

POPOUT

POPOUT

Properties detected by the low-level visual system

very rapid - 200-250 milliseconds

very accurate

processed in parallel

Happens before focused attention → pre-attentive

Attention is very important for cognition

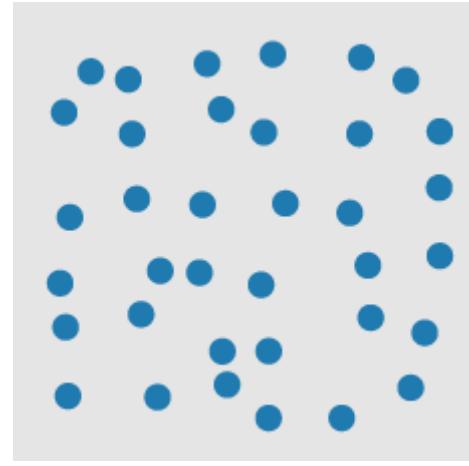
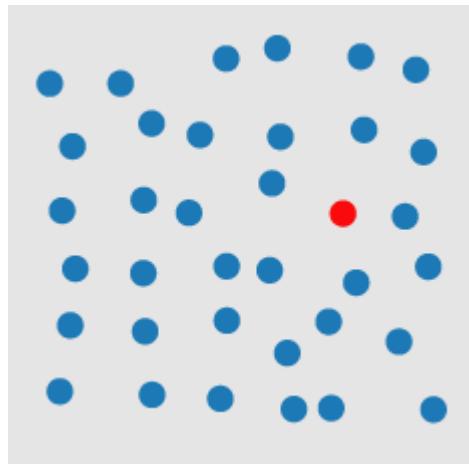
Independent of the number of distractors

Opposite: sequential search (processed serially)

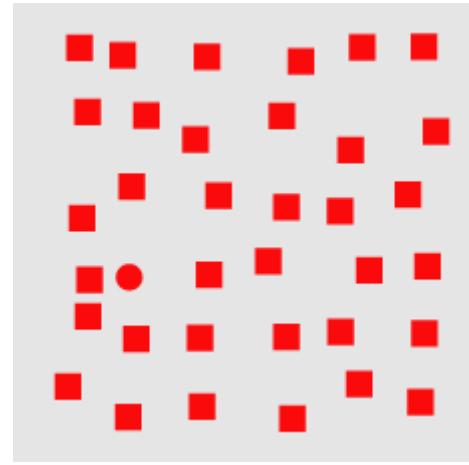
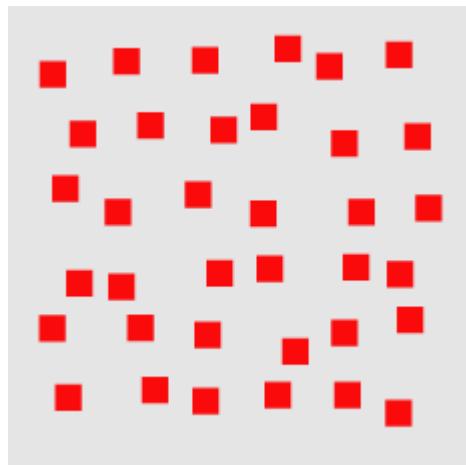
Examples based on Healey,

