# Visual Thinking and Visualization

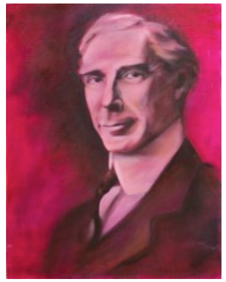
June 2016
Assoc. Prof. Michelle Kuttel
Department of Computer Science
University of Cape Town

# About me

University of Cape Town, South Africa

- Computational Science
  - Chemistry
  - Astronomy
- High Performance Computing
- **Visualization**
- Software for science

And some painting…



# Visualizations for thinking and interrogating

Complex thinking typically requires interaction with **cognitive tools:**

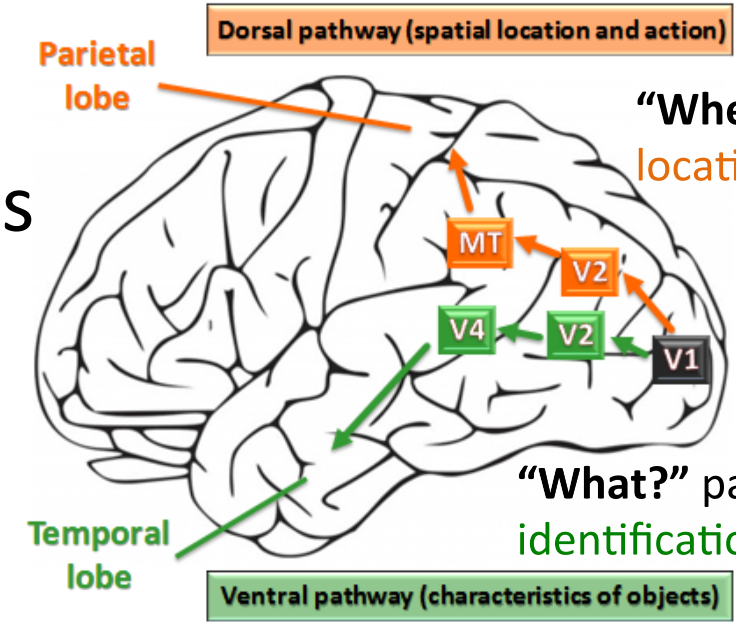
- pencils and paper
- calculators
- **software**

Visualizations

- graphical representation of data/concepts
- increasingly important for interrogating complex data
  - Interactive visualizations
- **Why are they important and useful?**

# *active vision*

- Almost **half** our brain is devoted to vision
- graphic designs are powerful **cognitive tools**




  - diagrams, maps, technical illustrations all help us to understand and solve problems
    - **visual thinking**
  - enhances and amplifies our mental abilities

Image from: Lyes Bachatene, Vishal Bharmauria and Stéphane Molotchnikoff (2012). Adaptation and Neuronal Network in Visual Cortex, Visual Cortex - Current Status and Perspectives, Prof. Stephane Molotchnikoff (Ed.), ISBN: 978-953-51-0760-6, InTech, DOI: 10.5772/46011.
http://www.intechopen.com/books/visual-cortex-current-status-and-perspectives/adaptation-and-neuronal-network-in-visual-cortex

# *visual thinking*

**This course aims to:**

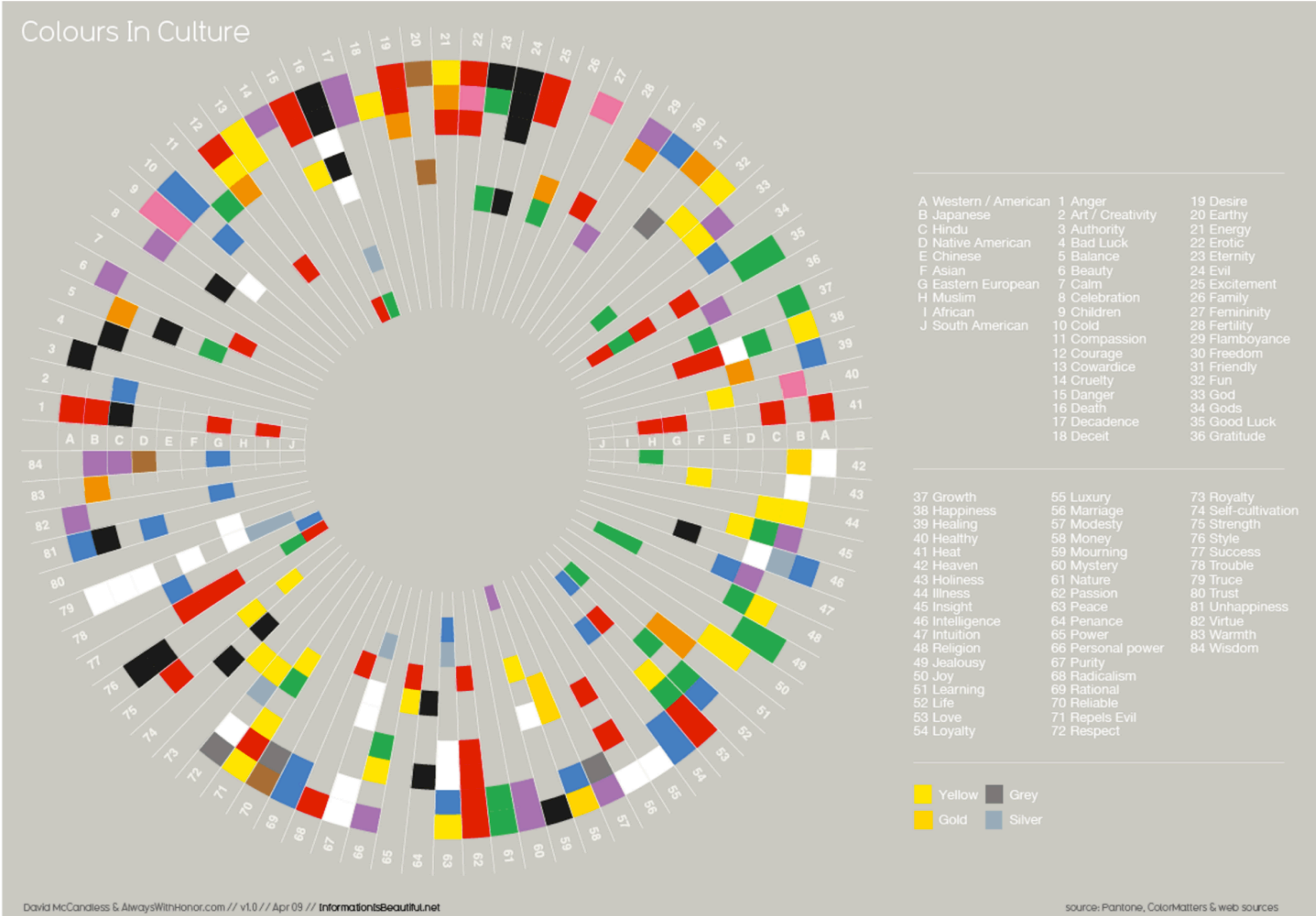
- outline current understanding of how we think visually
- demonstrate how we can use this knowledge to design better visualizations and graphical interfaces
  - display important quantitative information effectively

# Visualizations

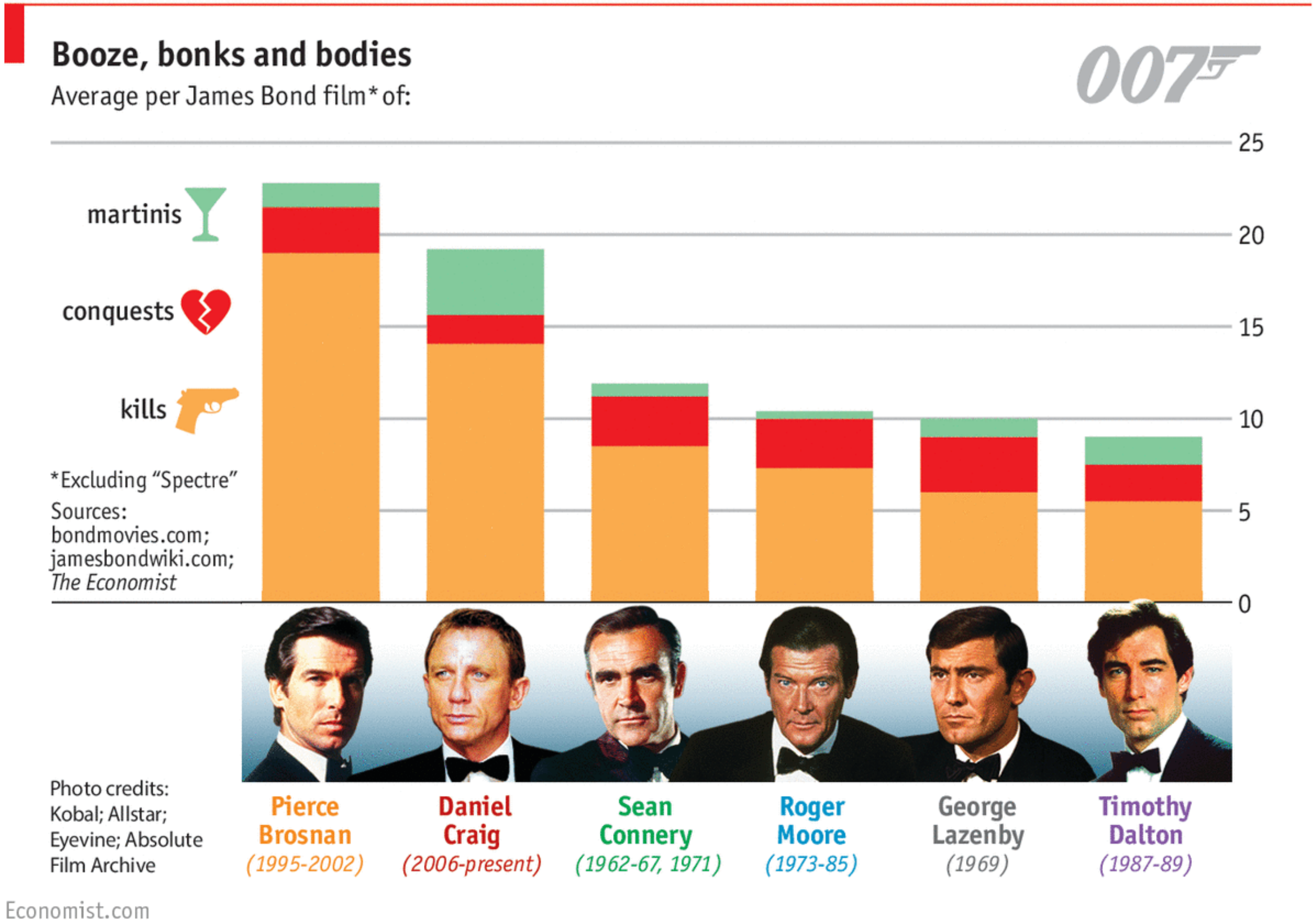
**Good** data visualizations allow huge quantities of information to be processed rapidly

a good visualization allows us to represent, and therefore grasp, an entire process or system – we can focus on a component while still having access to the global view.

