

Cognitive (Neuro) Psychology

V. Perceiving and recognizing objects

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What do you see?



What do you see?



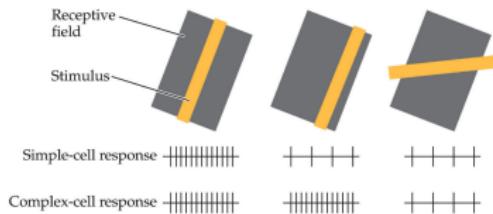
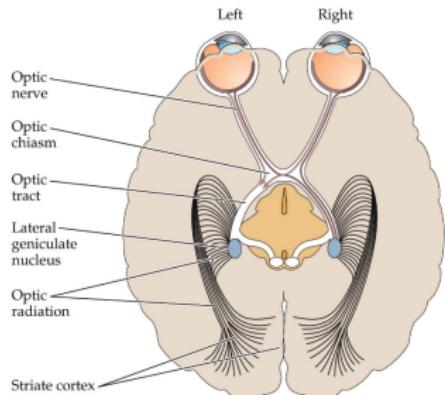
What do you see?



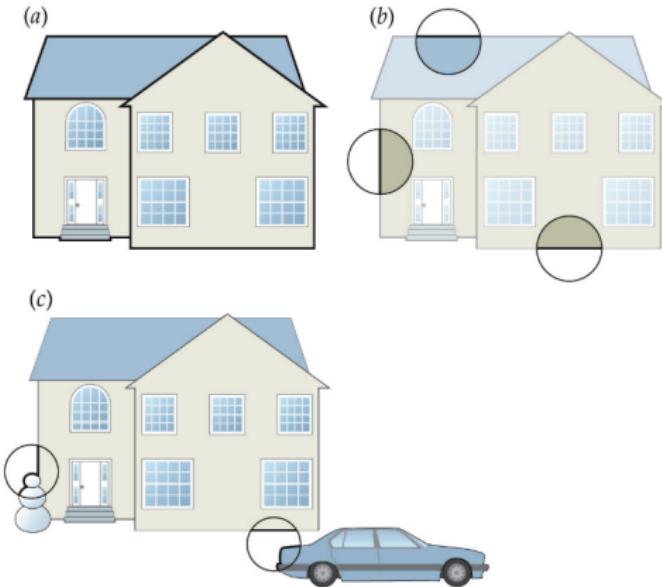
The problem of object recognition

- The pictures were just a bunch of pixels on a screen, but in each case you perceived a house
- How did you recognize all three images as depicting a house?
- How did you recognize the first and third images as depicting the same house, but from different viewpoints?
- How does your visual system move from points of light, like pixels, to whole entities in the world, like houses?

So far ...



Edge detection



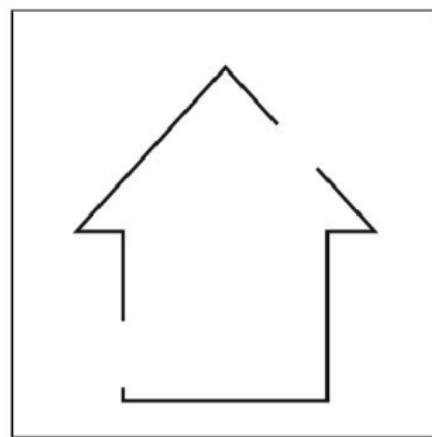
- cells in primary visual cortex have small receptive fields and respond to edges of varying orientations
- How do you know which edges go together and which ones don't?