<https://www.csc2.ncsu.edu/faculty/healey/PP/index.html>

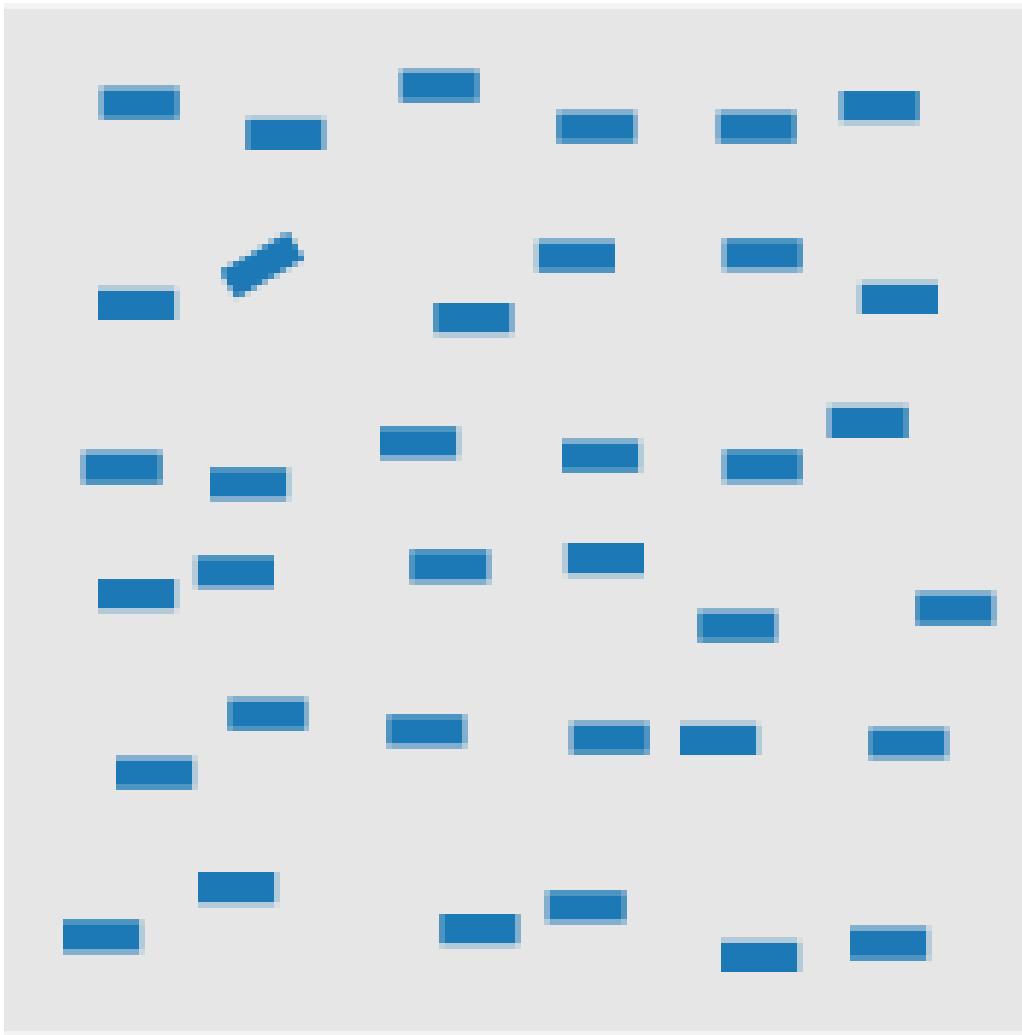
DIFFERENCE IN HUE



DIFFERENCE IN CURVATURE / FORM



64

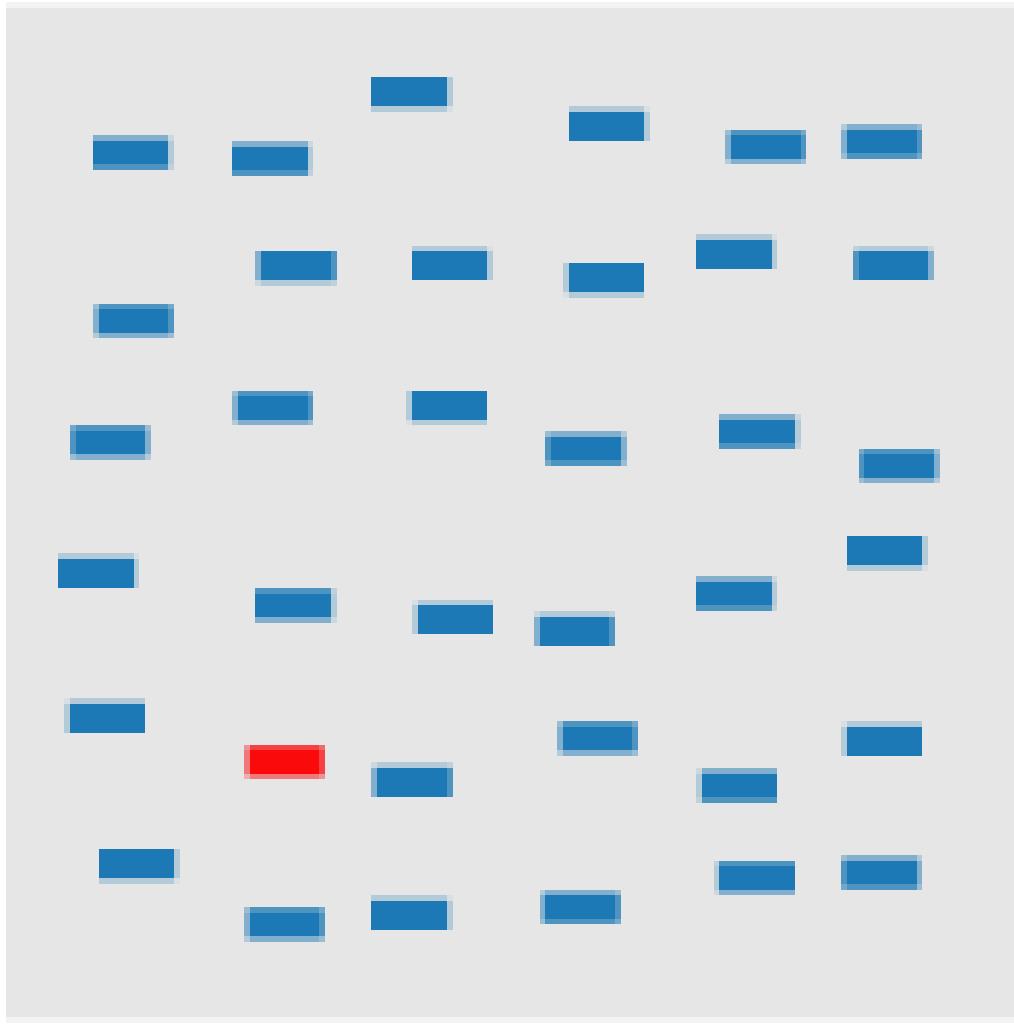


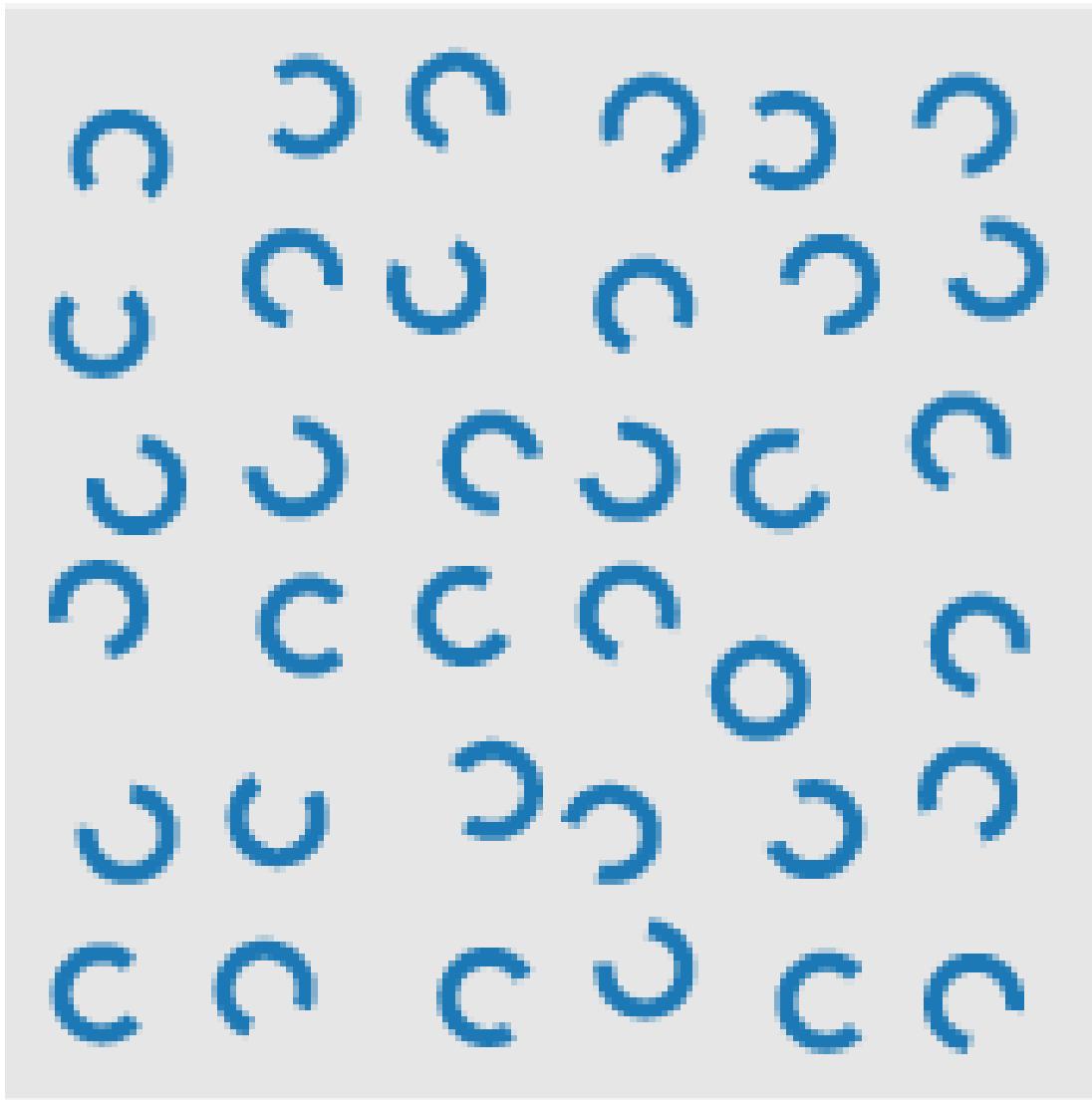
orientation

65

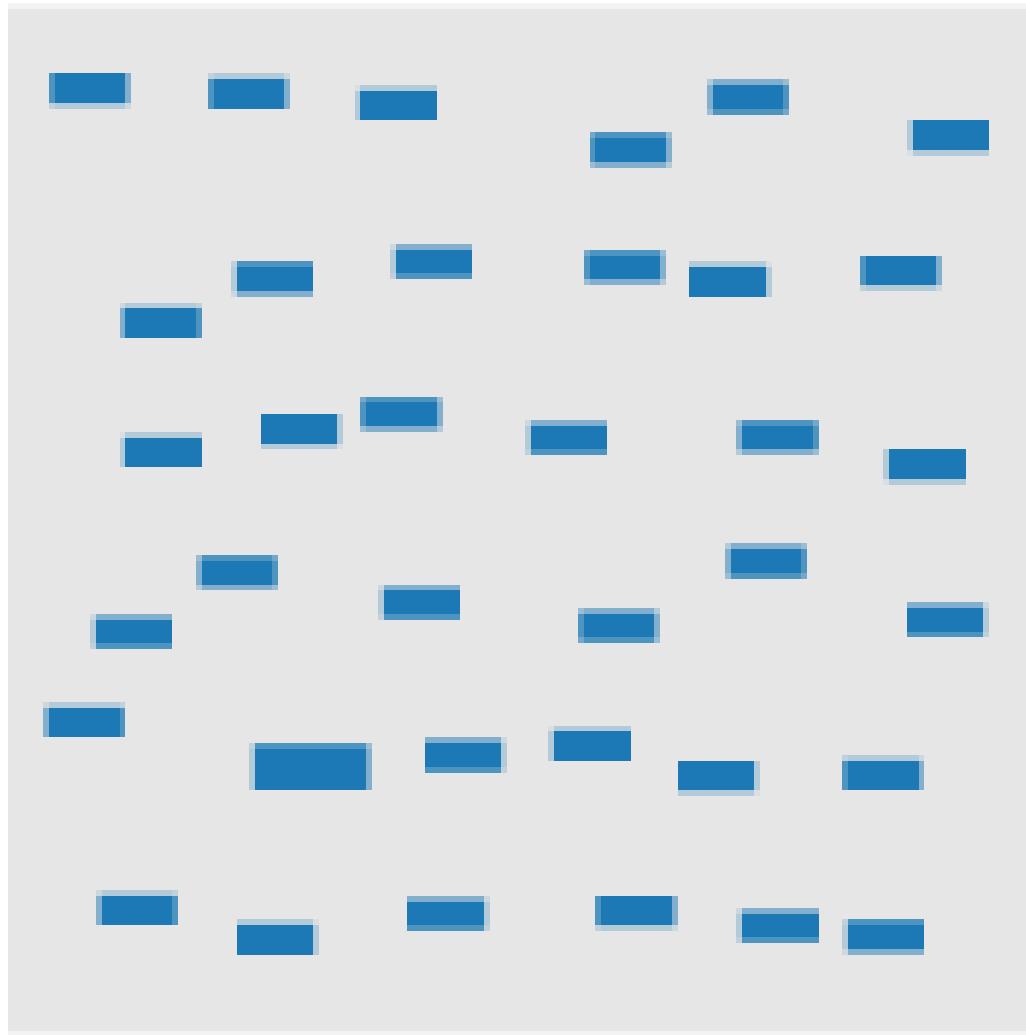
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Hue

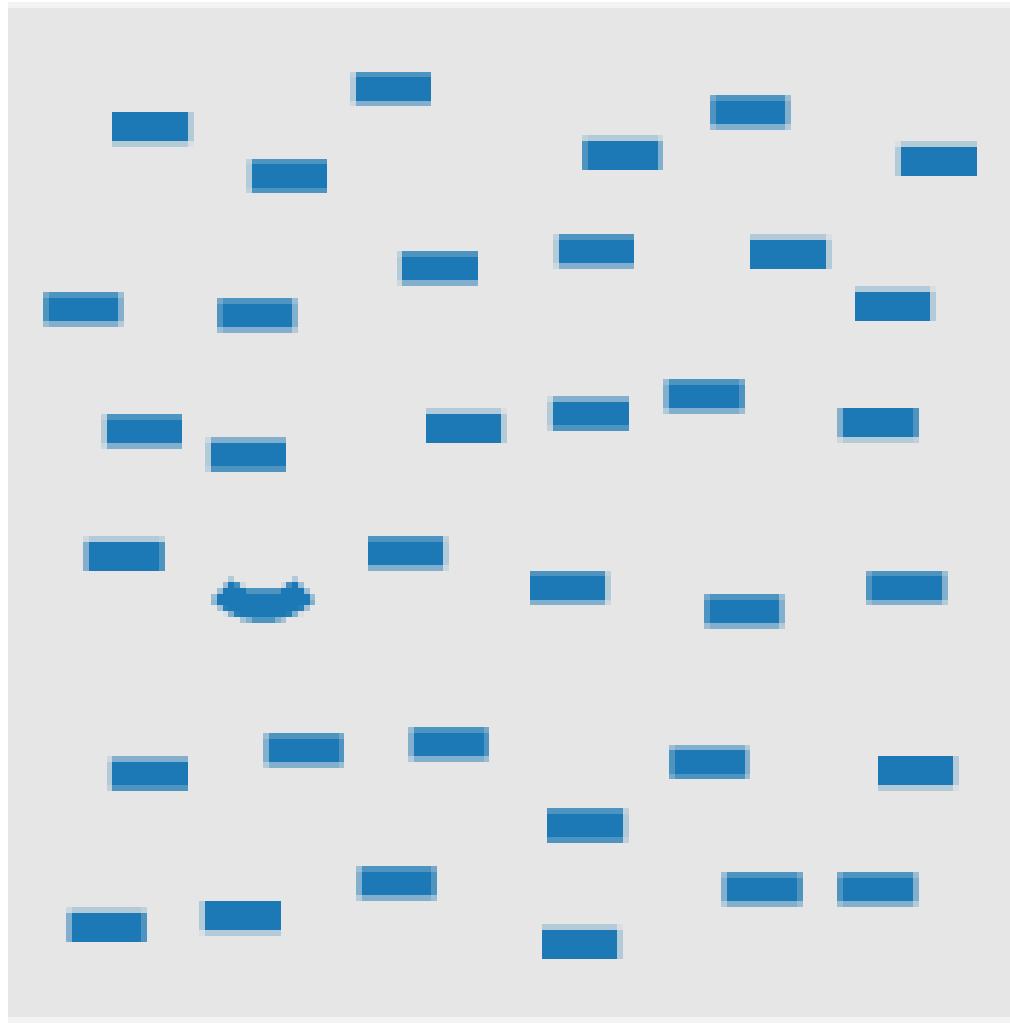




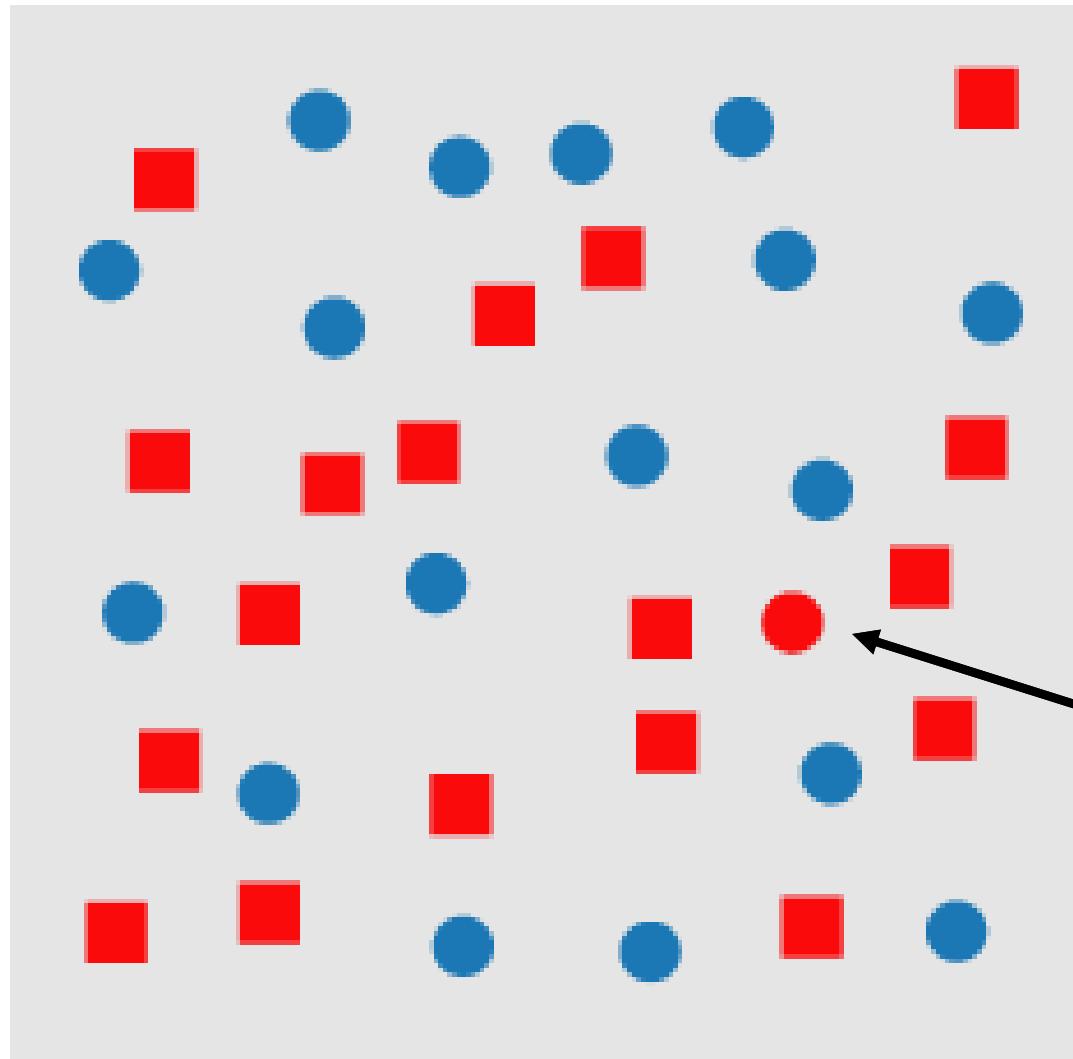
Closure



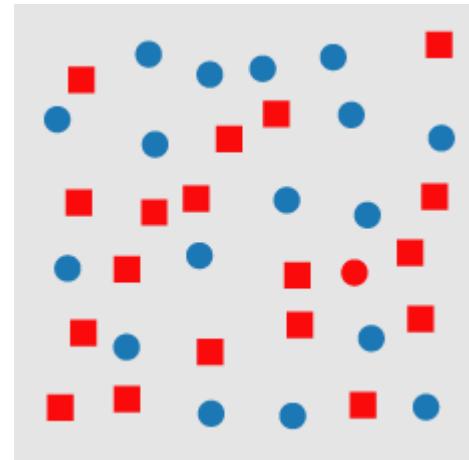
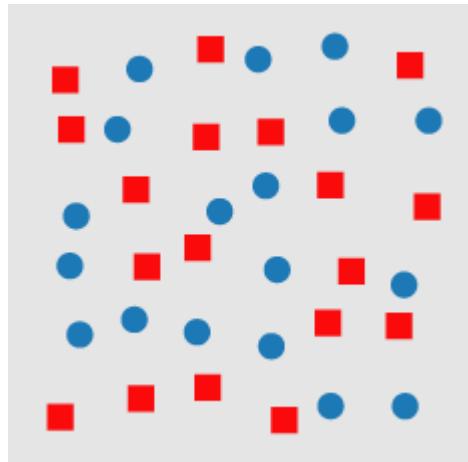
size



curvature

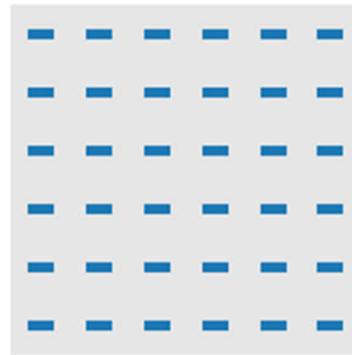
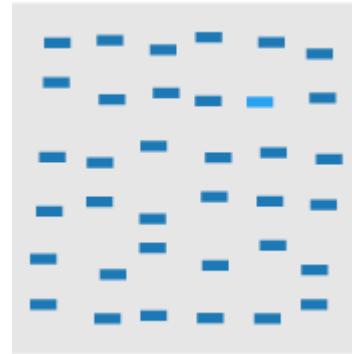
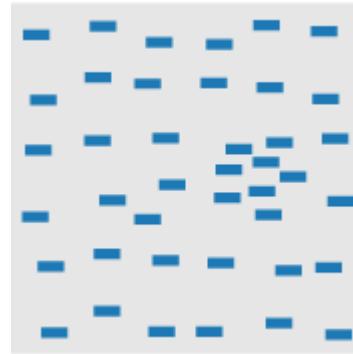