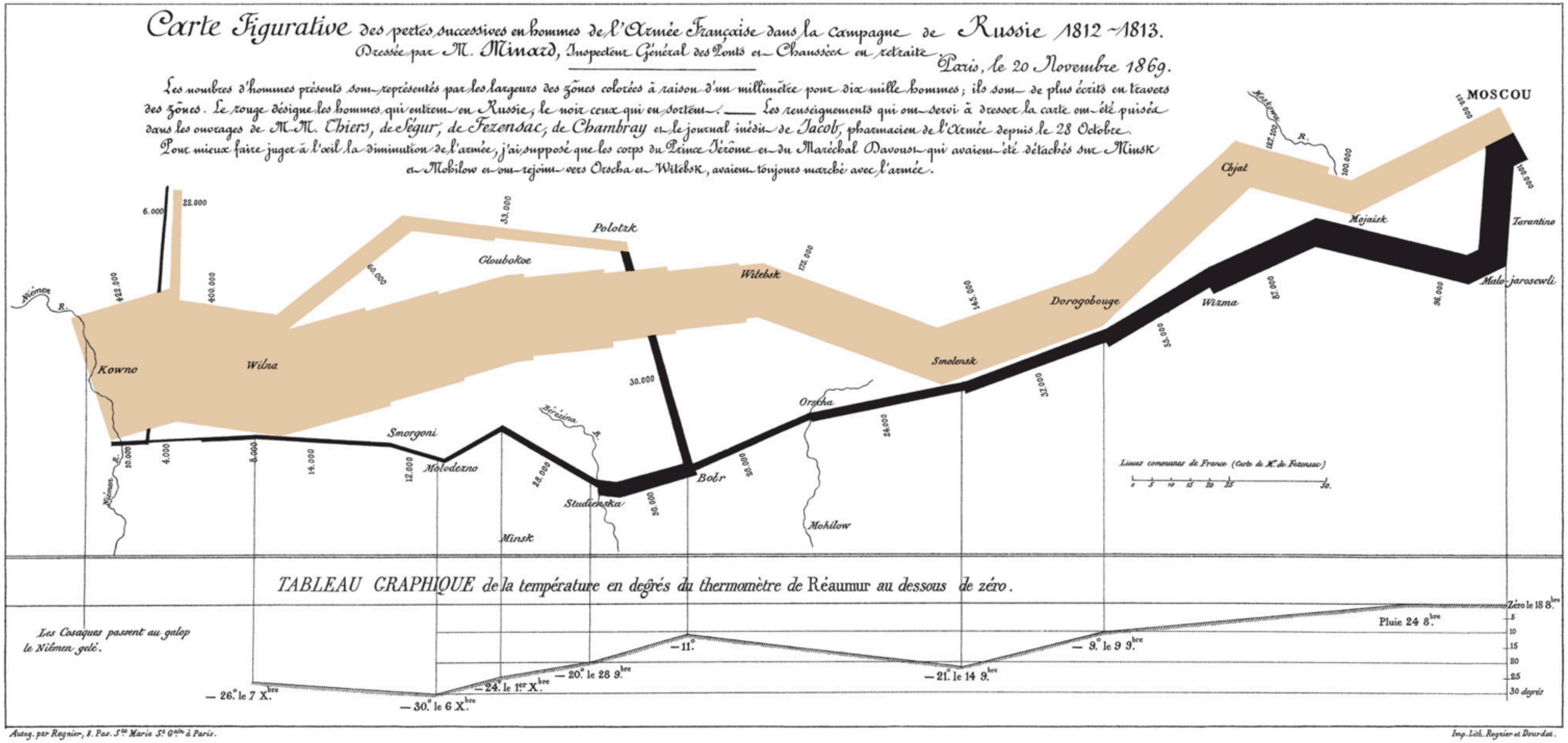
What is a “good visualization”?


Colours In Culture
A Western / American
B Japanese
C Hindu
D Native American
E Chinese
F Asian
G Eastern European
H Muslim
I African
J South American
1 Anger
2 Art / Creativity
3 Authority
4 Bad Luck
5 Balance
6 Beauty
7 Calm
8 Celebration
9 Children
10 Cold
11 Compassion
12 Courage
13 Cowardice
14 Cruelty
15 Danger
16 Death
17 Decadence
18 Deceit
19 Desire
20 Earthy
21 Energy
22 Erotic
23 Eternity
24 Evil
25 Excitement
26 Family
27 Femininity
28 Fertility
29 Flamboyance
30 Freedom
31 Friendly
32 Fun
33 God
34 Gods
35 Good Luck
36 Gratitude
37 Growth
38 Happiness
39 Healing
40 Healthy
41 Heat
42 Heaven
43 Holiness
44 Illness
45 Insight
46 Intelligence
47 Intuition
48 Religion
49 Jealousy
50 Joy
51 Learning
52 Life
53 Love
54 Loyalty
55 Luxury
56 Marriage
57 Modesty
58 Money
59 Mourning
60 Mystery
61 Nature
62 Passion
63 Peace
64 Penance
65 Power
66 Personal power
67 Purity
68 Radicalism
69 Rational
70 Reliable
71 Repels Evil
72 Respect
73 Royalty
74 Self-cultivation
75 Strength
76 Style
77 Success
78 Trouble
79 Truce
80 Trust
81 Unhappiness
82 Virtue
83 Warmth
84 Wisdom
Yellow
Grey
Gold
Silver
David McCandless & AlwaysWithHonor.com // v1.0 // Apr 09 // InformationIsBeautiful.net
source: Pantone, ColorMatters & web sources

# Visualizations



# Famous visualization: Minard's Map of Napoleon's march to Moscow




Created in 1861. Described by E. Tufte* as "*Probably the best statistical graphic ever drawn, this map by Charles Joseph Minard portrays the losses suffered by Napoleon's army in the Russian campaign of 1812. Beginning at the Polish-Russian border, the thick band shows the size of the army at each position. The path of Napoleon's retreat from Moscow in the bitterly cold winter is depicted by the dark lower band, which is tied to temperature and time scales.* "

** Image and text from Graphics Press, http://www.edwardtufte.com/tufte/posters*

# How do we design effective visualizations?

Which colours and **shapes** will stand out clearly?

- How do we organise space?

How do we show lots of data effectively?

When should we use images instead of words?

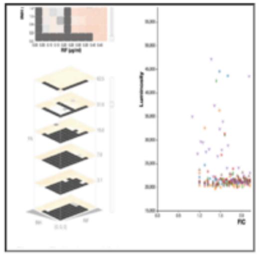
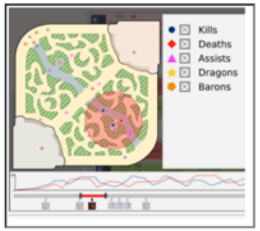
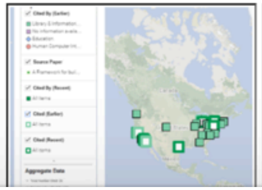
– and vice-versa?

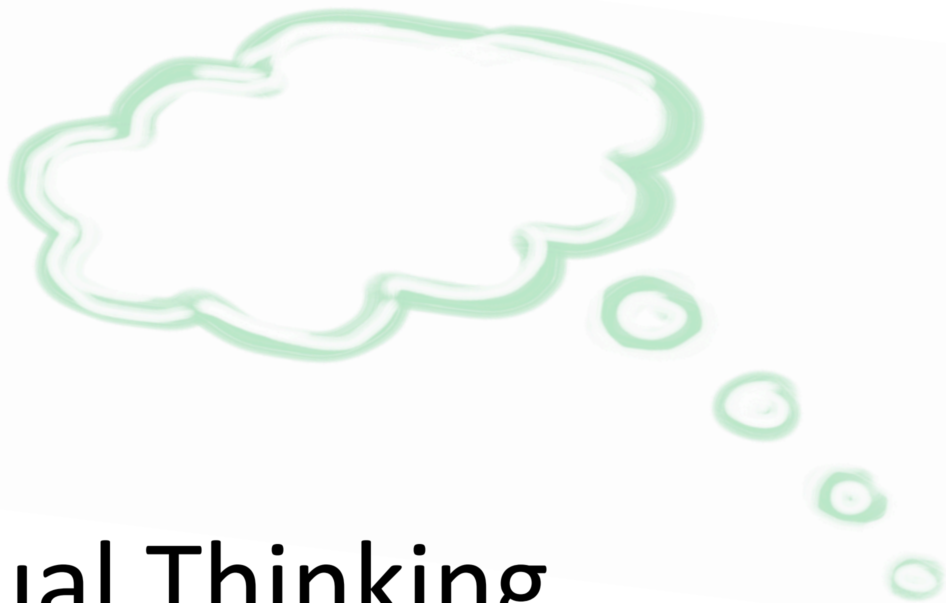
# Recommended Reading

- ***Visual Thinking for Design*** by Colin Ware
- ***Information visualization: perception for design*** by Colin Ware
- ***The Visual Display of Quantitative Information.*** by Edward R. Tufte (second edition)
- ***Visual Complexity. Mapping Patterns of Information.*** by Manuel Lima (Princeton Architectural Press, New York)
- ***Visual Language for Designers. Principles for creating graphics that people understand.*** by Connie Malamed

# http://people.cs.uct.ac.za/~mkuttel/VisProjects2015.html

**Selected projects from the UCT CS Honours class of 2015**

| | Title | Group |
|---|---|---|
|  | Platevis report<br>Platevis visualization | **Jarred de Beer**<br>**Steven Rybicki** |
|  | School salary | **Andrew van Rooyen** |
|  | LOLStatsWeb | **Eugene De Beste**<br>**Mark Grivainis**<br>**Calvin (Goldfish) Mills** |
|  | Google Scholar Citation Visualization | **Lauren Sanby**<br>**Ion Todd**<br>**Chantal Yang** |



# Visual Thinking

## Perception, Attention and Visual Queries

# **Perception** and visual attention

Our minds don't work as well as we think they do

At any given instant, we apprehend only a tiny fraction of the information stored in our surroundings

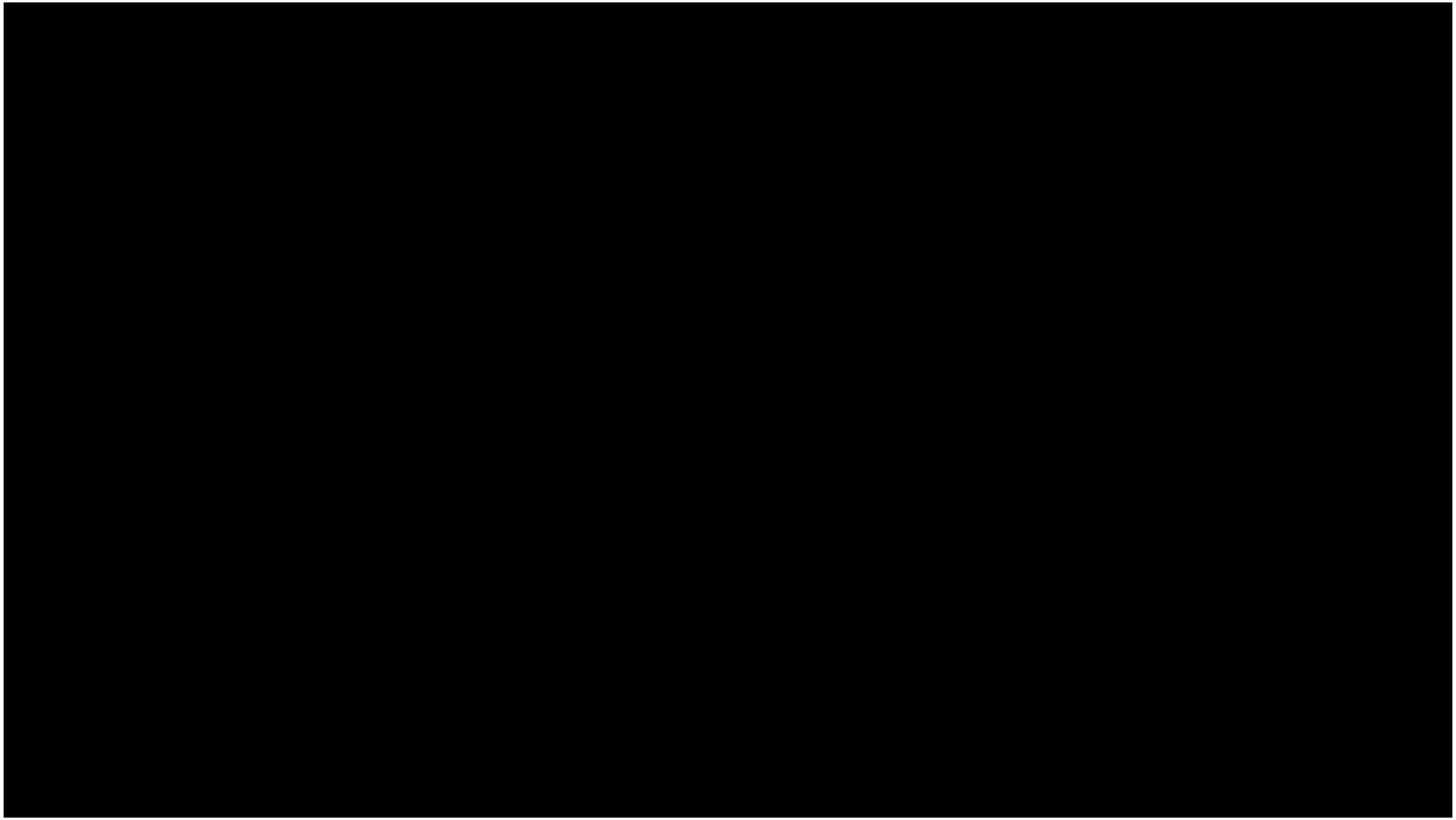
- "The world is its own memory."