Mid-level vision

- A loosely defined stage of visual processing that comes after basic features have been extracted from the image and before object recognition and scene understanding
- Involves the perception of edges and surfaces
- Determines which regions of an image should be grouped together into objects

Finding edges: computers are not as good as humans

- Sometimes computers don't find enough edges

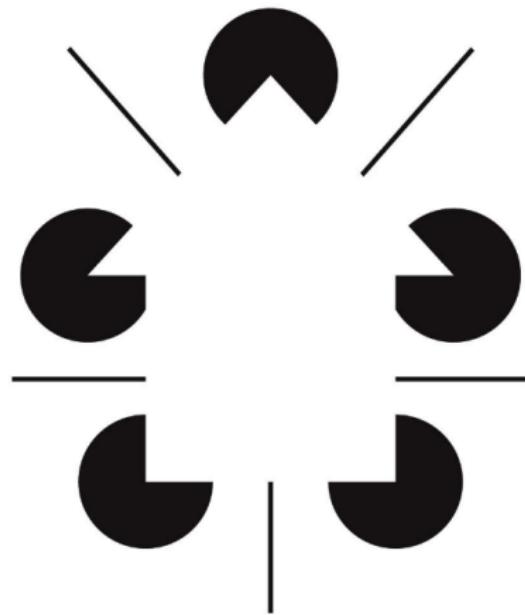


Finding edges: computers are not as good as humans

- Sometimes computers find too many edges

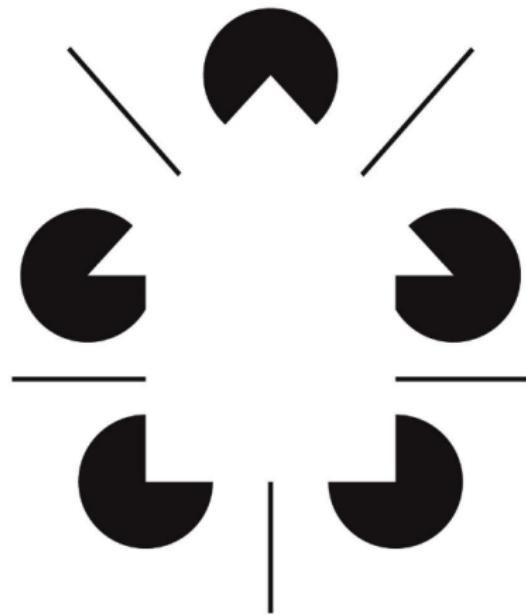


Human contour perception is inferential

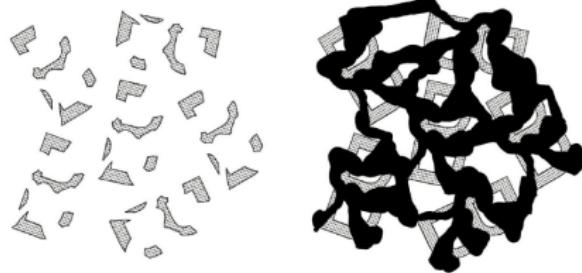


Kanizsa's illusory contours

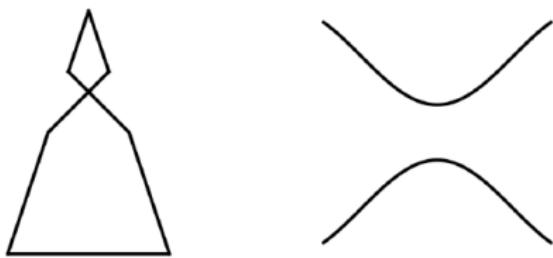
Human contour perception is inferential

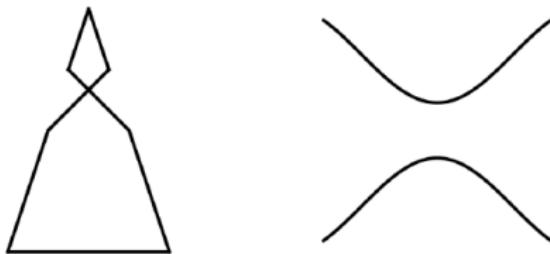


The perceptual whole is more than the sum of its parts





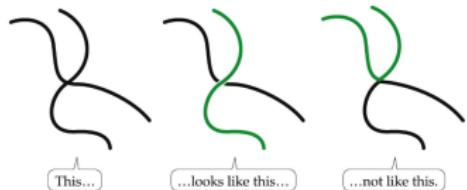




What kind of regularities in the stimulus are taken as evidence for a contour in the world?