NOT PRESERVED ON COMBINATIONS



Conjunction Targets – no unique visual property
target: red, circle
distractor objects have both properties

SOME MORE PRE-ATTENTIVE PROPERTIES

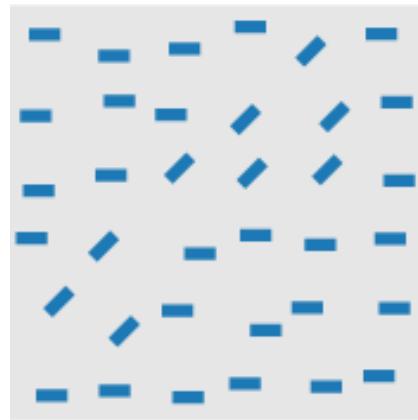


TASK

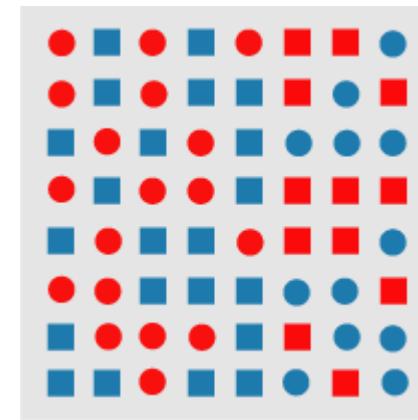
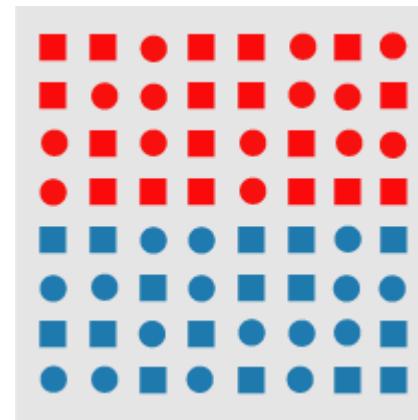
- **Target detection**
Detect the presence or absence of a target
- **Boundary detection**
Detect a texture boundary between two groups of elements, where all of the elements in each group have a common visual property
- **Region tracking**
Track one or more elements with a unique visual feature as they move in time and space
- **Counting and estimation**
Users count or estimate the number of elements with a unique visual feature

TASK

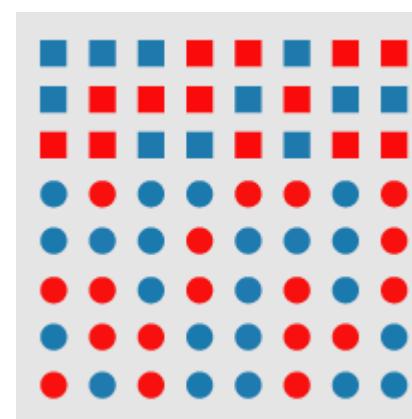
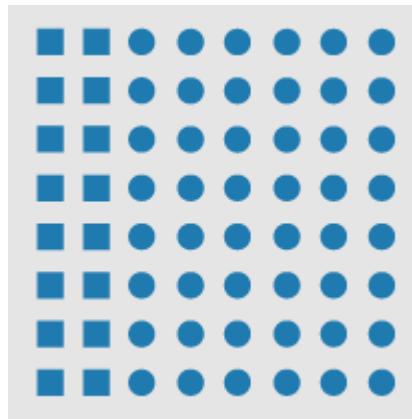
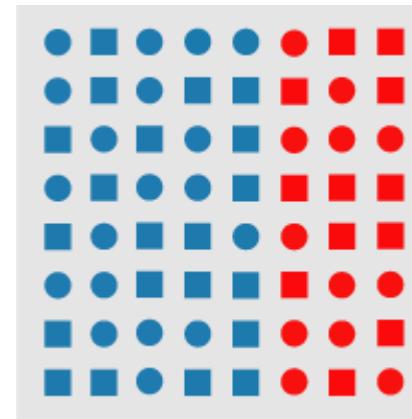
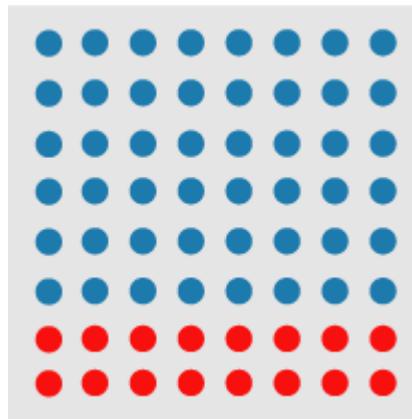
Number Estimation



Boundary Detection



HIERARCHY OF PREATTENTIVE FEATURE



THEORIES OF PREATTENTIVE PROCESSING

For more theories

<http://www.csc.ncsu.edu/faculty/healey/PP/index.html>

PREATTENTIVE PROCESSING IN VIS

Can be used to draw attention to areas of interest

Can be used to express similarity/group memberships

Visual features must be carefully designed

Conjunctions must be avoided

colorful vis vs highlight

CHANGE BLINDNESS

CHANGE BLINDNESS

**Detail of an image cannot be remembered across separate scenes
except in areas with focused attention**

**Interruption (e.g. a blink, eye saccade or blank screen) amplifies
this effect**

Not failure of vision system
Failure due to inappropriate attentional guidance





CHANGE BLINDNESS

Various theories about causes

- Overwriting: information that was not abstracted is lost
- First impression: only initial view is abstracted
- Nothing is stored: only abstract concepts are committed to memory
- Everything is stored, nothing is compared: we compare only when we are forced to
- Feature combination: scenes are combined as long as they make sense

Influencing factors

- Attention
- Expectation (knowing something will change)
- Semantic importance of changed object
- Low level object properties overlooked more easily





ATTENTION BLINDNESS



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KEY POINTS

To find meaning in what we see **we must selectively pay attention** to what is important

Low-level vision is driven by object features rather than a conscious effort where to look (e.g., pre-attentive processing)

Attention is driven by preexisting knowledge, expectations, and goals stored in long-term memory



GESTALT PRINCIPLES

Wertheimer, 1923, and recent extensions

GESTALT PRINCIPLES

Patterns that transcend the visual stimuli that produced them

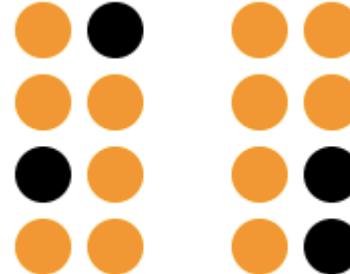
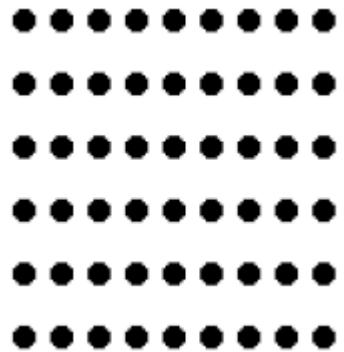
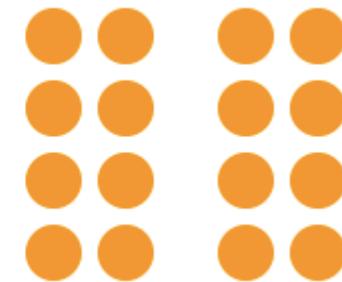
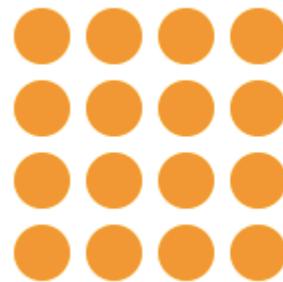
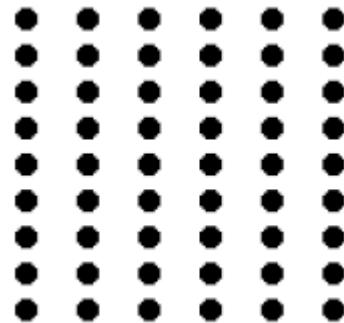
- The whole is something else than the sum of its parts - Kurt Koffka

Vs

- The whole is greater than the sum of the parts

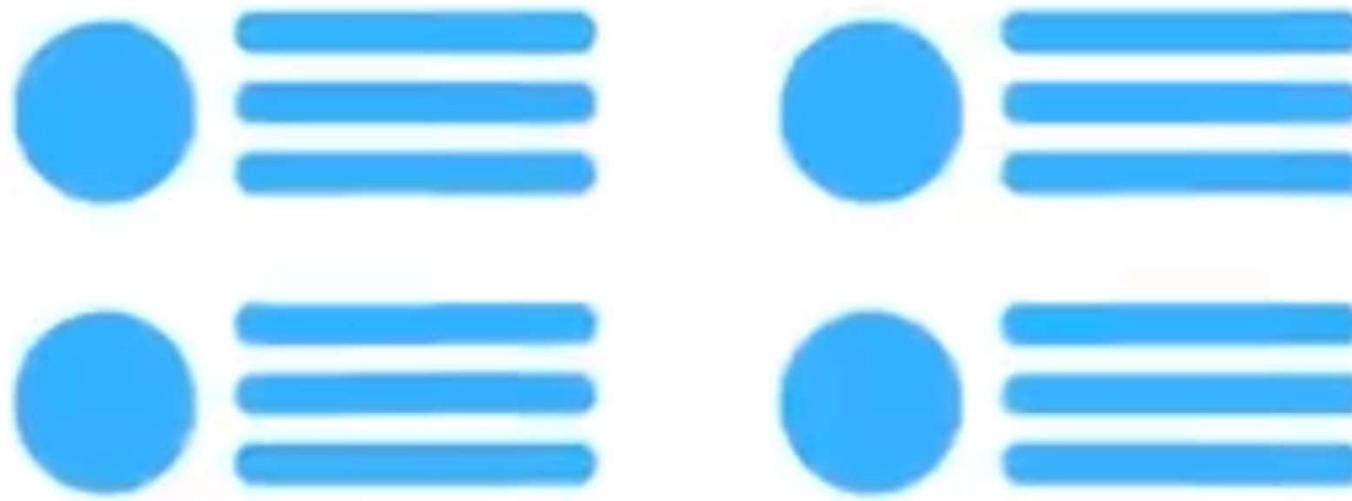


PROXIMITY



Andy Rutledge, "Gestalt Principles of Perception"