We are not immediately conscious of the world:

- conscious of the "field of information" to which we have "rapid access"

# The monkey business illusion

by Christopher Chabris and Daniel Simons



# Change blindness

## We cannot even remember new faces!

Simons, D.J., & Levin, D.T. (1998). Failure to detect changes to people during a real-world interaction. Psychonomic Bulletin and Review , 5 , 644-649

a) b) c) d)

http://scienceblogs.com/mixingmemory/2006/12/coolest_experiment_ever.php

a) An experimenter approaches a passerby with **a map** and asks for **directions** to a campus building.

b) After about 15 seconds, two guys carrying **a door** pass between the experimenter and the passerby.

c) As the door went past, the experimenter **switched places** with the guy carrying the back end of the door!

# Change blindness

## We cannot even remember new faces!

Simons, D.J., & Levin, D.T. (1998). Failure to detect changes to people during a real-world interaction. Psychonomic Bulletin and Review , 5 , 644-649


http://scienceblogs.com/mixingmemory/2006/12/coolest_experiment_ever.php

a) An experimenter approaches a passerby with **a map** and asks for **directions** to a campus building.

b) After about 15 seconds, two guys carrying **a door** pass between the experimenter and the passerby.

c) As the door went past, the experimenter **switched places** with the guy carrying the back end of the door!

# Change blindness

- We cannot even remember new faces!


Simons, D.J., & Levin, D.T. (1998). Failure to detect changes to people during a real-world interaction. Psychonomic Bulletin and Review , 5 , 644-649

http://scienceblogs.com/mixingmemory/2006/12/coolest_experiment_ever.php

d) After the experimenter finished giving directions, he/she asked:
*We're doing a study as part of the psychology department [experimenter points to the psychology building next door] of the sorts of things people pay attention to in the real world.*

*Did you notice anything unusual at all when that door passed by a minute ago?*

If the passerby didn't say that the person to whom he was talking changed when the door passed, the experimenter then asked:
*Did you notice that I'm not the same person who approached you to ask for directions?*

# Change blindness

- We cannot even remember new faces!


Simons, D.J., & Levin, D.T. (1998). Failure to detect changes to people during a real-world interaction. Psychonomic Bulletin and Review , 5 , 644-649

http://scienceblogs.com/mixingmemory/2006/12/coolest_experiment_ever.php

**Eight out of fifteen** direction-givers failed to notice that the person they were talking to changed in mid conversation!

# Change blindness

Simons, D.J., & Levin, D.T. (1998). Failure to detect changes to people during a real-world interaction. Psychonomic Bulletin and Review , 5 , 644-649

http://scienceblogs.com/mixingmemory/2006/12/coolest_experiment_ever.php

All seven people who did notice the change were students, like the experimenters, 20-30 years old.
Older participants didn't notice the change.
In a second experiment, the two experimenters who acted as direction-takers were dressed as construction workers.
This time, only 4 of 12 young participants (college age) noticed the switch, supporting the hypothesis that people only notice the change when the appearance of the individuals is relevant to them.

# Perception and visual attention

- Why did this happen?
  - people were concentrating on the map
  - we have limited capacity for attention and unnecessary information is discarded
    - working memory is limited
    - tradeoff of space vs time!
  - We see very little at any given instant, but can sample the world so rapidly* by eye, that we have the illusion of having it all in our brains at once

* 0.1 s per eye movement

# **Perception** and visual attention

- The knowledge that we only visually sample the world on a need-to-know basis only emerged over the last decade
  - led to profoundly different model of perception
  - we are conscious of the "field of information" to which we have "rapid access"

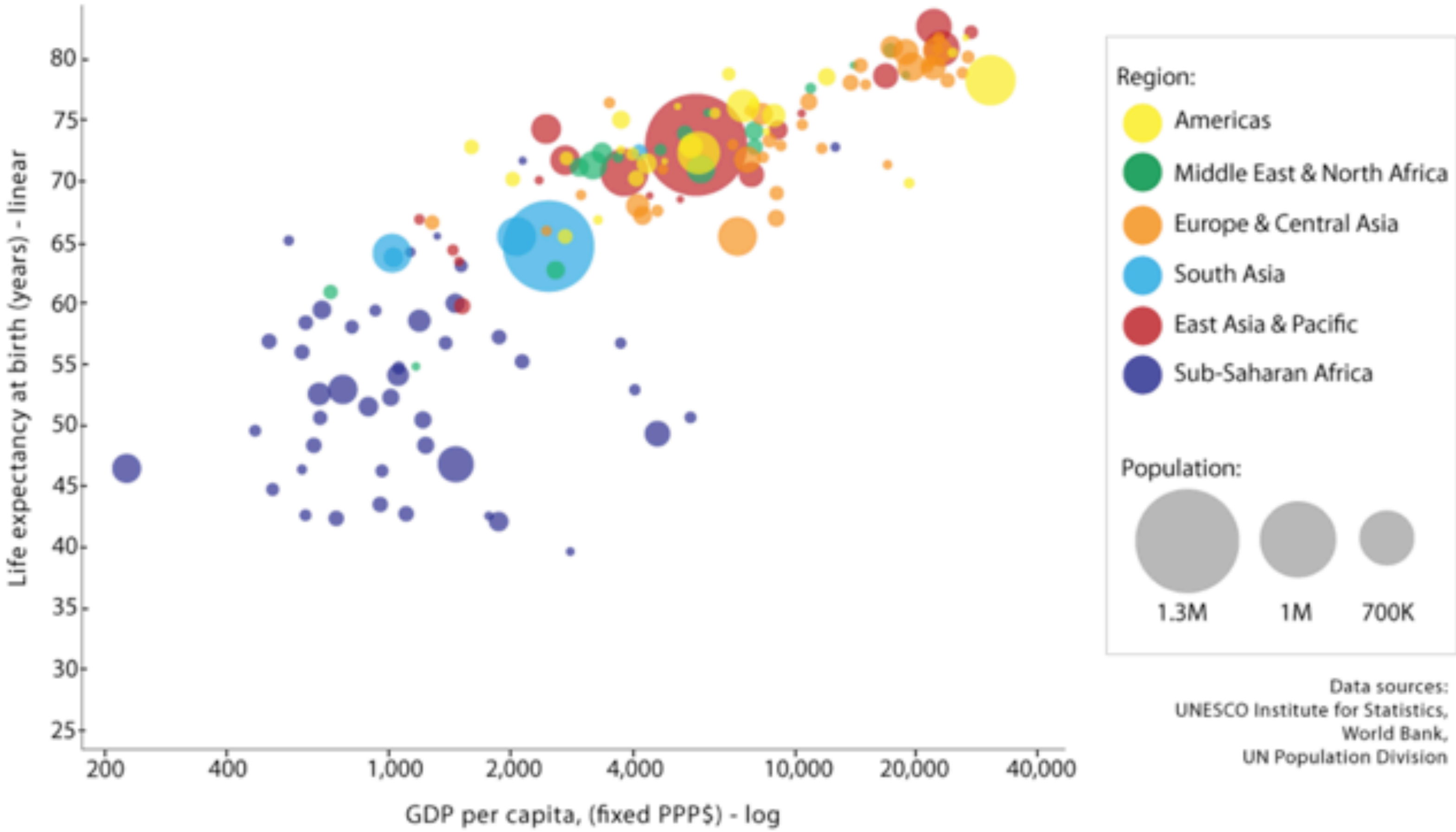
Visual thinking consists of a series of "acts of attention" -

**visual queries**

- which drive eye movements and tune our pattern-finding circuits.

A good graphic enables **visual queries** to be processed **rapidly.**

- For the figure below, give two distinct visual queries that are quick to answer and two that are slow.



# The act of perception

Perception is driven by 2 processes:

- **bottom-up**:
  - driven by **external stimulus**

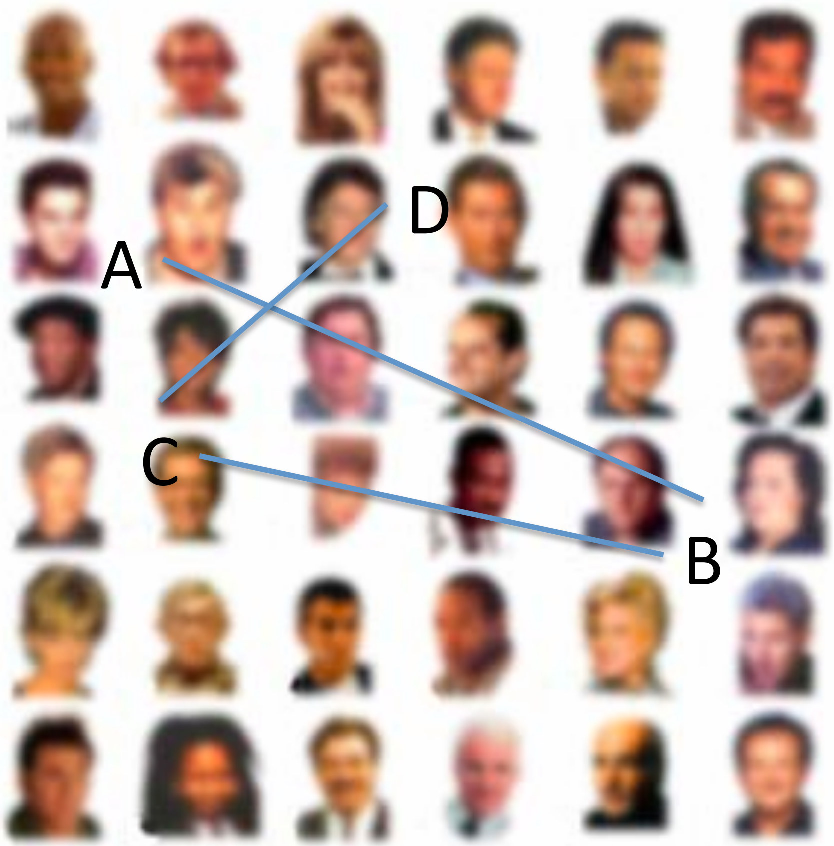
  retinal image -> features -> patterns -> objects

  We detect motion, edges of shapes, colours, contours, contrasts through bottom-up processes without conscious awareness.

# The act of perception

- **top-down** or attention
  - driven by need to accomplish some goal, prior knowledge, expectations
    - biased in favour of signals we are looking for
  - only get information we need when we need it
    - sequence of rapid eye movements to locate important objects
- Brain functions as a kind of distributed processor, accessing information as necessary.