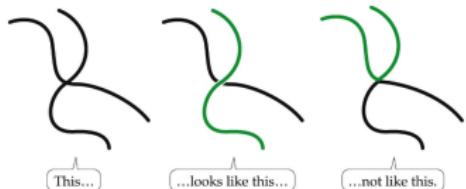
Gestalt grouping rules

- Good continuation

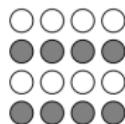


Gestalt grouping rules

- Good continuation

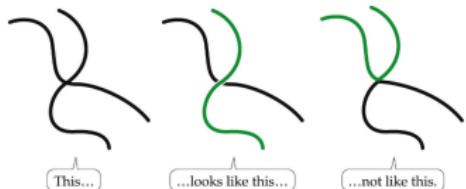


- Similarity

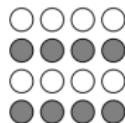


Gestalt grouping rules

- Good continuation



- Similarity

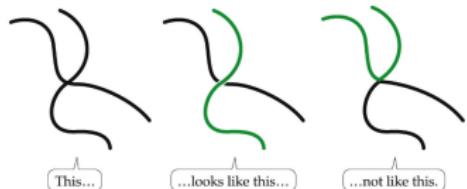


- Proximity

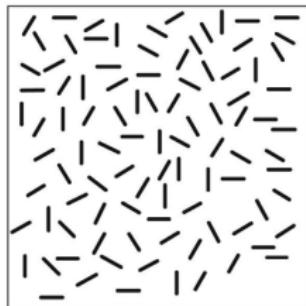
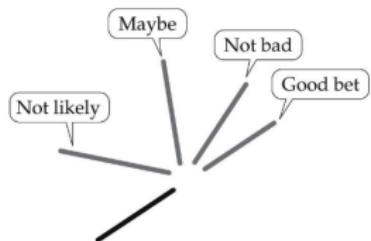


Gestalt grouping rules

- Good continuation

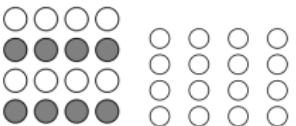


Which gray line is a likely continuation of the black line?



Gestalt grouping rules

- Proximity and similarity serve texture segmentation



Activity

Explore the Gestalt grouping principles with the activity on the following webpage