Law of proximity



0:01

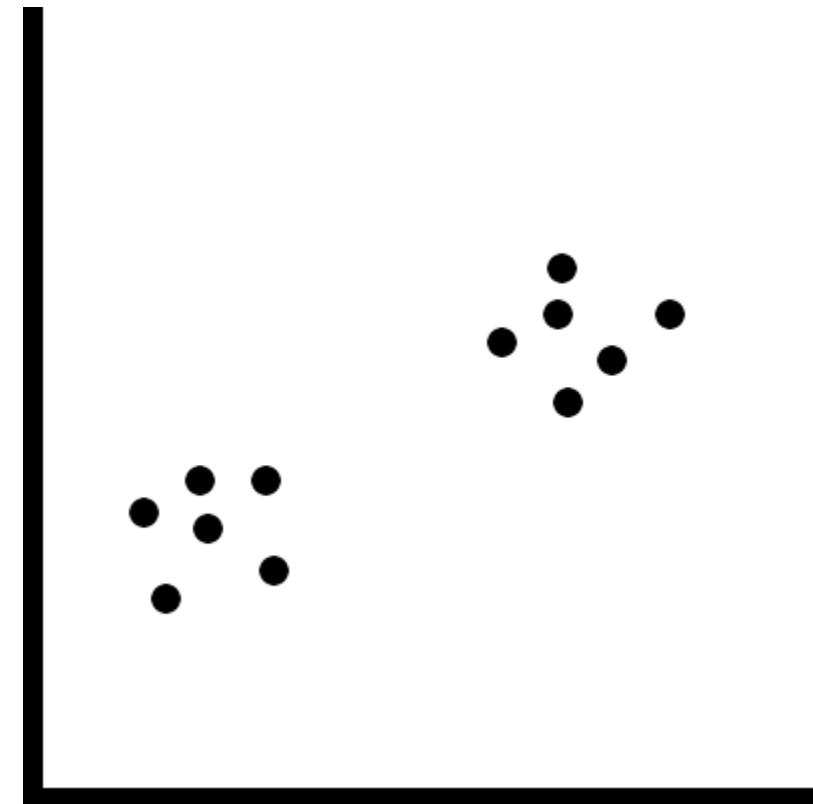
57.5K views

4 cards

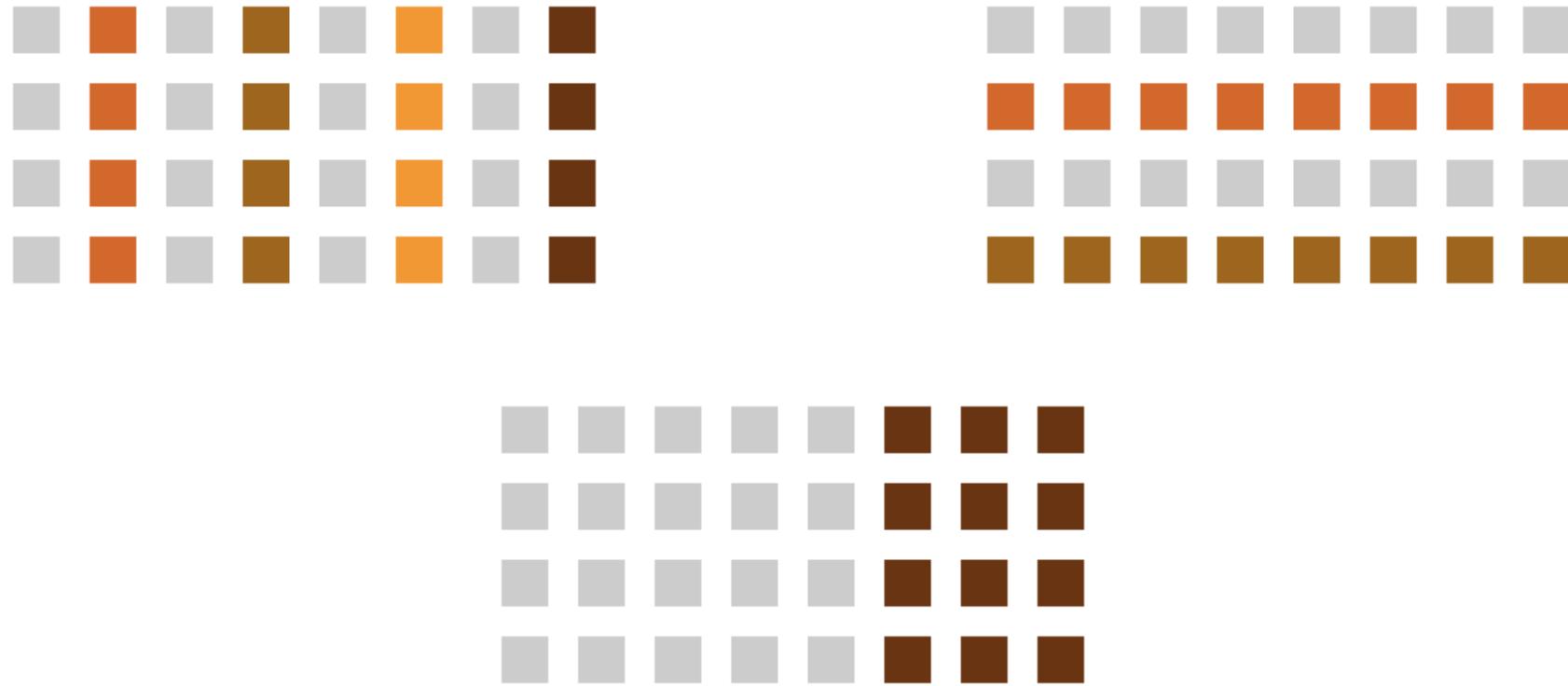
<https://twitter.com/pablostanley/status/974303621092225024>

PROXIMITY

Grouping/linking by placing entities in close proximity

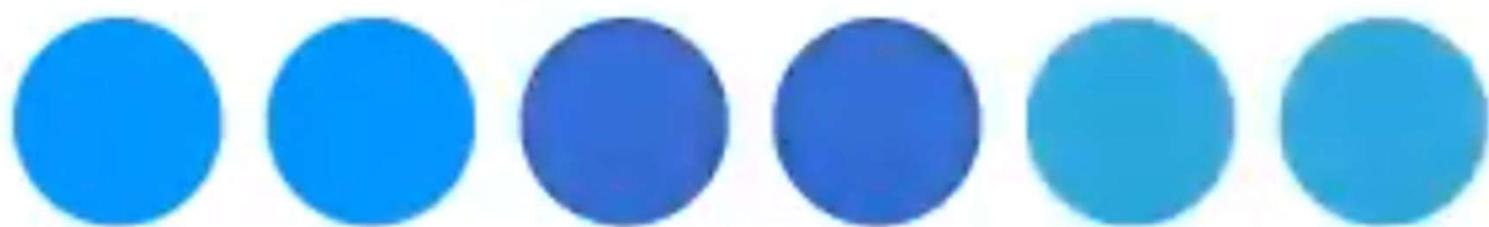


SIMILARITY



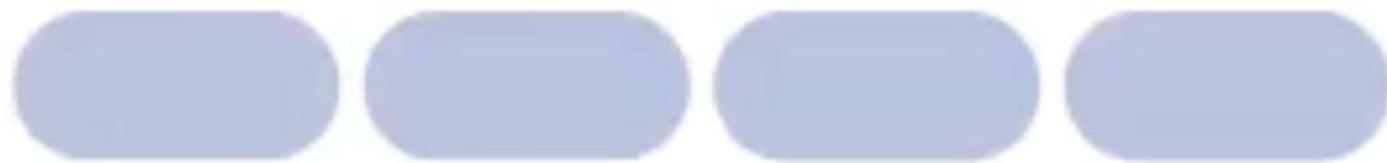
Andy Rutledge, "Gestalt Principles of Perception "

Similarity Principle



0:00 | 9.8K views

Focal Point



9K views

No focus

0:00 / 0:04

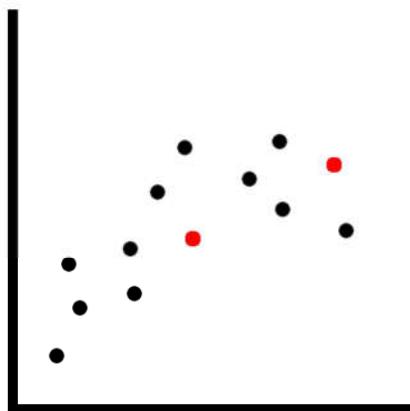


SIMILARITY

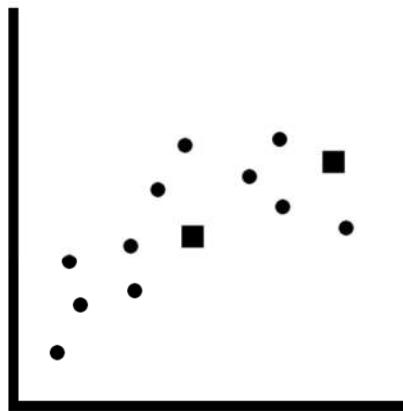
Co-modulation of a **channel**

color, shape, size, value, orientation, texture...

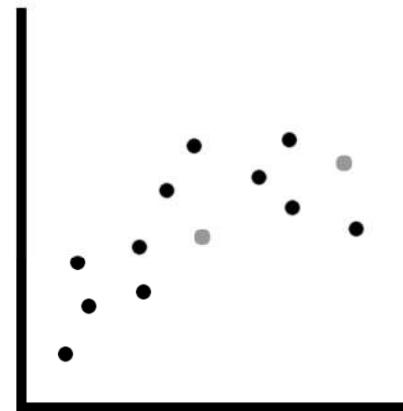
Adding a **glyph**, **label**, **frame**, **background**



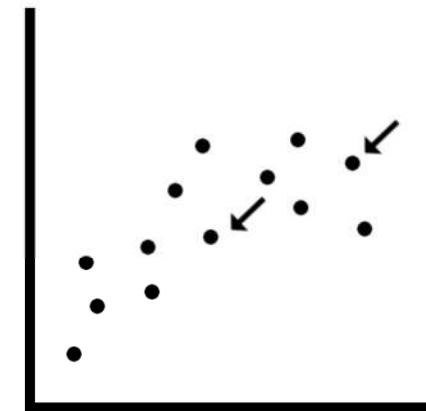
Color



Shape



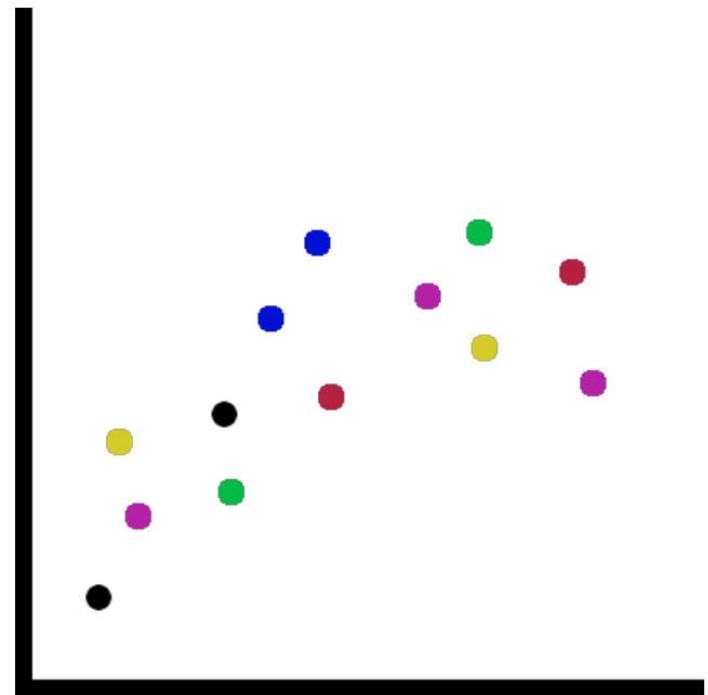
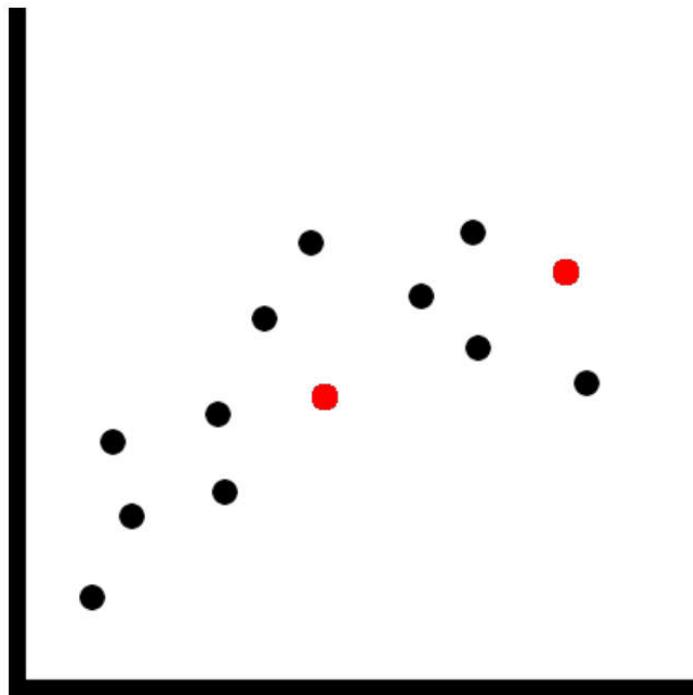
Value



Glyph

COLOR – PERCEPTION ISSUES

Popout: works for 1-2 simultaneous, but not for more



COLOR – PERCEPTION ISSUES

Slower in a cluttered environment

Size of colored object relevant

The area which is now Providence was first settled in June 1636 by Roger Williams, and was one of the original Thirteen Colonies of the United States.^[10] Although the west bank of the Providence River was later claimed by both the English and the Dutch, the actual inhabitants and true masters of the region were the Pokanoket Tribe of the Wampanoag Nation led by Massasoit Ousamequin.^[11] Williams secured permission to settle from the Pokanoket and gave the city its present name.^[12] Williams' Providence soon became a refuge for persecuted religious dissenters, as he himself had been exiled from Massachusetts.^[13] Providence's growth would be slow during the next quarter-century—the subsuming of its territory into surrounding towns, difficulty of farming the land, and differing of local traditions and land conflicts all slowed development.^[13]

In the mid-1770s, the British government levied taxes that impeded Providence's maritime, sailing and agricultural industries, the mainstay of the city's economy. One example was the Sugar Act, which was a tax levied against Providence's distilleries that adversely affected its trade in rum and slaves. These taxes caused Providence to join the other colonies in renouncing allegiance to the British Crown. In response to enforcement of unpopular trade laws, Providence residents spilled the first blood of the American Revolution in the notorious Gaspée Affair of 1772.^[13]

Though during the Revolutionary War the city escaped enemy occupation, the capture of nearby Newport disrupted industry and kept the population on alert. Troops were quartered for various campaigns and Brown University's University Hall was used as a barracks and military hospital.^[13]

After departing from Newport, French troops sent by King Louis XVI and commanded by the Comte de Rochambeau passed through Providence on their way to join the attack against British forces. The march from Newport to Providence was the beginning of a campaign led jointly by General George Washington in a decisive march that ended with the defeat of General Cornwallis in the Siege of Yorktown at Yorktown, Virginia and the Battle of the Chesapeake.

Following the war, Providence was the country's ninth-largest city^{[6][13]} with 7,614 people. The economy shifted from maritime endeavors to manufacturing, particularly machinery, tools, silverware, jewelry and textiles. By the turn of the twentieth century, Providence boasted some of the largest manufacturing plants in the country, including Brown & Sharpe.