# Blurred Picture exercise



# The working memory bottleneck

- very limited capacity
  - on average, a person can manipulate around three to five chunks of awareness in memory at one time
- short duration
- cognitive load:
  - when high, cannot process information
  - good designs should limit cognitive load

# Implications for design

- Goal is to design displays so that visual queries are **processed** both **rapidly** and **correctly** for every important cognitive task
  - Therefore, we must understand the cognitive tasks and visual queries a graphic is intended to support
    - usually done intuitively, but can be made explicit
- the goal is not to make you neuropsychologists, but to give you a **theoretical understanding** of how we perceive, in order to inform the design process.
- Understanding how people process information will help you to produce graphics that users understand

# Visual Apprehension

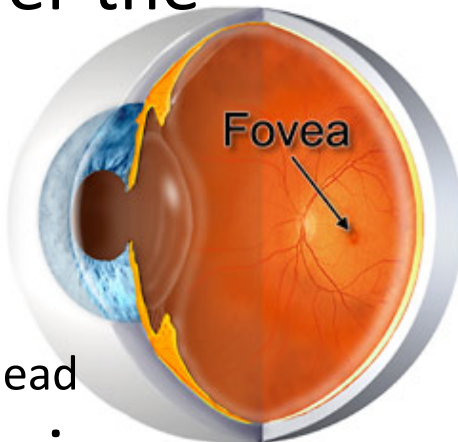
What we can see

**most easily.**

# The process of seeing

Eyes are like digital cameras with a range of light-seeing elements: rods and cones

- brain pixels vary enormously in size over the visual field:
  - tiny ones at the centre (fovea)
  - large ones at the periphery
    - at the end of the visual field, vision is terrible
      - can resolve objects about the size of a human head




- Non-uniformity means that half our brain power is devoted to viewing less than 5% of our visual world

# Facilitating visual queries

- Visual attention works like a **spotlight**
- In a graphic or interface, you want to ensure that all **visual queries** can be rapidly and effectively served
- How do we design graphical symbols that can be rapidly located?
- The most important and frequent queries should be supported by the most **visually distinct objects.**

What makes a small thing easy to spot?

# Visual query illustration #1

- In the following text, find the two p's

# Visual query illustration #1

- In the following text, find the two p’s

ahklhsdfasdgdramzxmxzcbkdkhjsdnnpksdfjzxnc xnfhagspdjgruioqweuyruywutsdbsmawqw

# Visual query illustration #1

- Now, find the two q's

ahklhsdfasdgdramzxmxzcbkdkhjsdnnpksdfjzxnc
xnfhagspdjgruioqweuyruywutsdbsmawqw

# Visual query illustration #1

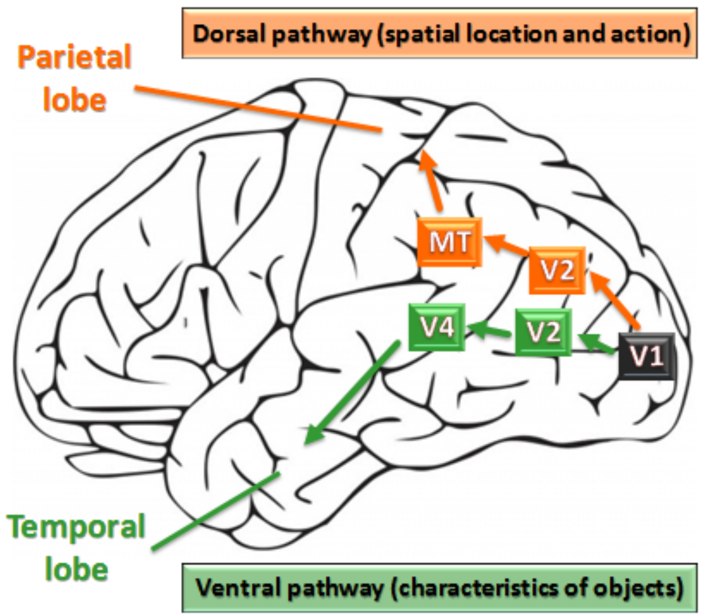
- Finding the p’s is very easy
- Finding the q’s takes much longer and imposes a much greater cognitive burden
- Why do the q’s take longer to find?

# Visual learning

- Finding things quickly is **not a matter of practice**
- it is the way our visual cortex works
  - learning can help with patterns, which are higher up the visual pathway

# How humans do low-level feature analysis

- Early stages of visual processing occur in the primary visual cortex:
  - V1 : general scanning
  - V2 : stereo vision
  - V3 : depth and distance
  - V4 : colour
  - V5 (or MT) : motion
  - V6 : objective position of object




**"Where?"** path: location of objects

V1-V2-V3-V5-V6

**"What?"** path: identification of objects

V1-V2-V4

very nice book on the brain ->

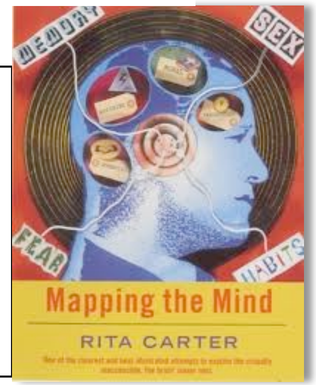



Image from: Lyes Bachatene, Vishal Bharmauria and Stéphane Molotchnikoff (2012). Adaptation and Neuronal Network in Visual Cortex, Visual Cortex - Current Status and Perspectives, Prof. Stephane Molotchnikoff (Ed.),

# How to find what you are looking for: biased competition

- If you are looking for a particular colour/ orientation/size of an object, the visual system highlights these
  - e.g. if picking **strawberries**, all red sensitive cells will "shout louder"

- some things pop out

much more easily than others

# What makes objects **pop out**?

- Some kinds of shapes have properties to which our eye-movement programming system is sensitive – they **pop out**
  - can be seen in a single eye movement: **at-a-glance**
  - processing takes less than a **tenth of a second**
    - compare with 1-5 seconds for a visual search
- easiest when single object differs in one feature from all the objects around it
  - to do with degree of contrast to the environment of the object

# What makes objects pop out?

- Simplest features that lead to pop out are:

colour,

orientation

size

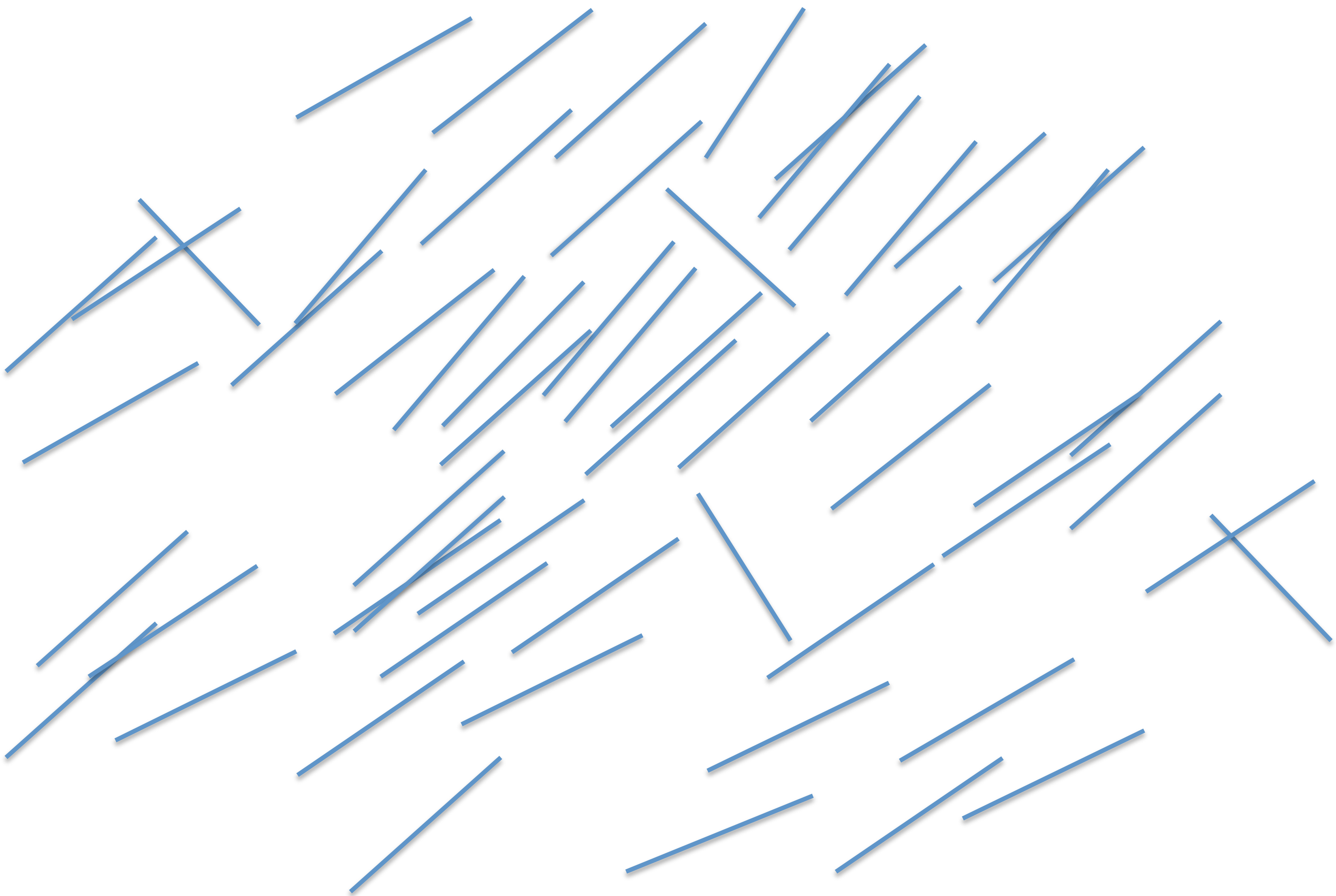
motion

stereoscopic depth

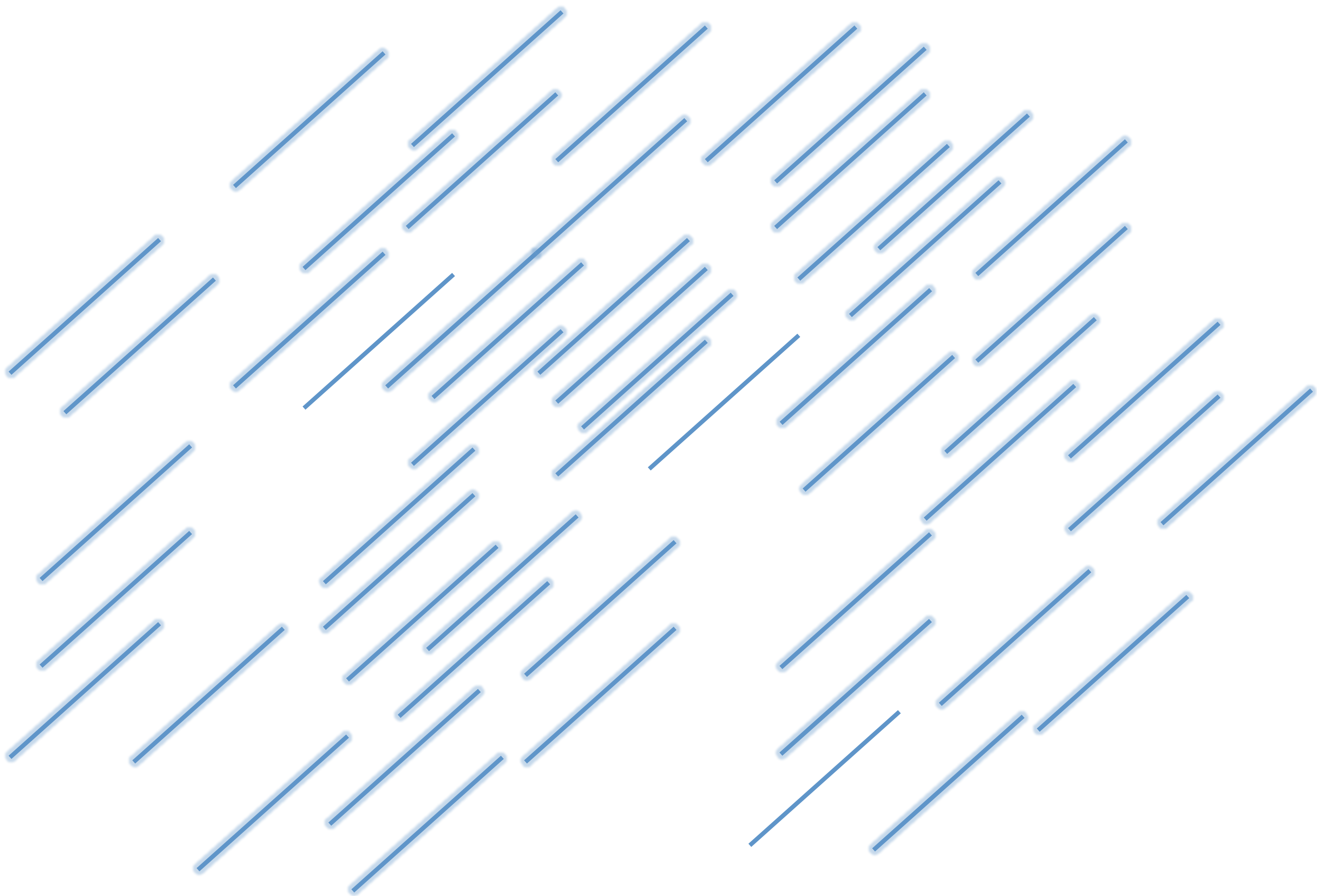
map to basic areas of visual cortex

- V1 : general scanning
- V2 : stereo vision
- V3 : depth and distance
- V4 : colour
- V5 (or MT) : motion
- V6 : objective position of object

