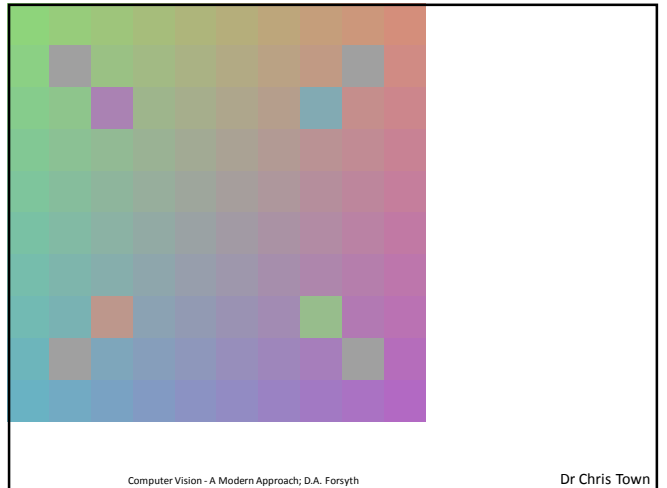
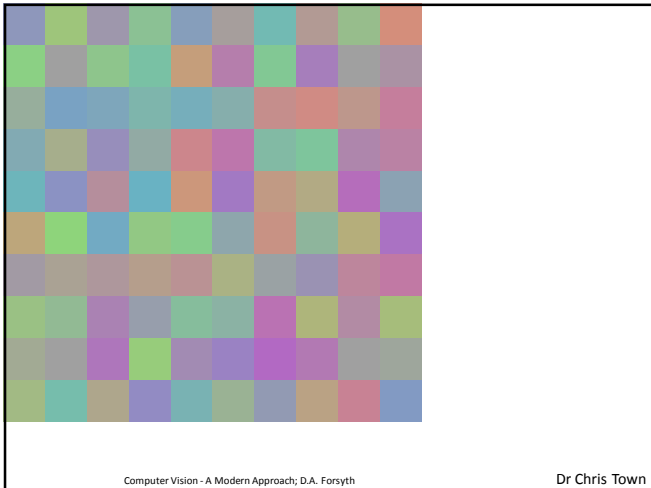
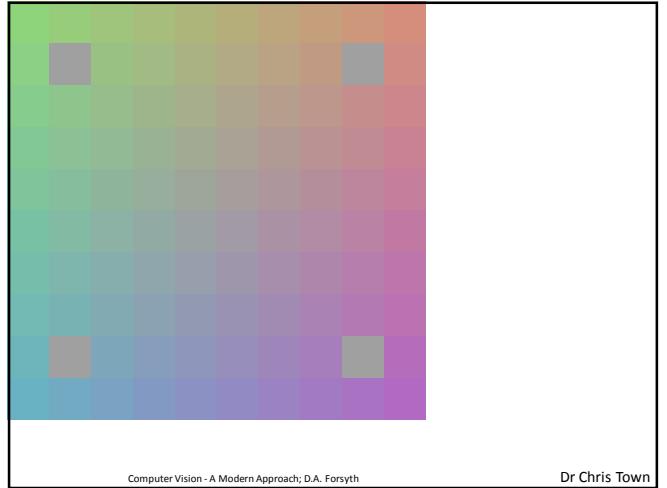
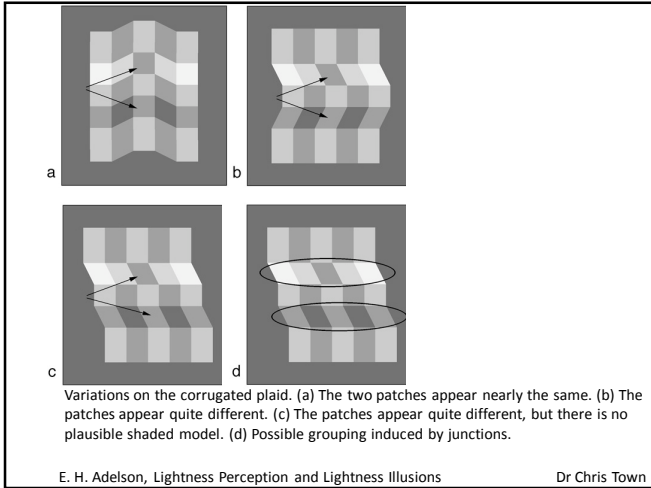


Name that Colour

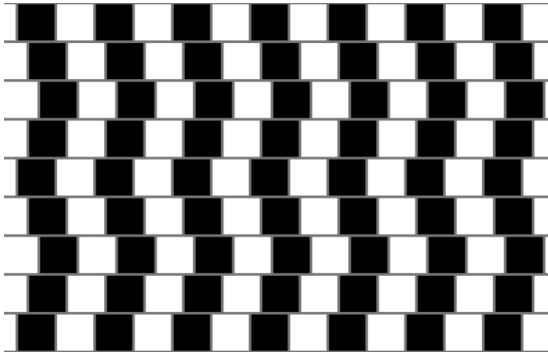
Blue Red Green Cyan
 Magenta Black Pink
 Yellow Orange Violet
 Brown Purple Cyan
 Indigo Red Green Blue

High level interactions affect perception and processing.