SIMILARITY

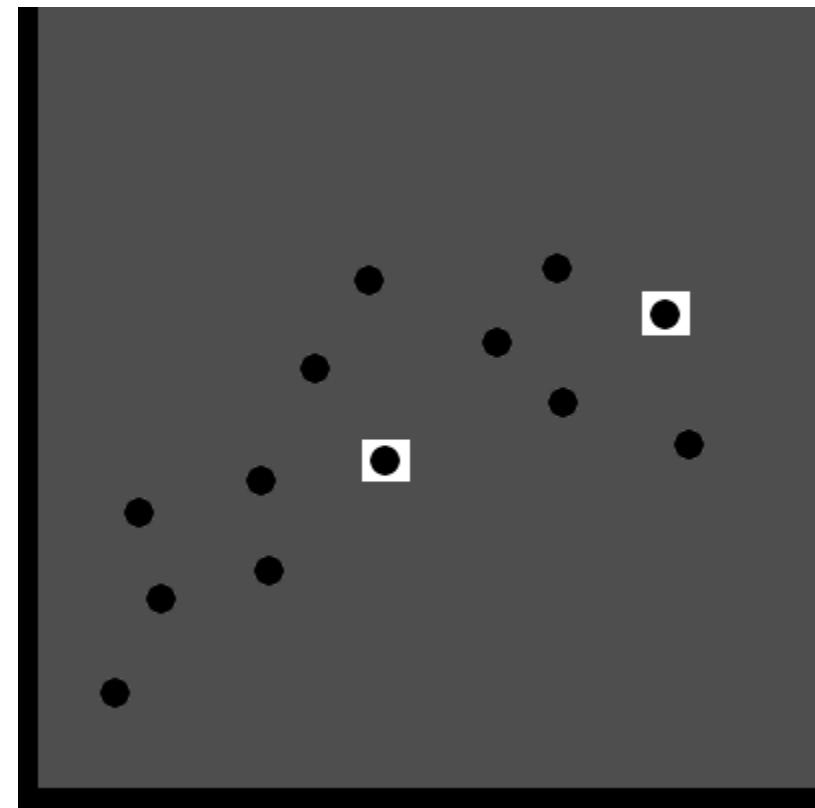
Modulate everything else

blurring, darkening, desaturating,

Blur

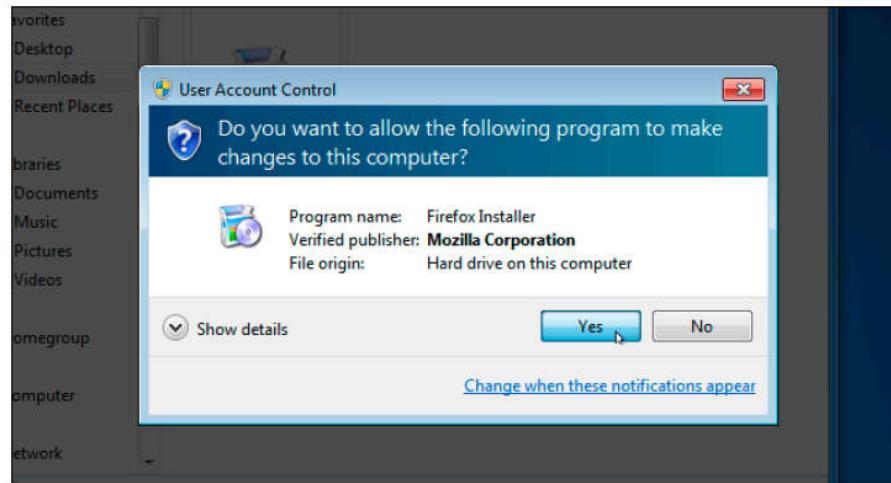


Darkening

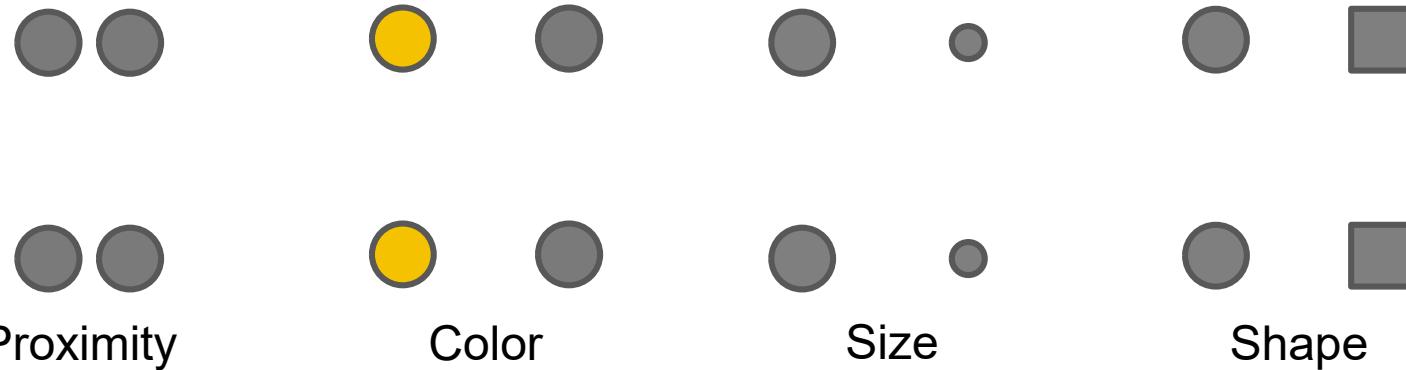


MODULATING EVERYTHING ELSE

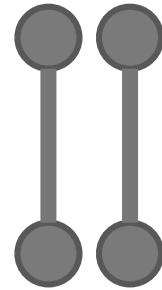
Don't use unless the sole objectives is to guide attention toward one (set of) items



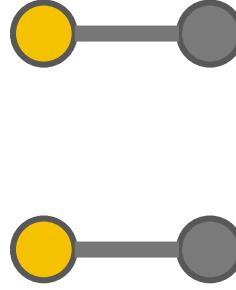
GROUPING



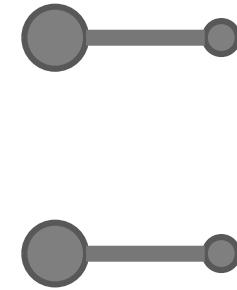
GROUPING



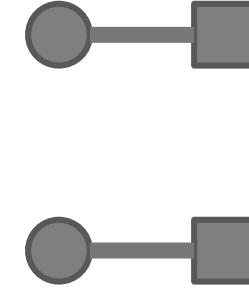
Proximity



Color



Size

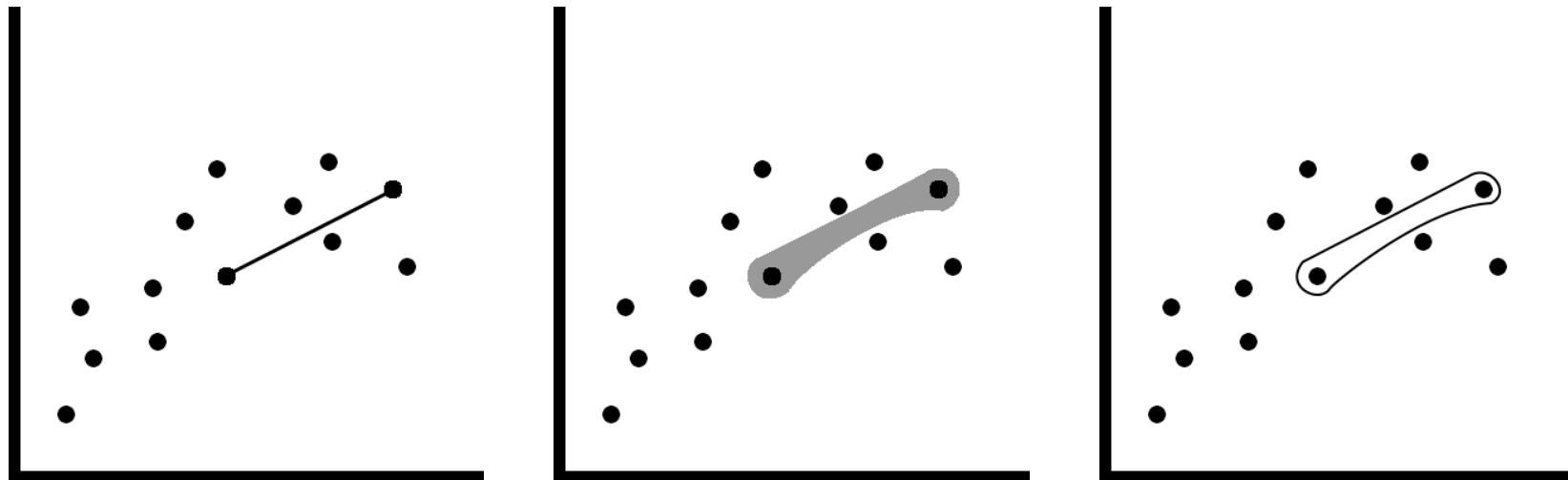


Shape

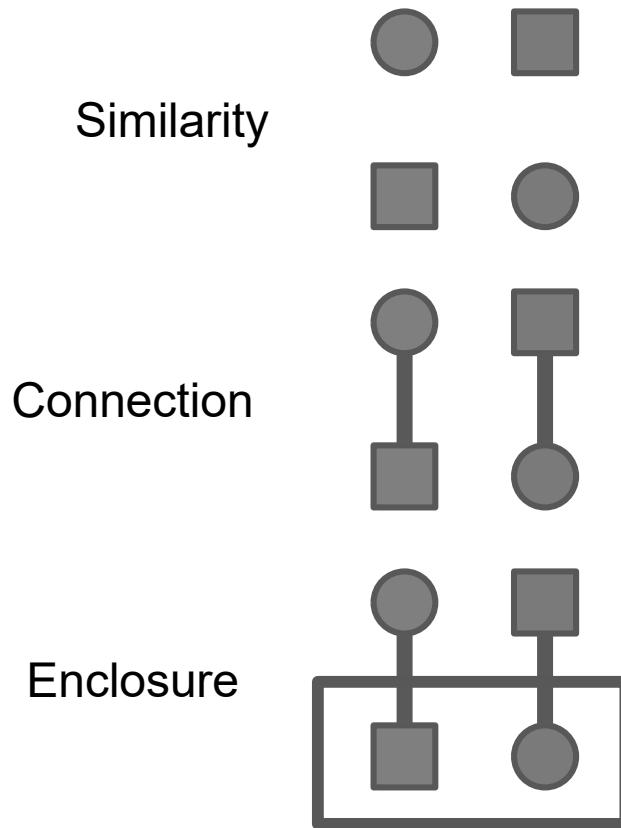
CONNECTEDNESS AND COMMON REGION

Connected items with a line or curve

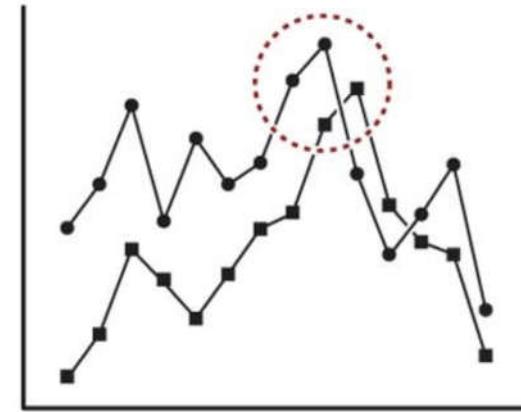
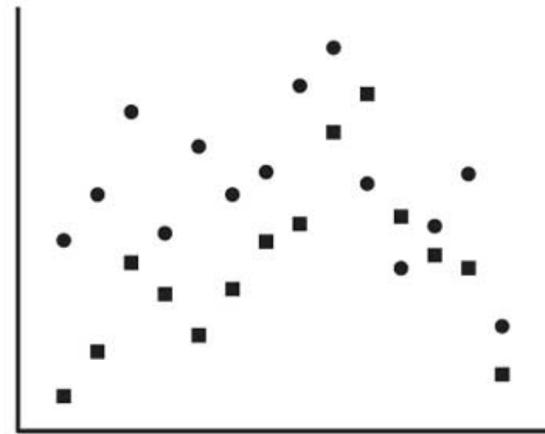
Surround items with a outline, surface, volume