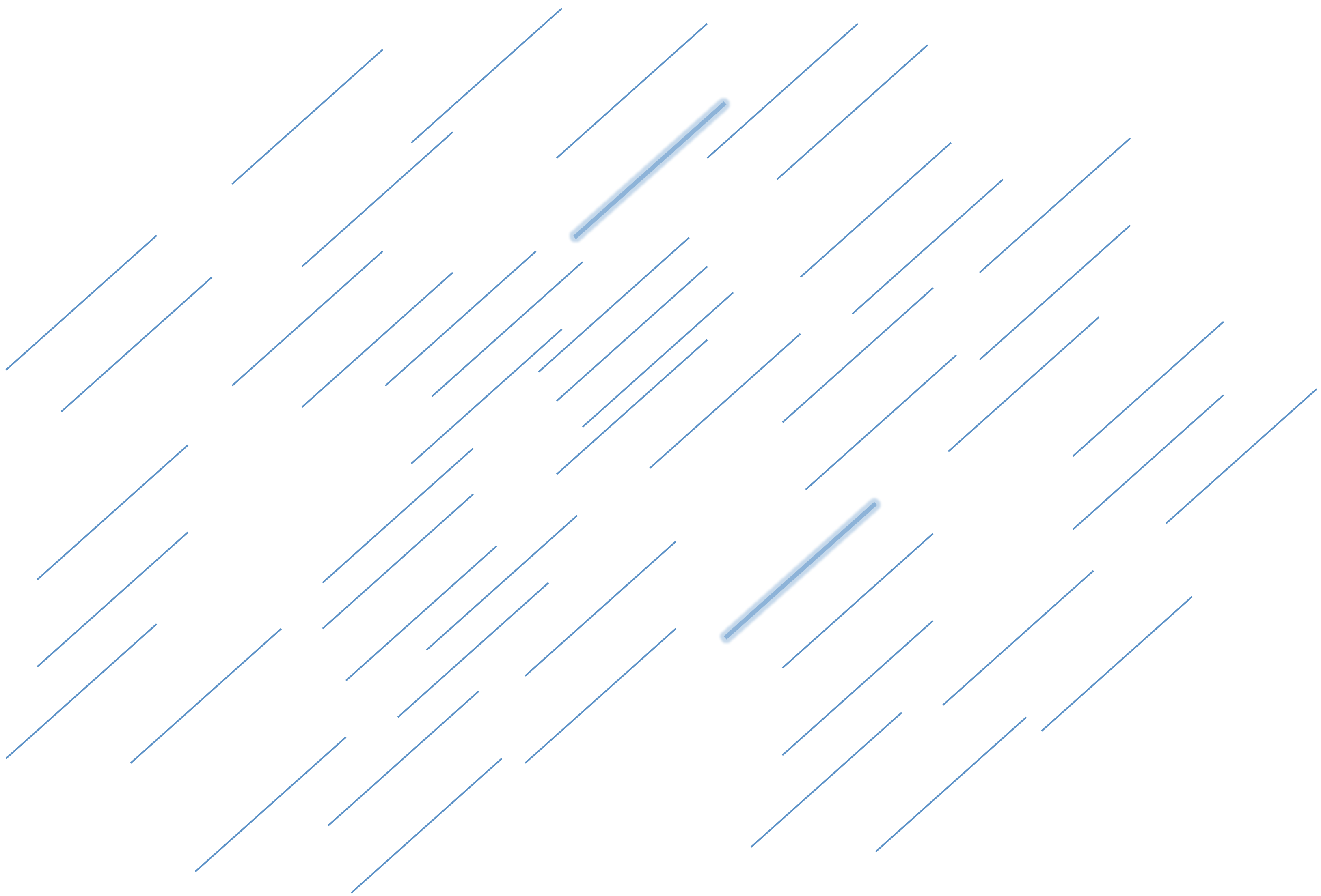
# What stands out: orientation



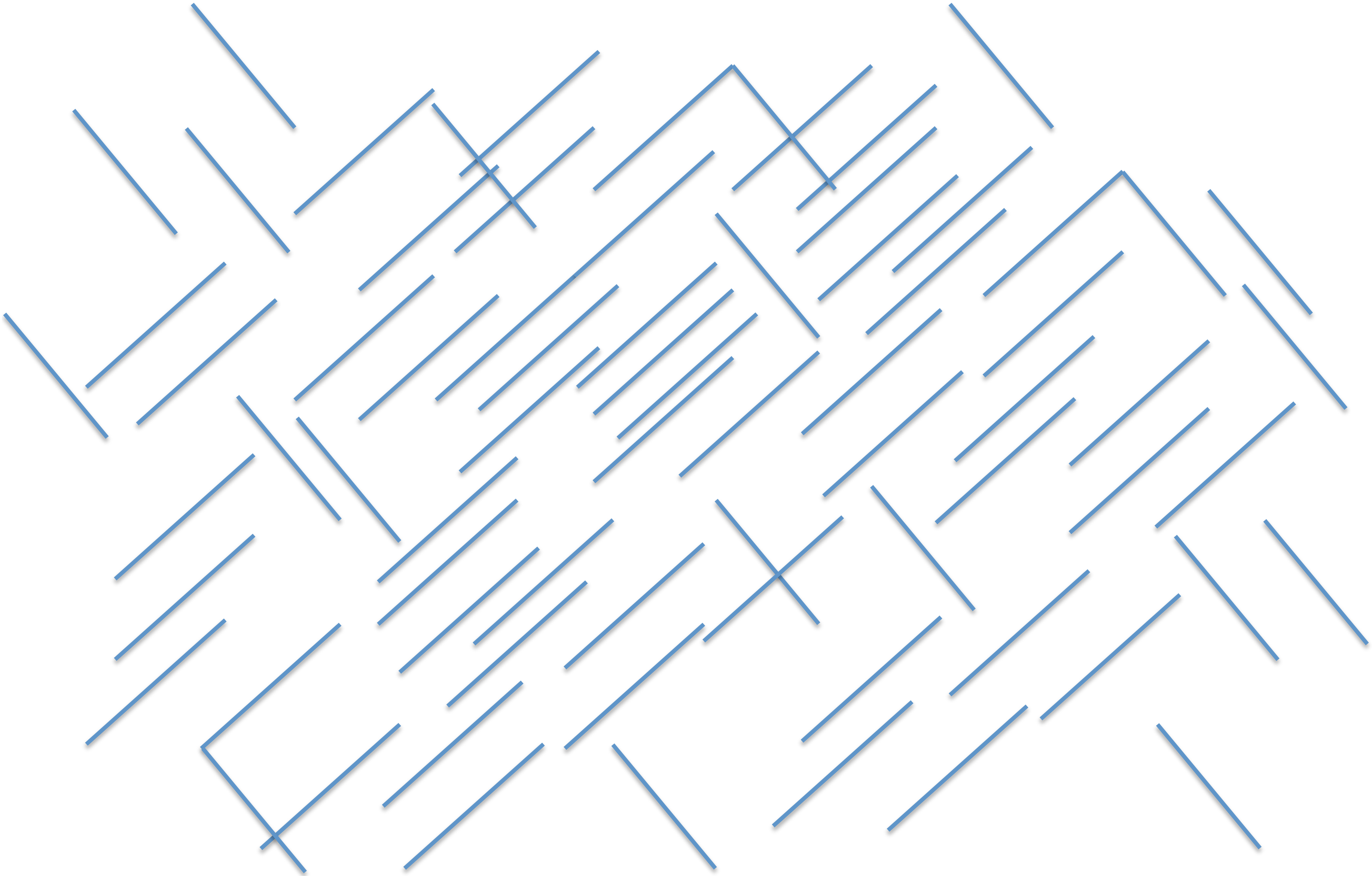
# What stands out: sharpness



# What stands out: sharpness

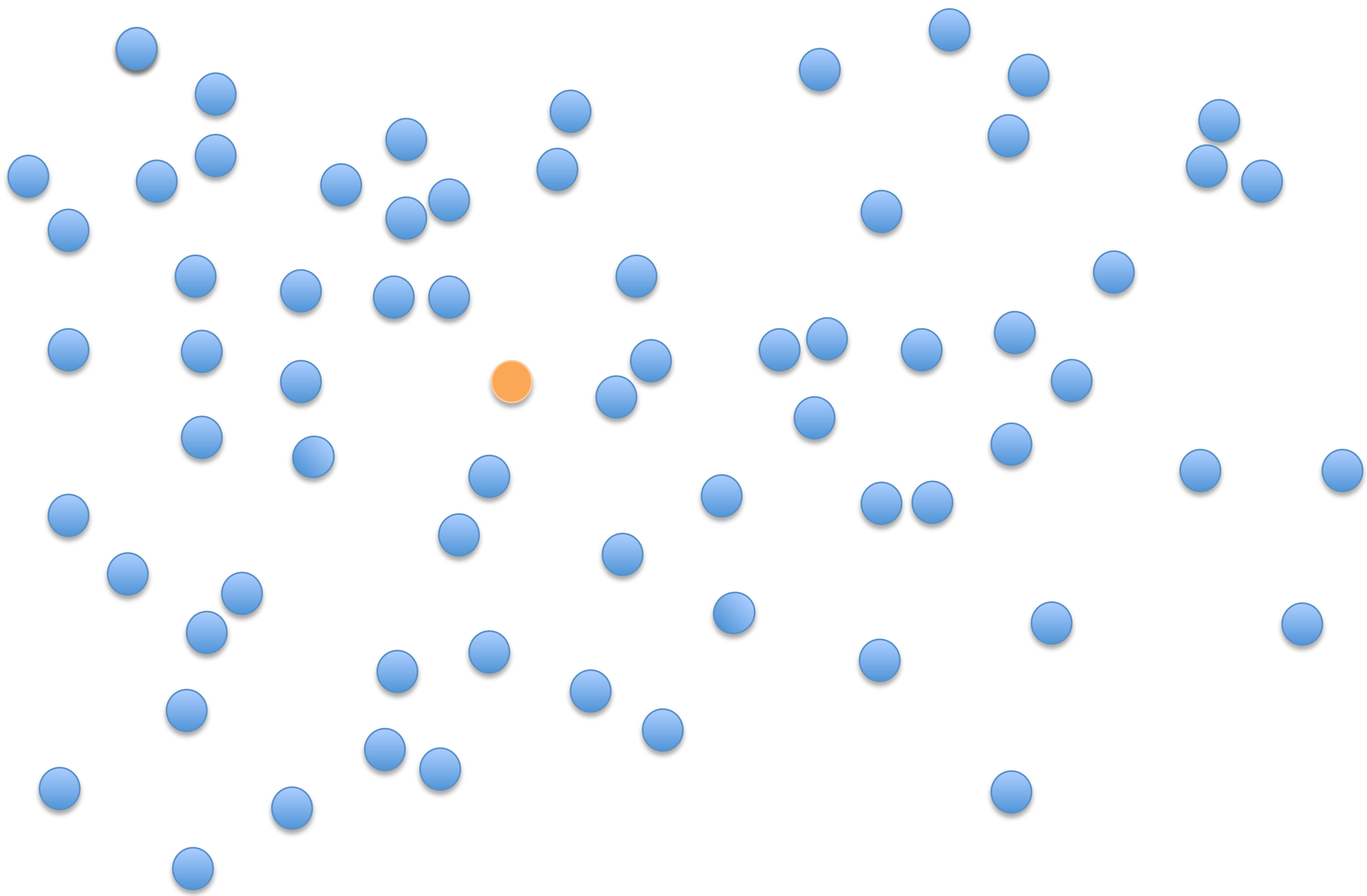