<http://sites.sinauer.com/wolfe4e/wa04.01.html>

Gestalt rules at work

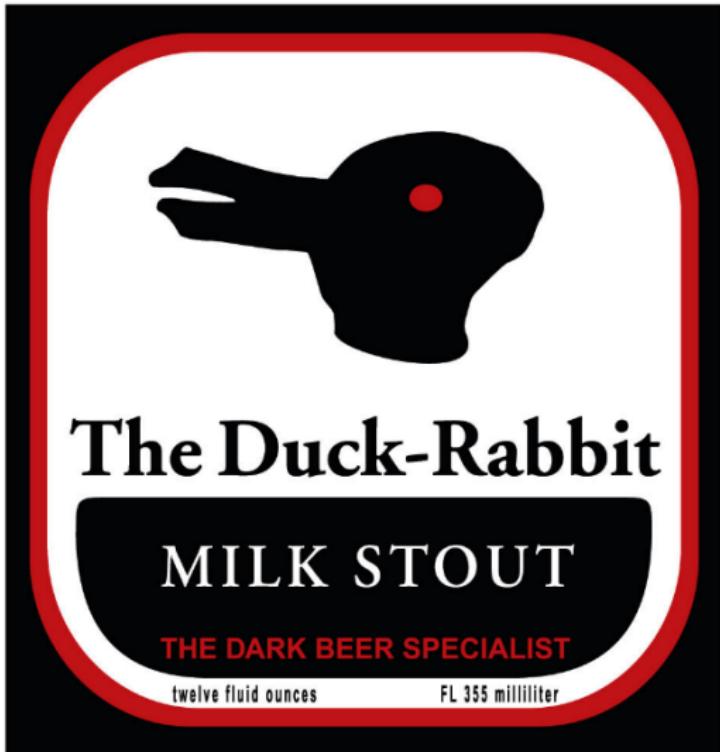


Gestalt rules at work

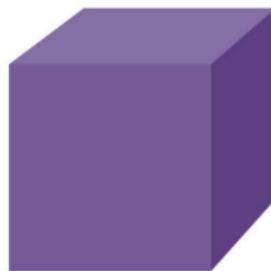
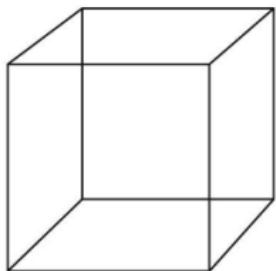


Camouflage

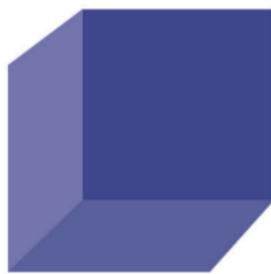
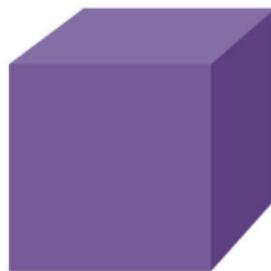
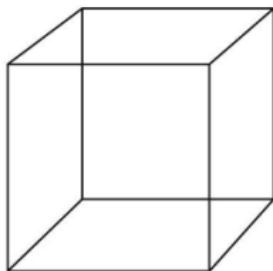
Ambiguous figures



Ambiguous figures

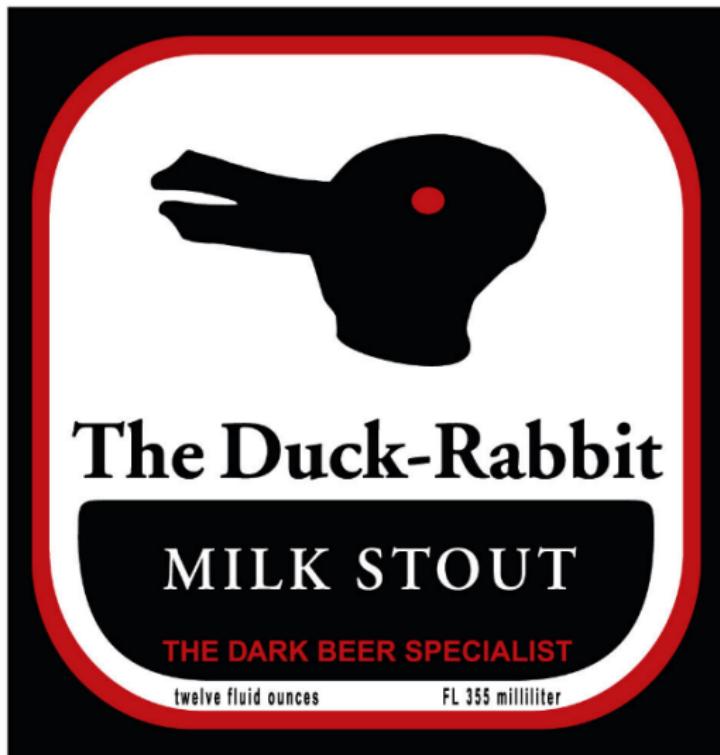


Ambiguous figures

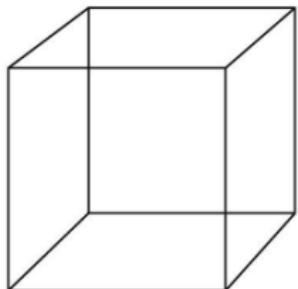


stimuli that give rise to two or more interpretations of their identity or structure