ENCLOSURE / COMMON REGION

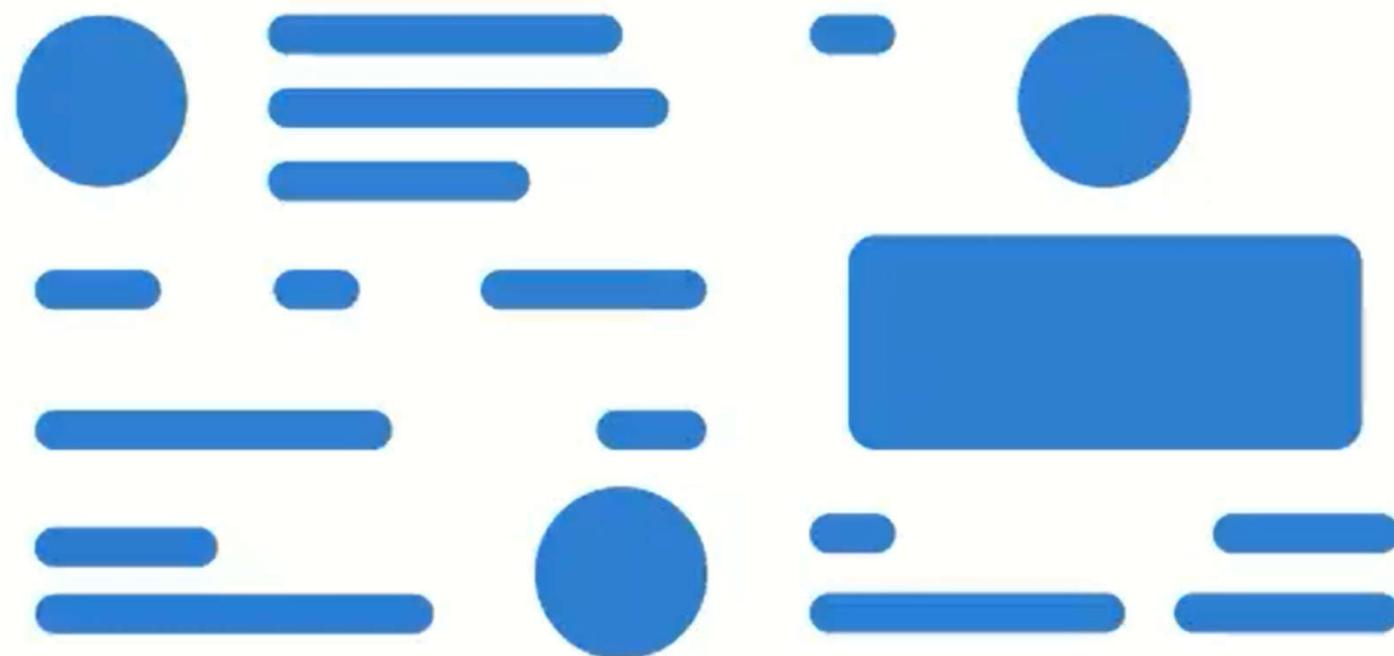


CONNECTEDNESS AND ENCLOSURE



Bang Wong, "Gestalt Principles, 1", Nature Methods

Common Region



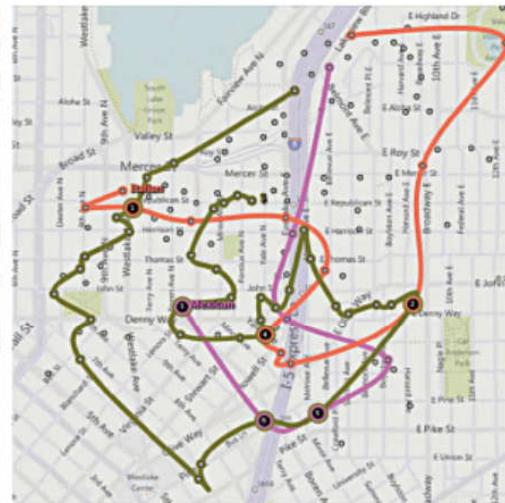
0:01

CONNECTEDNESS VARIETIES

Bubble Sets



Line Sets



Kelp Diagrams

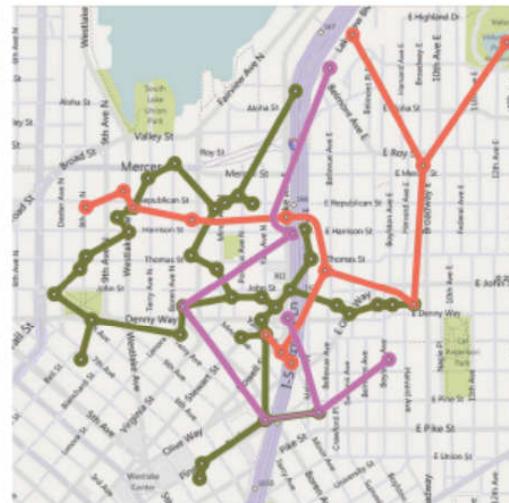


Image by [Dinkla et al., 2011]

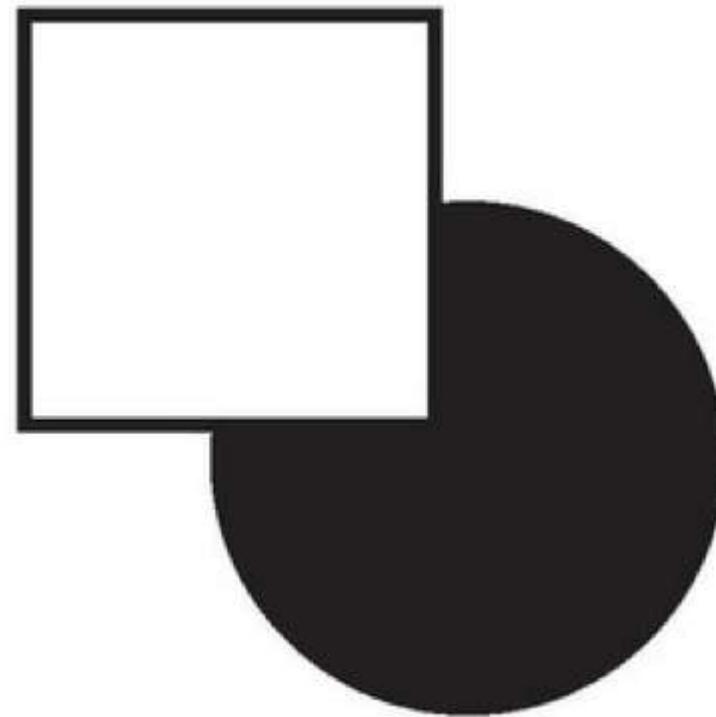
Technique by [Collins et al., 2009]

[Alper et al., 2011]

[Dinkla et al., 2012]

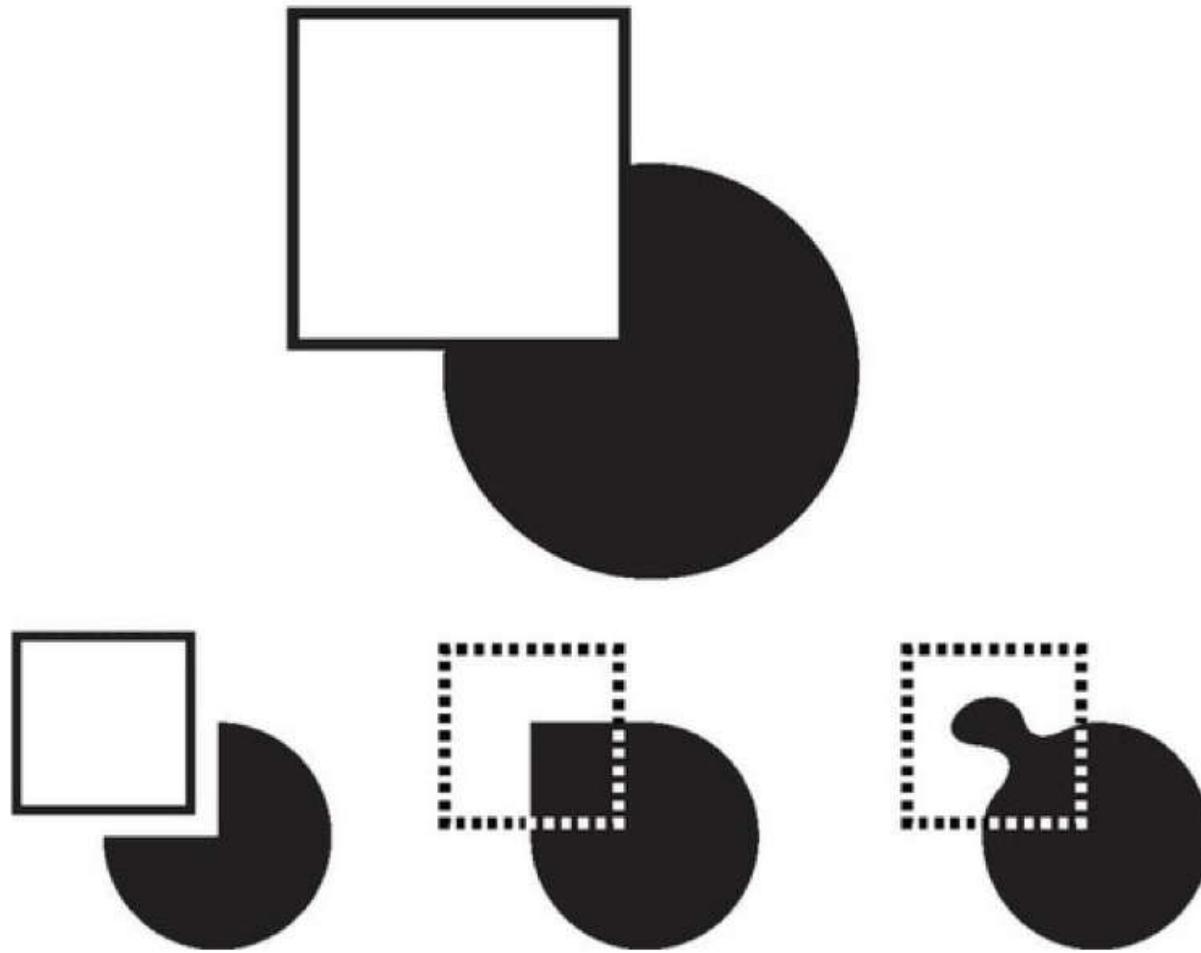
VisWeek Tutorial: Connecting the Dots – M. Streit, H.-J. Schulz, A. Lex

CONTINUITY



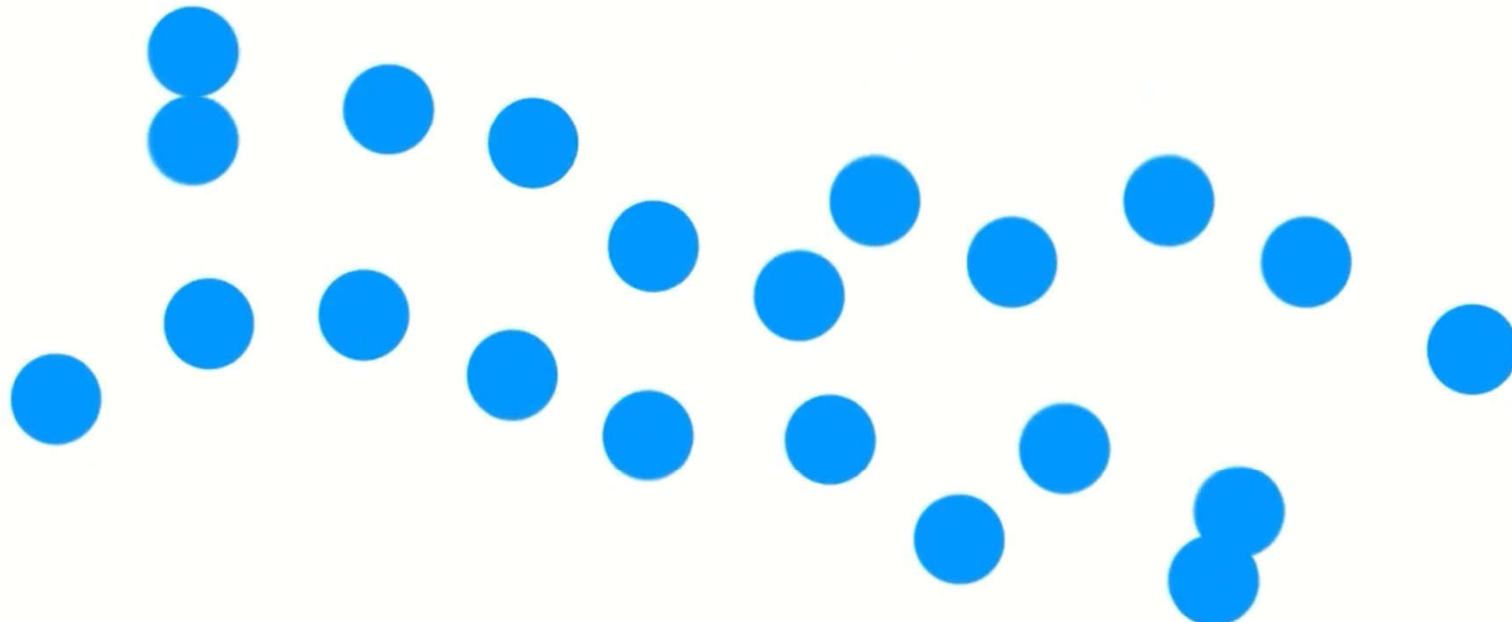
Bang Wong, "Gestalt Principles, II", Nature Methods