# What stands out: joined lines

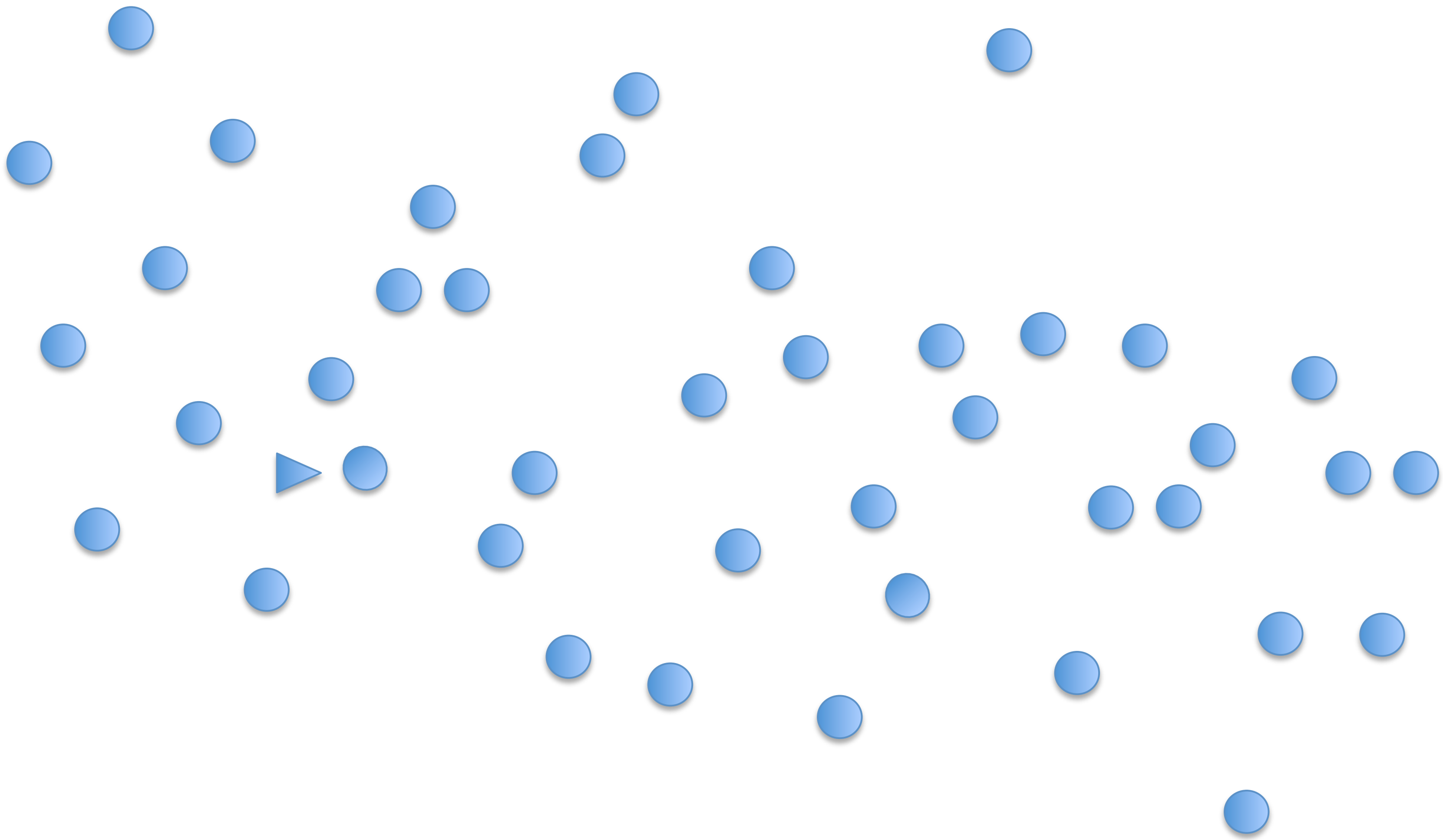


# What stands out: misalignment

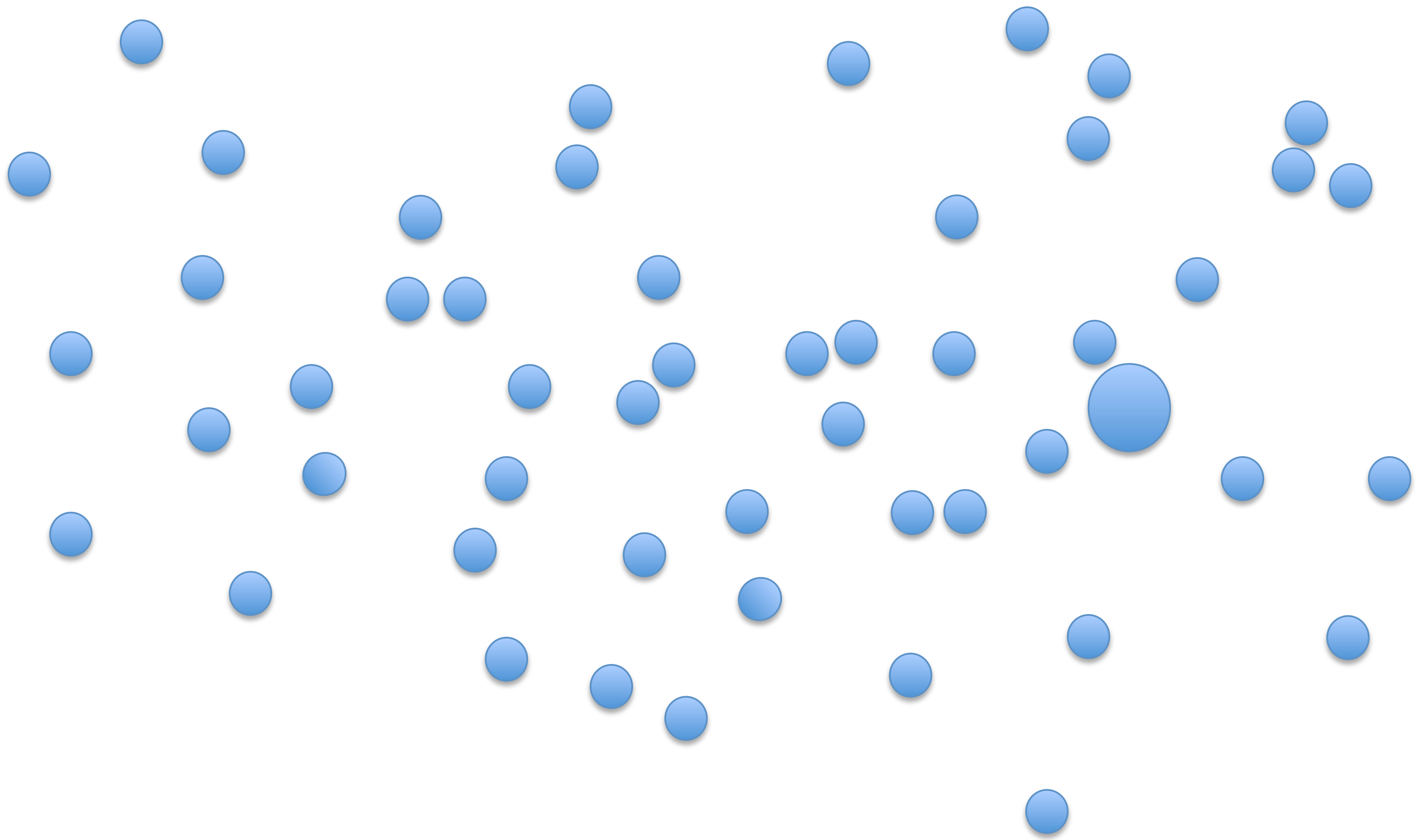
# What stands out: colour



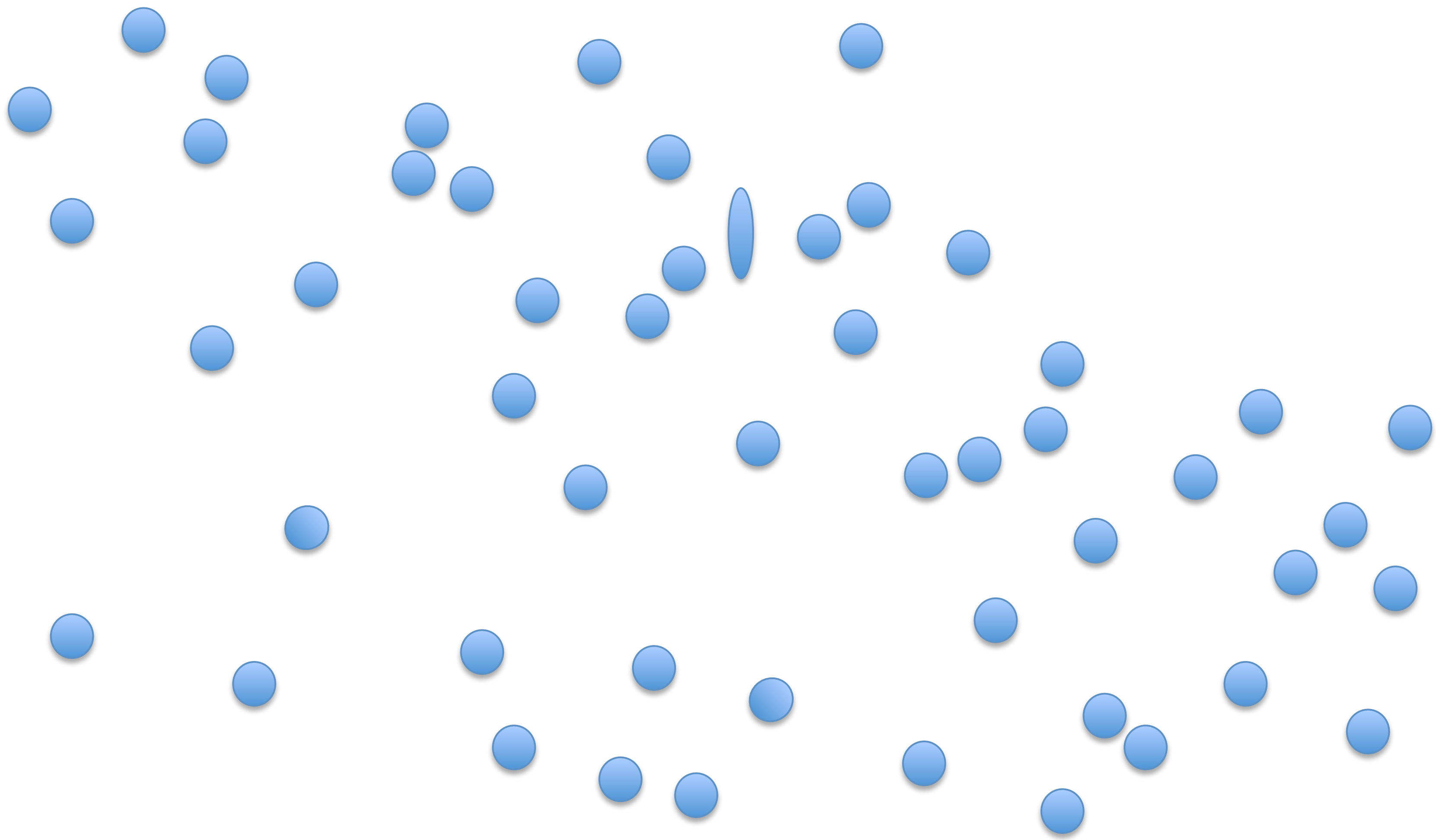