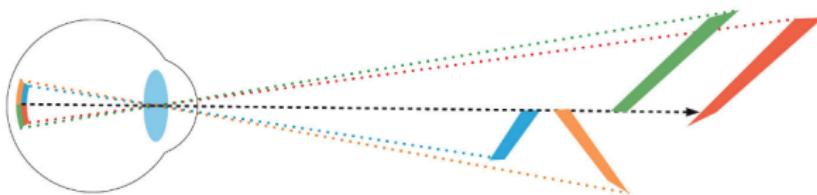
Ambiguous figures



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Ambiguous figures



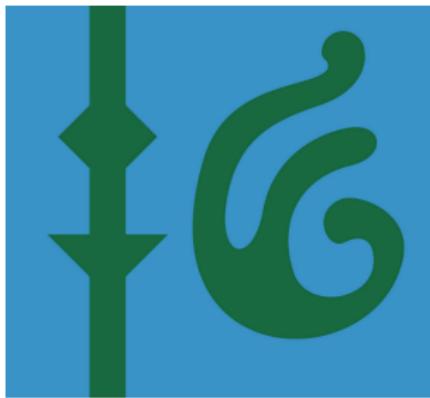
- **accidental viewpoints:** to see the arbitrary shapes just like the four squares would be quite a coincidence
- chances for this are so slim that the visual system might refuse this possibility

Activity

Explore ambiguous figures and accidental viewpoints with the activity on the following webpage

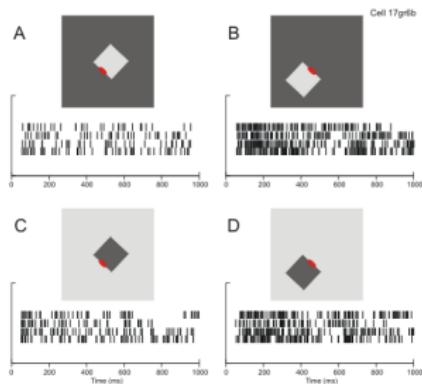
<http://sites.sinauer.com/wolfe4e/wa04.03.html>

What is figure and what is ground?



What is figure and what is ground?

- figure-ground assignment is a critical step on the path from image to object recognition
- happens as early as in the first extrastriate cortical area V2
- neurons are sensitive to border-ownership



Principles of figure-ground assignment

- surroundedness



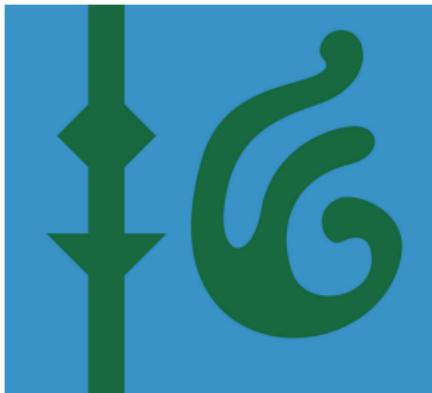
Principles of figure-ground assignment

- surroundedness
- size



Principles of figure-ground assignment

- surroundedness
- size
- symmetry



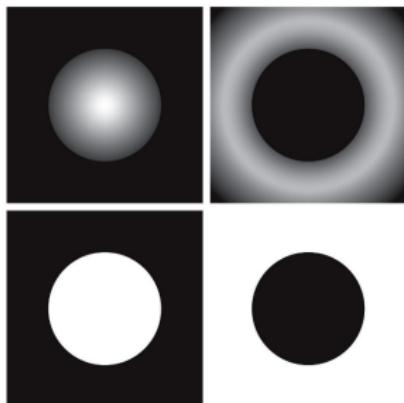
Principles of figure-ground assignment

- surroundedness
- size
- symmetry
- parallelism



Principles of figure-ground assignment

- surroundedness
- size
- symmetry
- parallelism
- extremal edges



Principles of figure-ground assignment

- surroundedness
- size
- symmetry
- parallelism
- extremal edges
- relative motion

Principles of figure-ground assignment

- surroundedness
- size
- symmetry
- parallelism
- extremal edges
- relative motion



Principles of figure-ground assignment



- size, surroundedness, symmetry, parallelism
→ purple squares = figures
- What about the circle in the middle of each square?