CONTINUITY



CONTINUITY PRINCIPLE

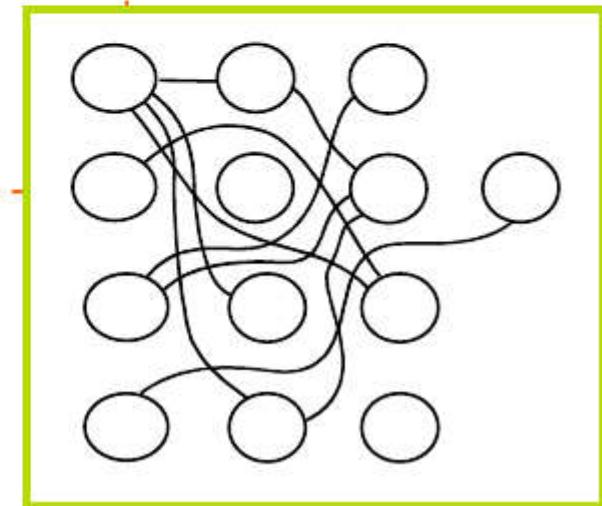
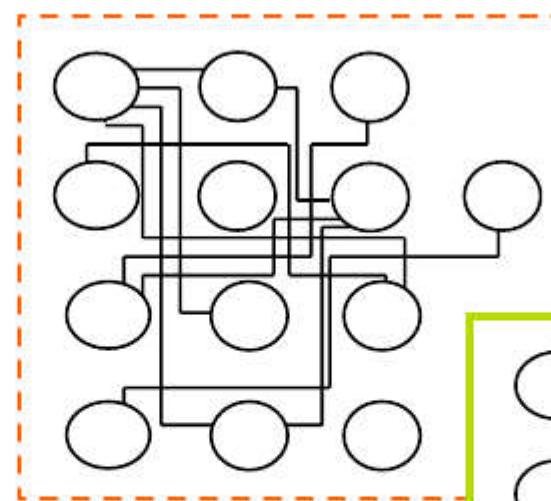
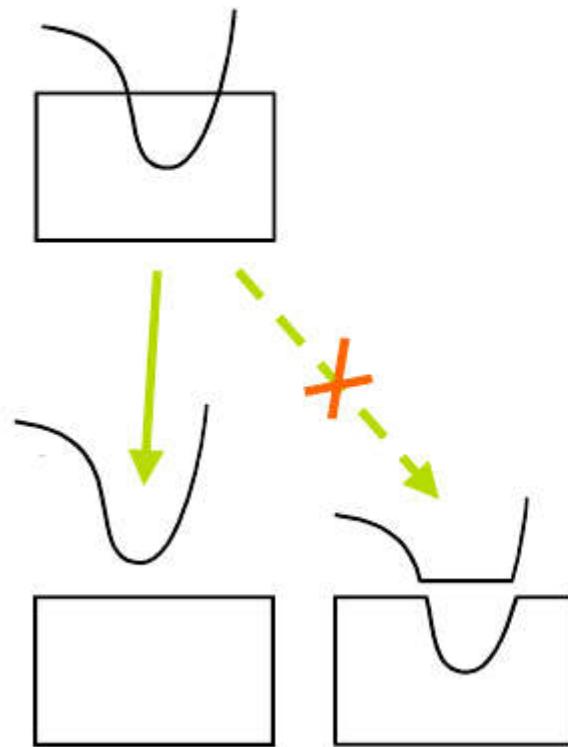
Continuity Principle



0:01 / 0:05

CONTINUITY

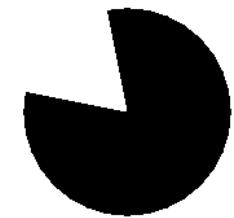
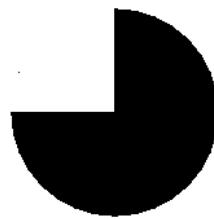
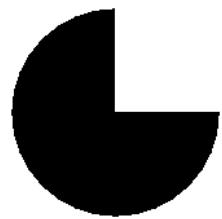
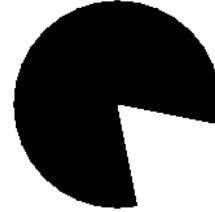
Things: smooth & continuous



CLOSURE / COMPLETION



CLOSURE

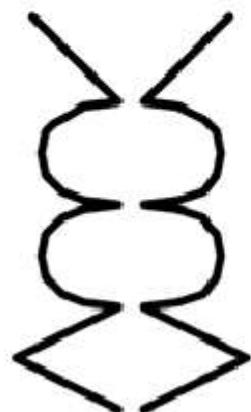


SYMMETRY

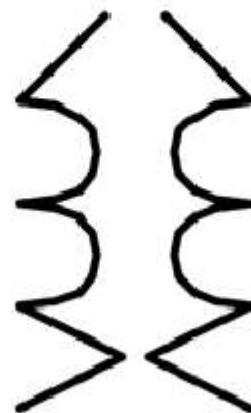
Things: symmetric



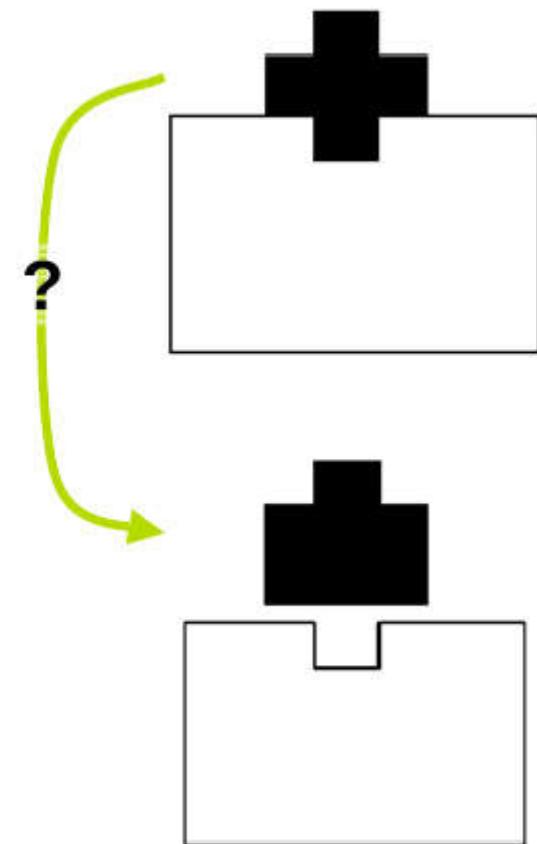
figure?



figure!



figure!



POPULATION PYRAMID

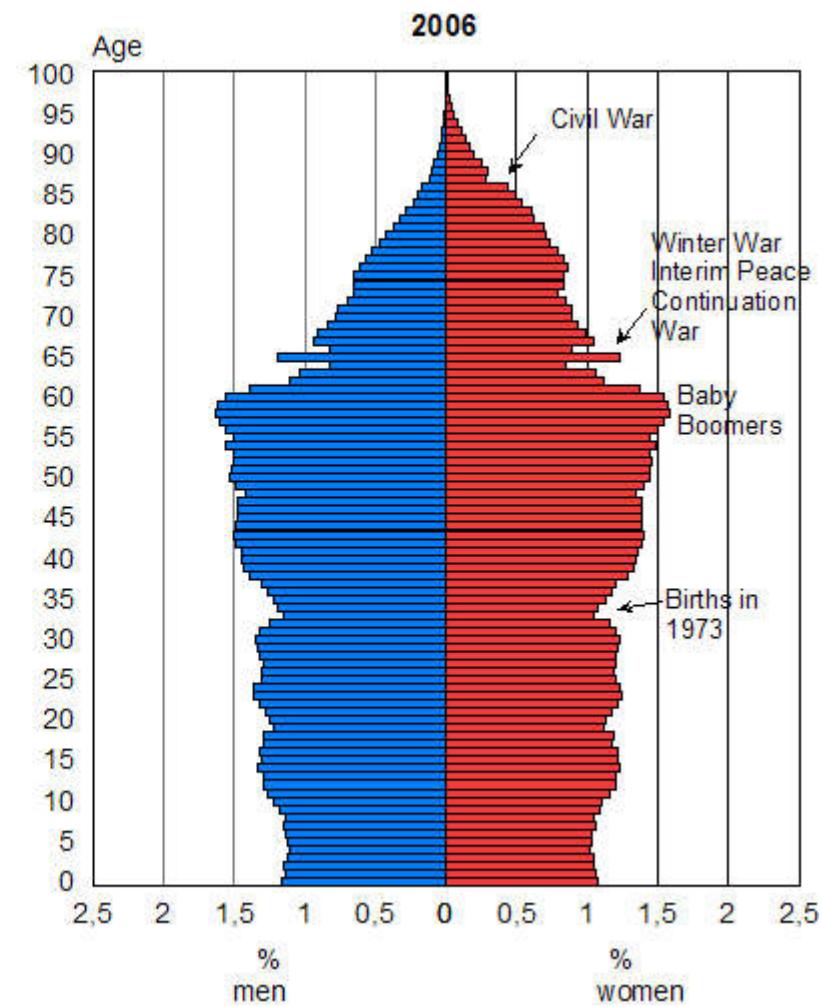
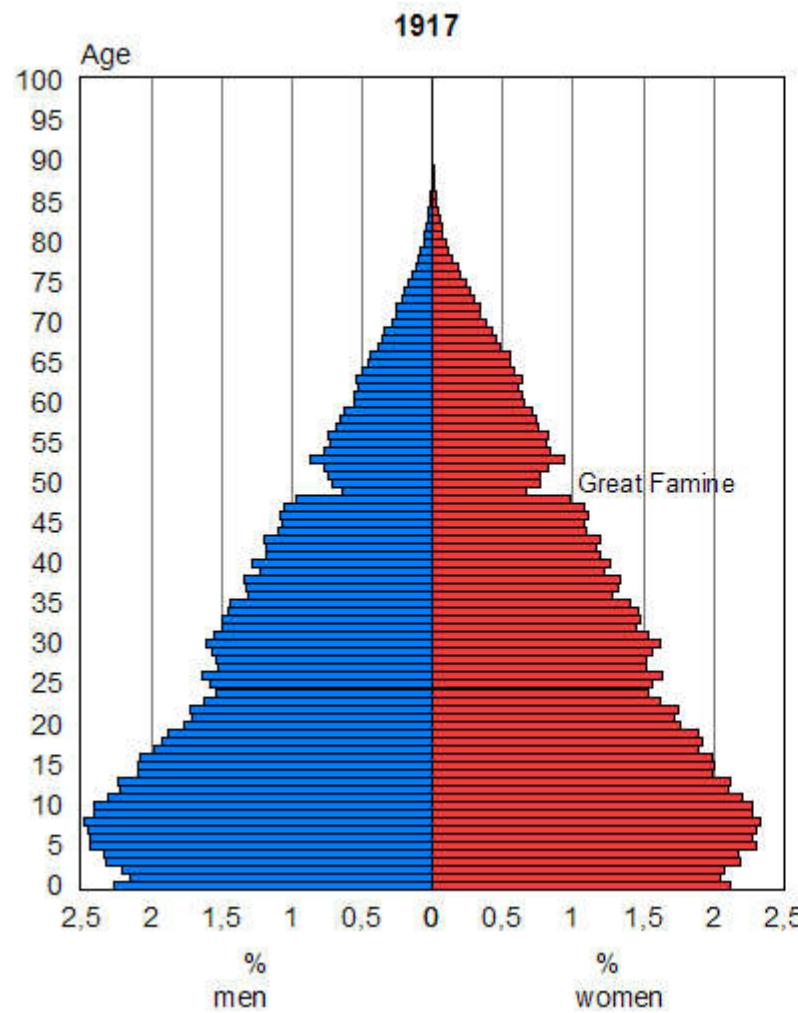
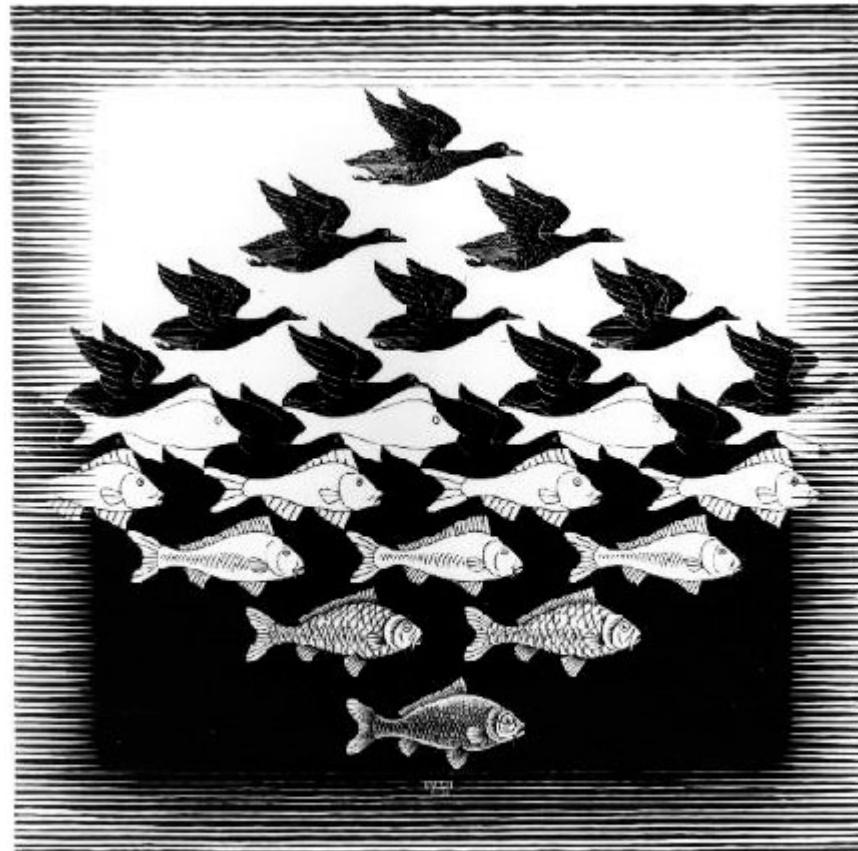
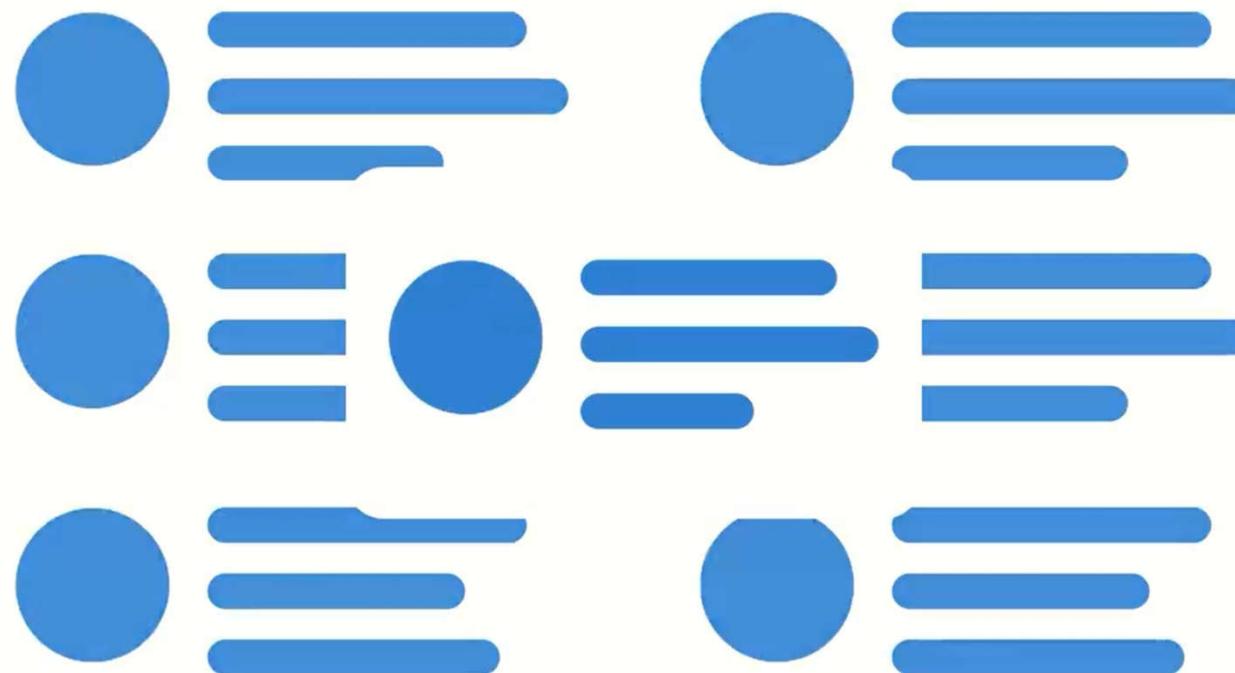