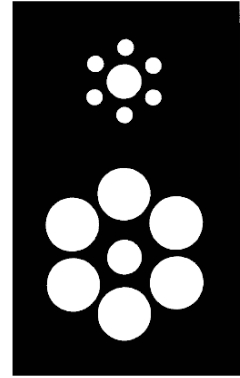
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Richard Gregory's "Café Wall Illusion"

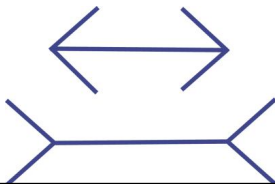
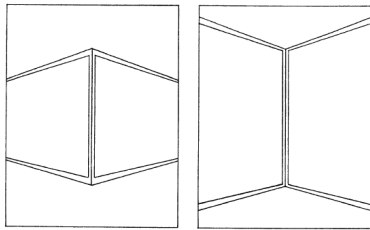


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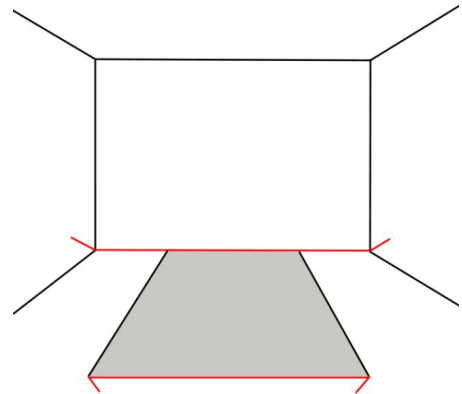


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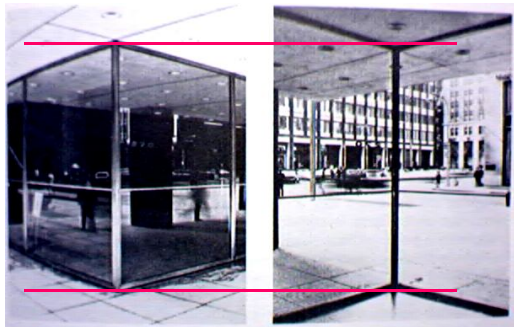
Müller-Lyer illusion



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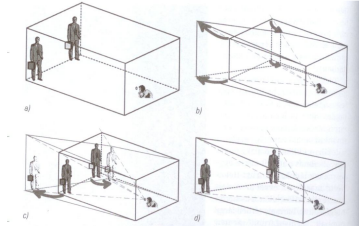
The Ames room



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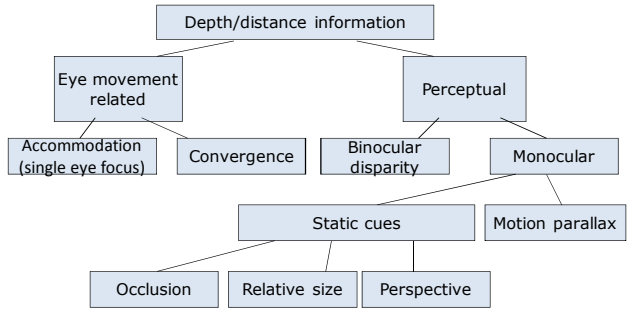
What is the trick?

- Viewed with one eye only
- The unusual shape of the room is not reflected in the retinal image

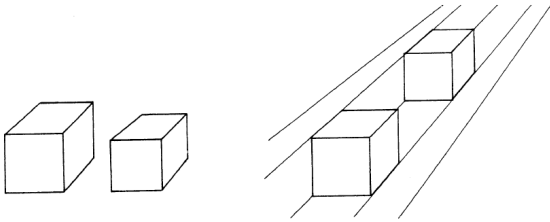


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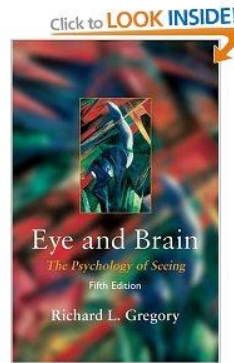
Depth perception arises from a variety of depth cues



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Eye and Brain: The Psychology of Seeing
[Richard L. Gregory](#)

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