Principles of figure-ground assignment



- size, surroundedness, symmetry, parallelism
→ purple squares = figures
- What about the circle in the middle of each square?
- only the one in the middle is seen as separate object, the other two are seen as wholes, why?

Dealing with occlusion in 2D: Relatability

Unrelatable



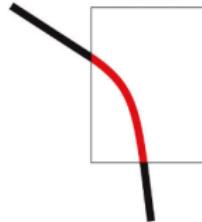
Relatable



S curve



Elbow



Dealing with occlusion in 2D: Relatability

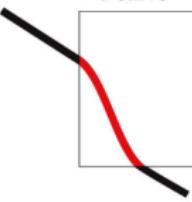
Unrelatable



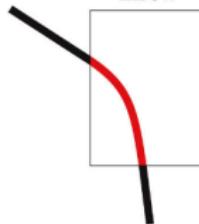
Relatable



S curve

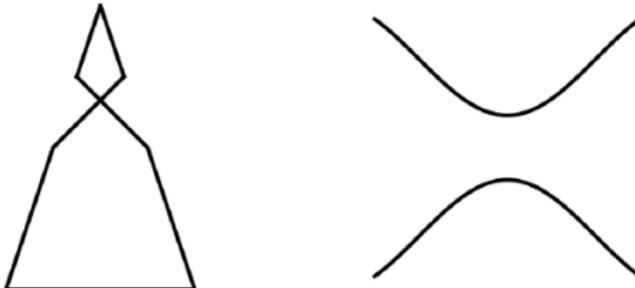


Elbow



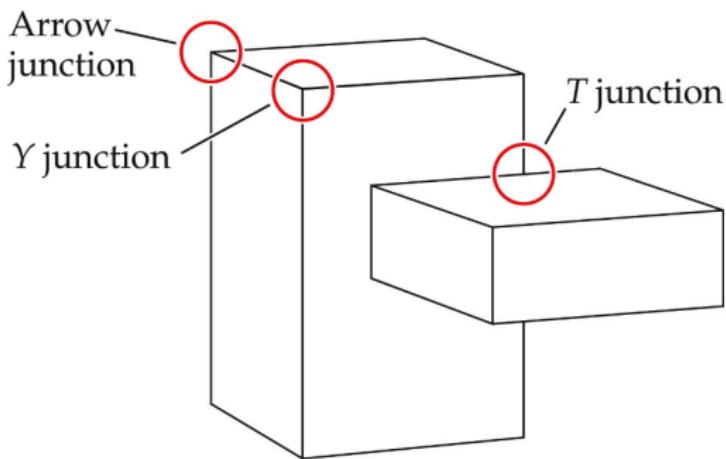
- complete line fragments that can be related by simple curves
- visual system “unwilling” to propose complex relationships between line fragments

Dealing with occlusion in 2D: Relatability

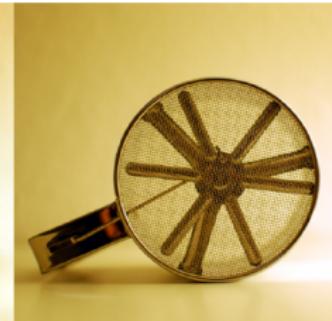


- complete line fragments that can be related by simple curves
- visual system “unwilling” to propose complex relationships between line fragments
- complete smooth curves = **heuristic**

Dealing with occlusion in 3D: T-junctions



T-junctions and (non-)accidental viewpoints



T-junctions and (non-)accidental viewpoints



Summary

- after early vision extracts basic features from the visual input, mid-level vision organizes these features into the regions, surfaces and objects that provide the basis for object recognition
- visual system applies rules for image segmentation, edge finding processes that divide regions from each other
- visual system applies rules for grouping such as similarity, symmetry, parallelism, proximity ...
- together these principles allow figure ground assignment
- visual systems avoids accidents

References

- Wolfe, J.M., Kluender, K.R. & Levi, D.M. (2012). *Sensation & Perception*. Sinauer Associates: Sunderland, MA.