FIGURE / GROUND



M.C. Escher: *Sky and Water I* 1938 woodcut

Figure-1 Calculation



No separation

0:01 / 0:04

APPLICATION

pedia.org/wiki/Providence,_Rhode_Island



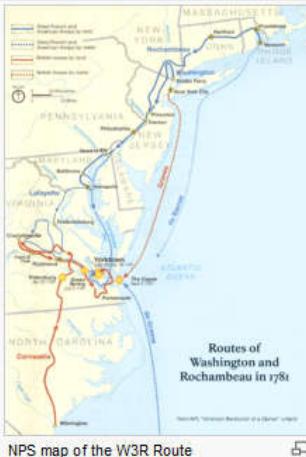
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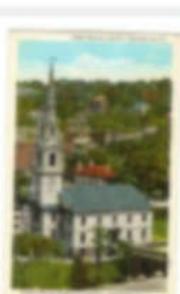
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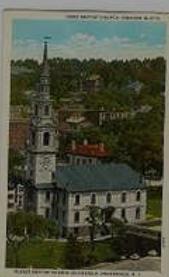
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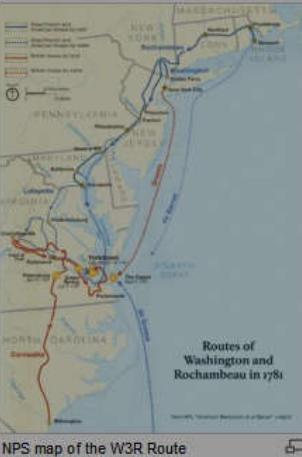
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First Baptist Church in America, founded 1638, present building occupied in 1776, is the oldest Baptist congregation in America



Providence in the mid-nineteenth century



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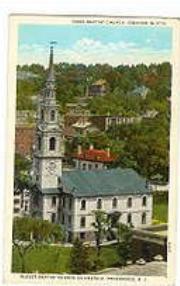
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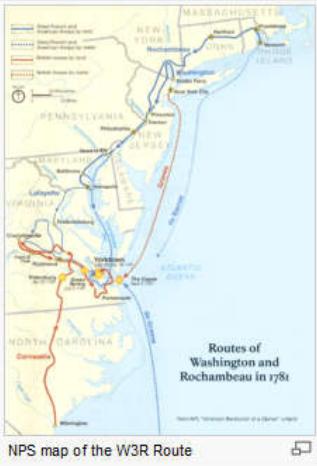
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www.nps.gov/w3r/parkhistory/sections/warof1812/routes.htm



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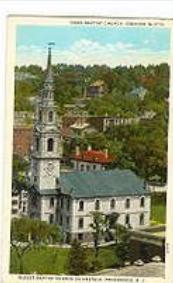
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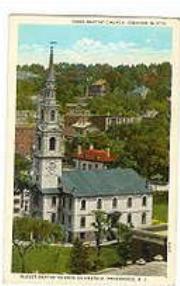
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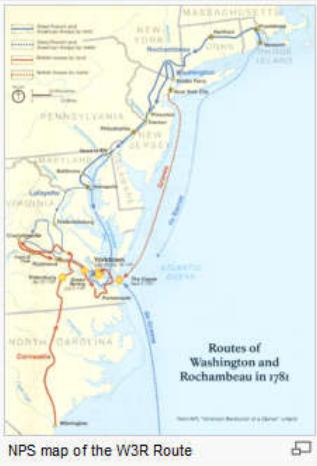
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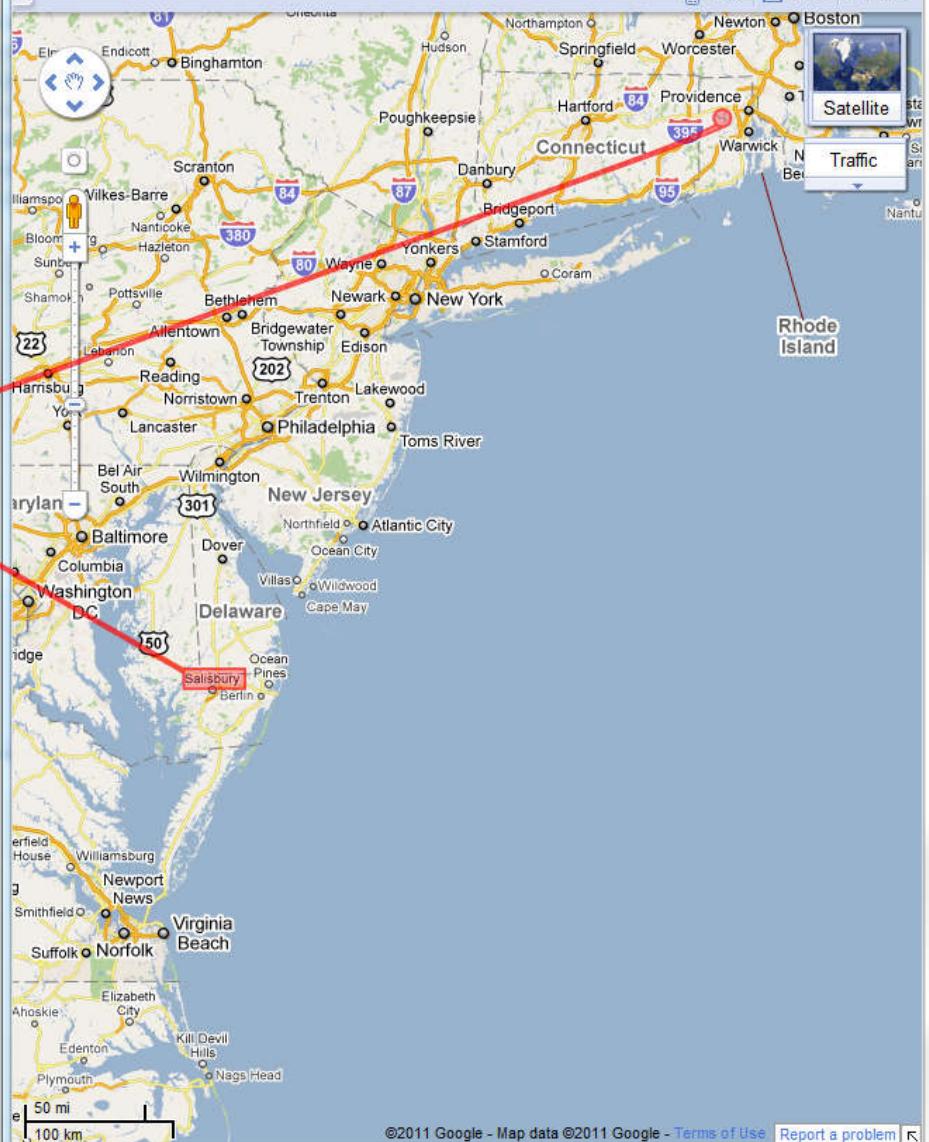
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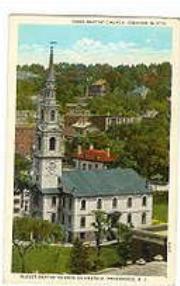
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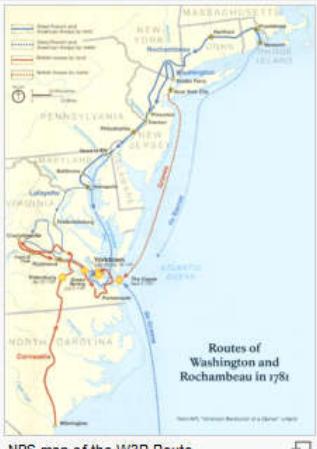
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Providence in the mid-nineteenth century



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Routes of Washington and Rochambeau in 1781

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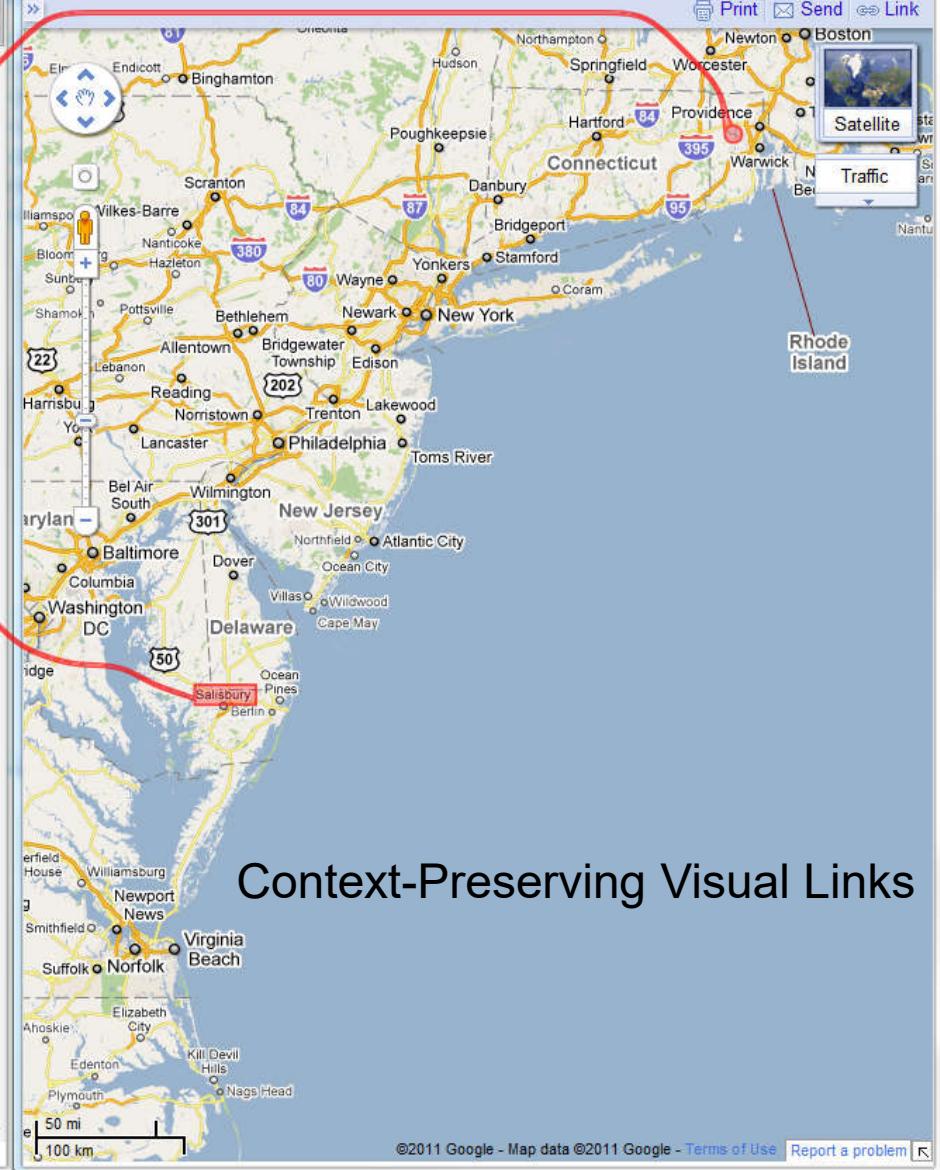
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Google Maps shows the location of Providence, Rhode Island, relative to New England and the surrounding states. The map includes major cities like Boston, Hartford, and New York, along with major highways like I-95 and I-90. A red circle highlights the location of Providence. A red line connects this highlighted location to the text in the left-hand sidebar, illustrating how visual links can preserve context across different types of media.

Context-Preserving Visual Links

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Knowing about Perception is important for Vis and UI design

- How to choose your colors
- How to show relationships
- How to draw attention
- How to minimize risk of overlooking