# What stands out: shape



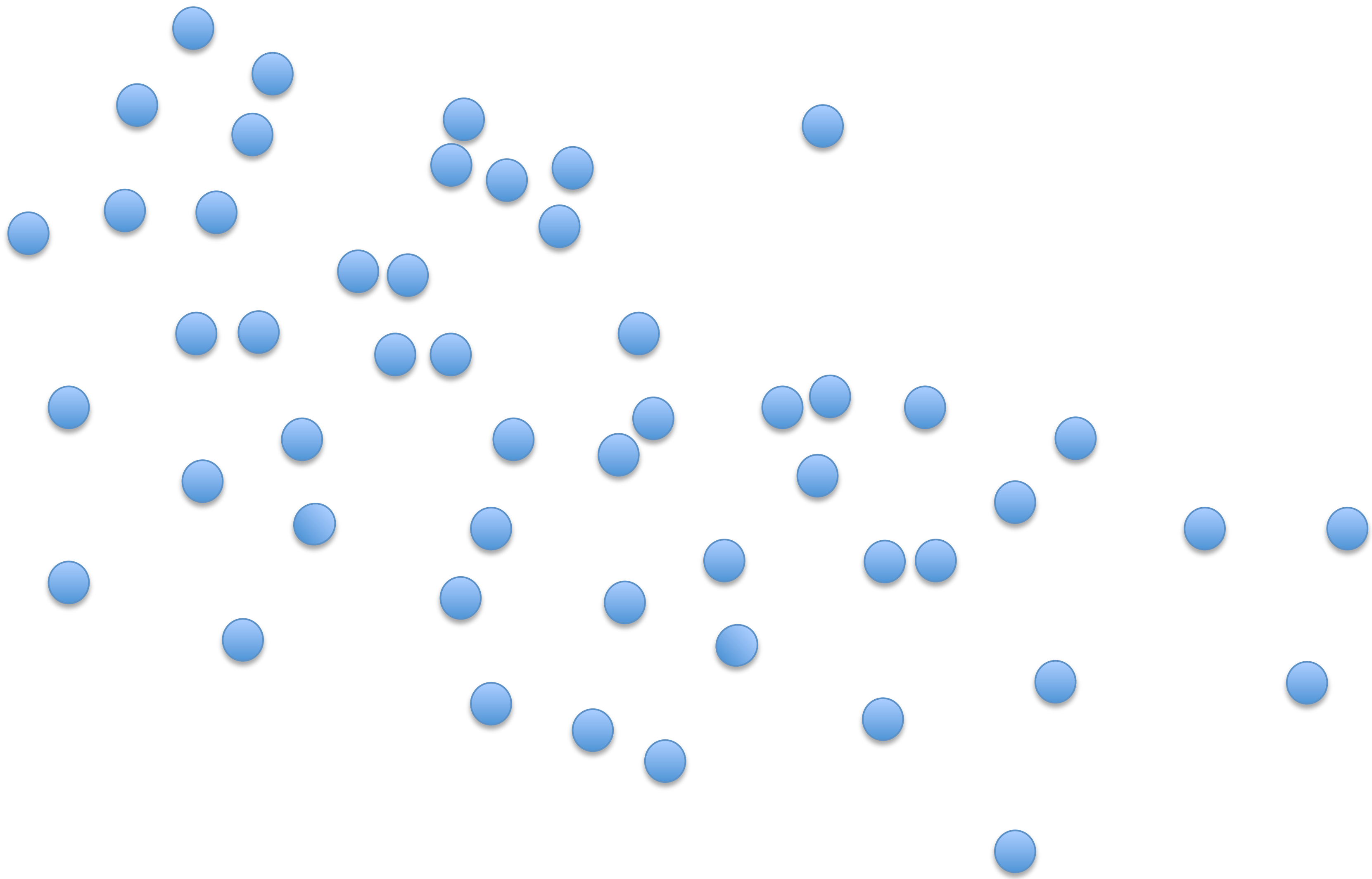
# What stands out: size



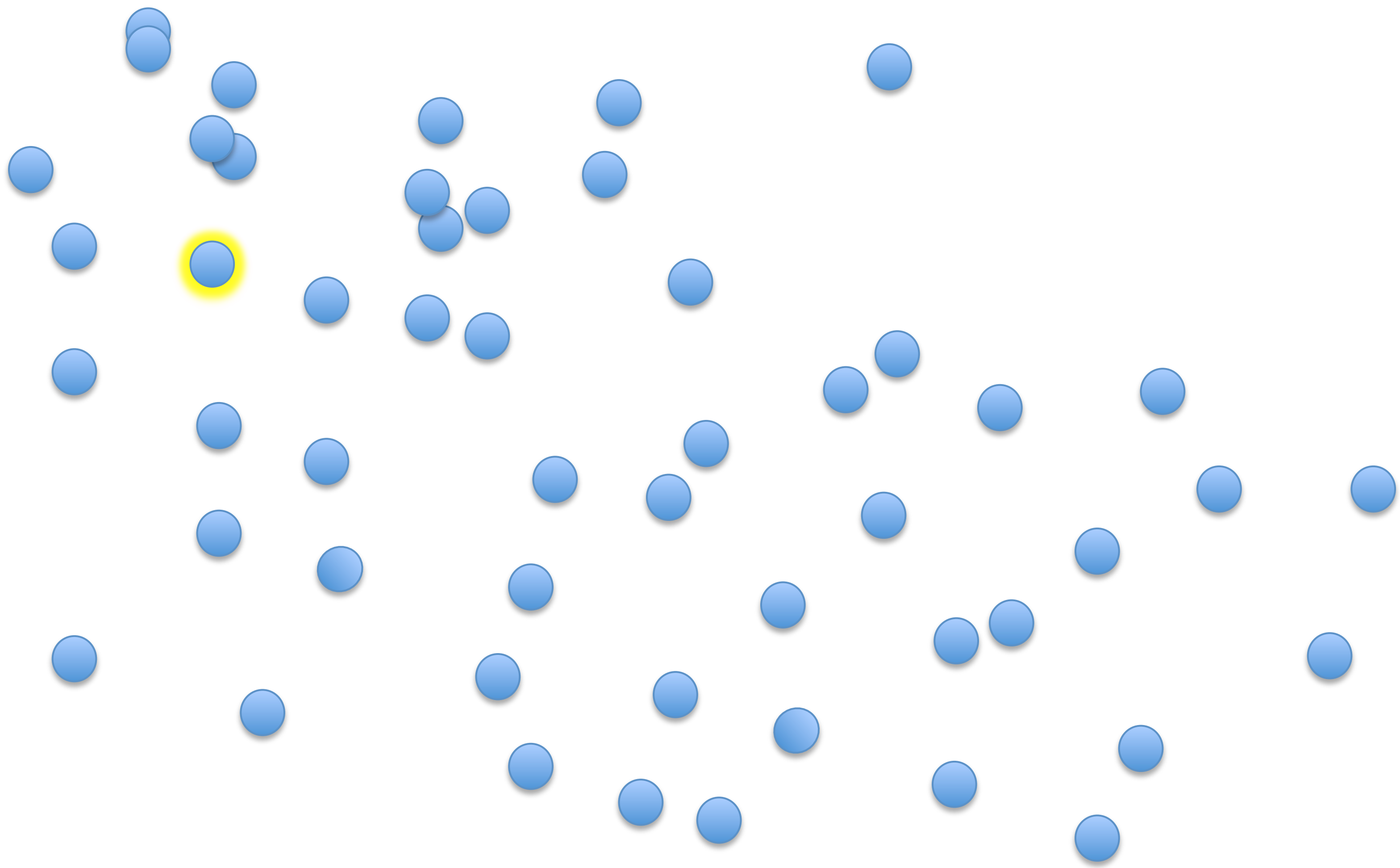
# What stands out: elongation



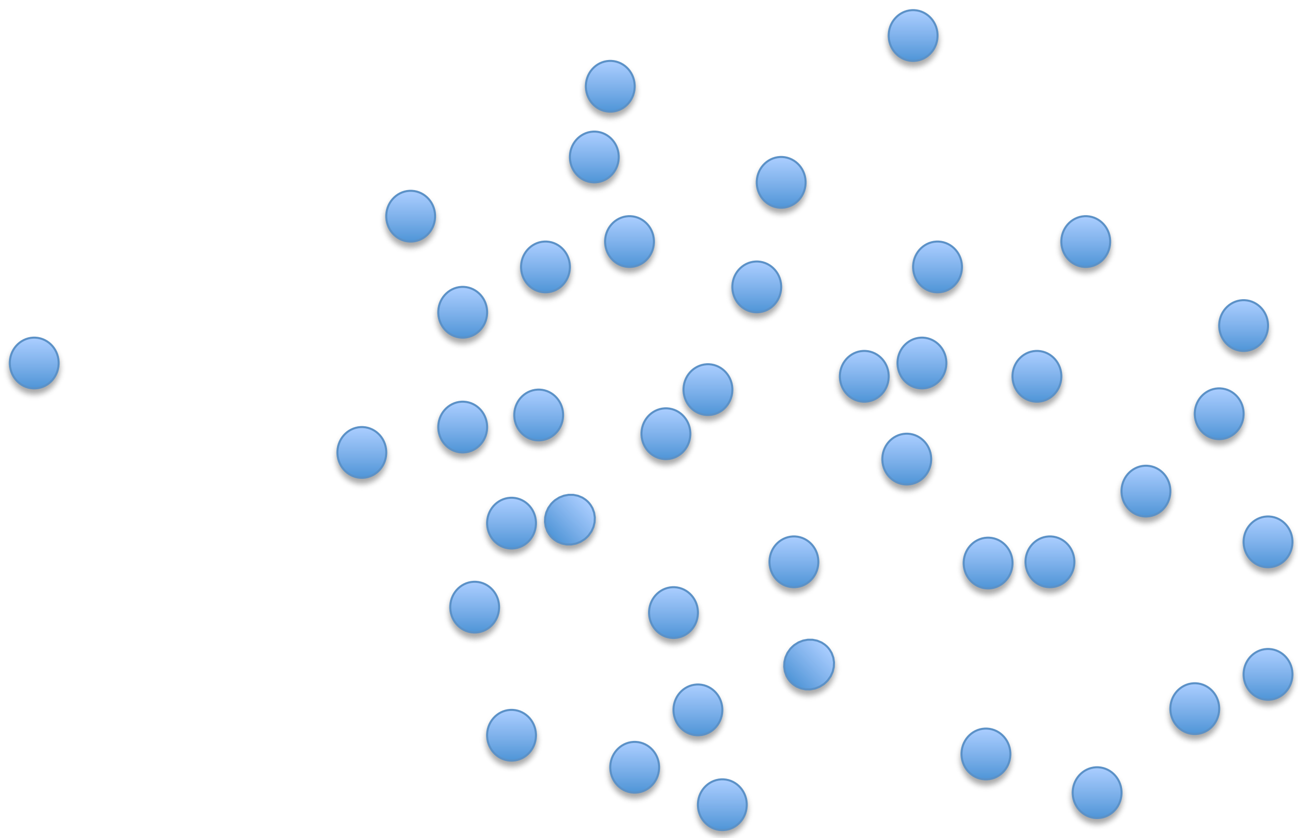
# What stands out: motion



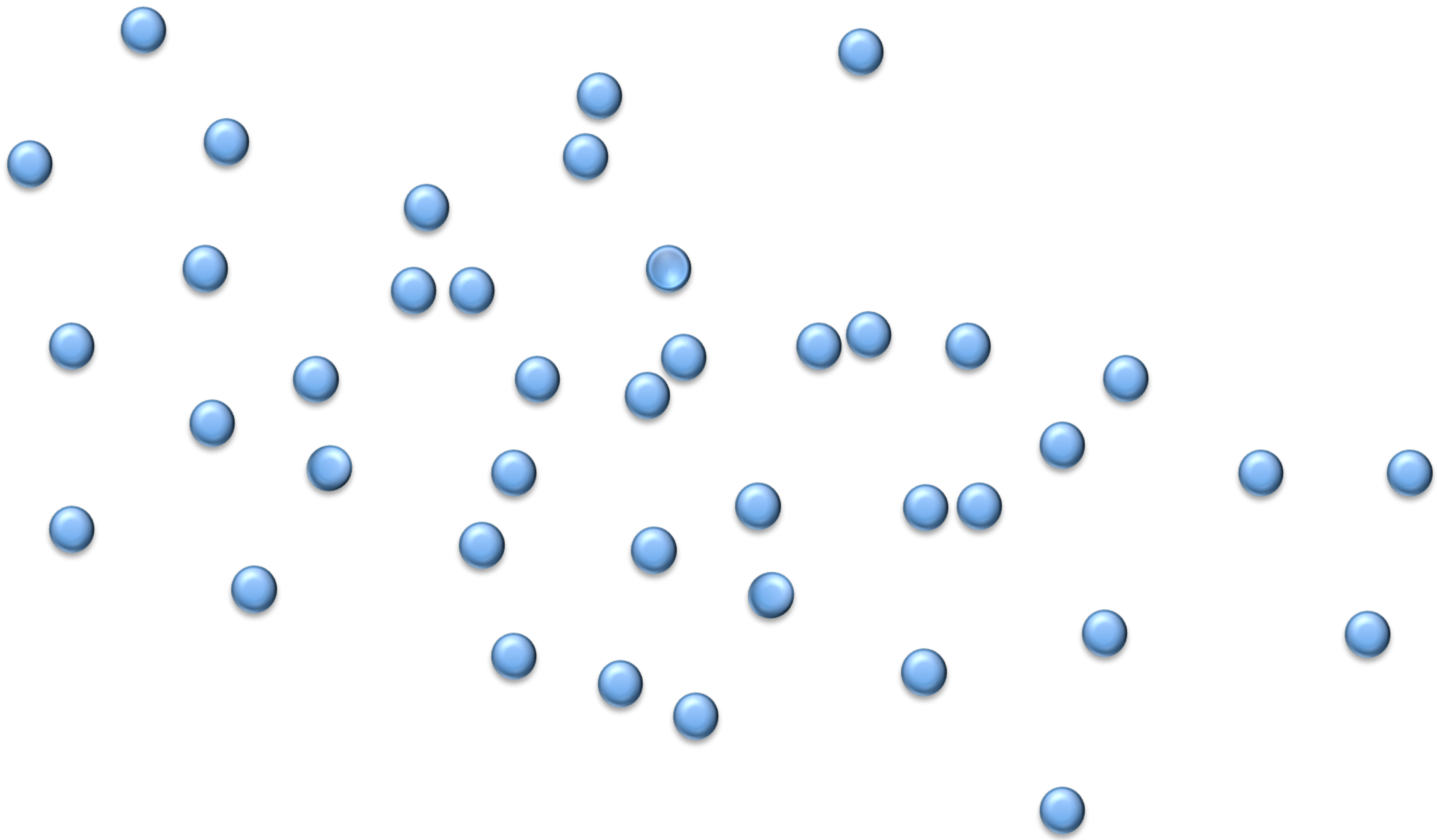
# What stands out: surround colour



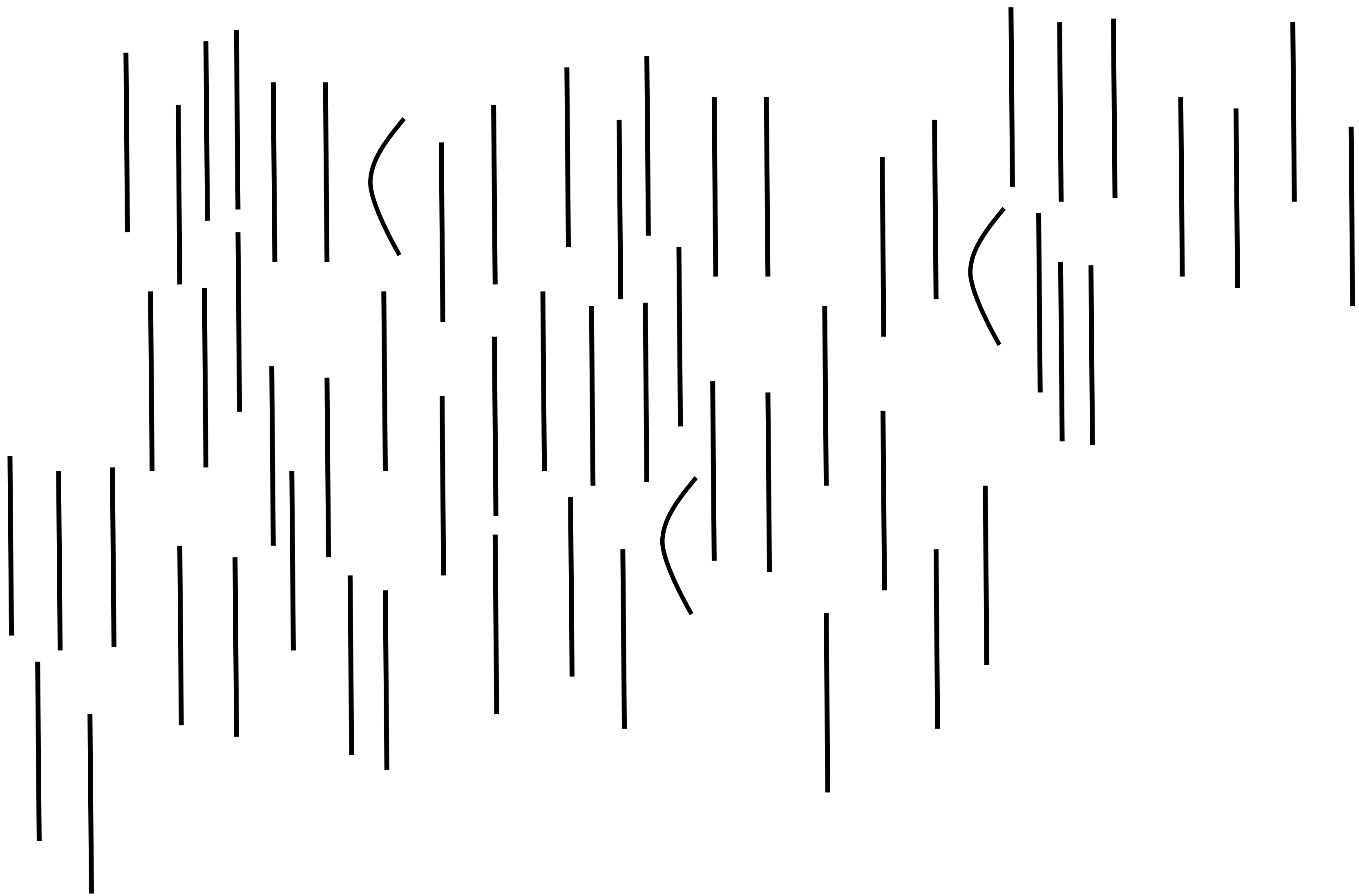
# What stands out: spacial grouping



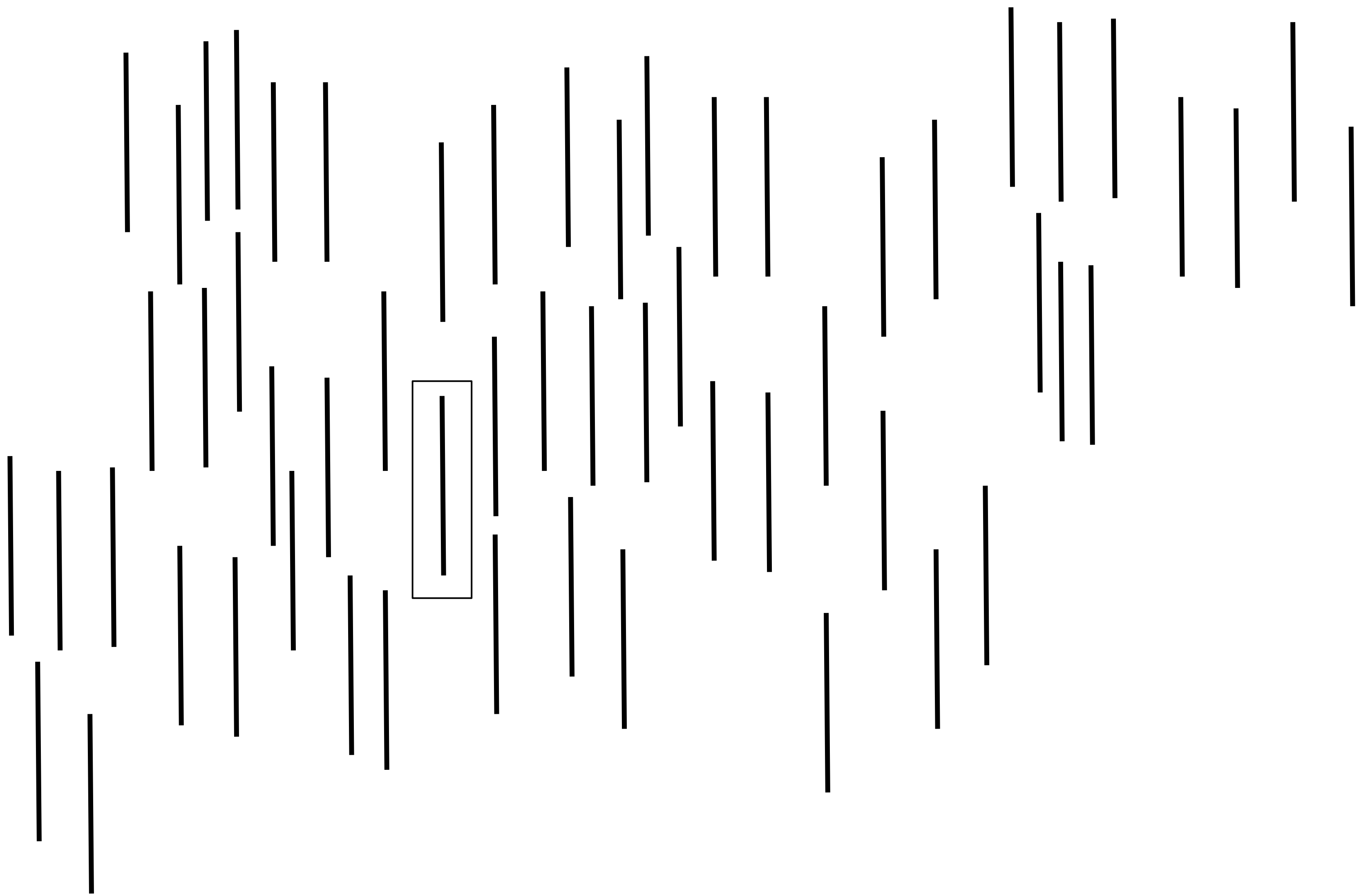
# What stands out: convex and concave



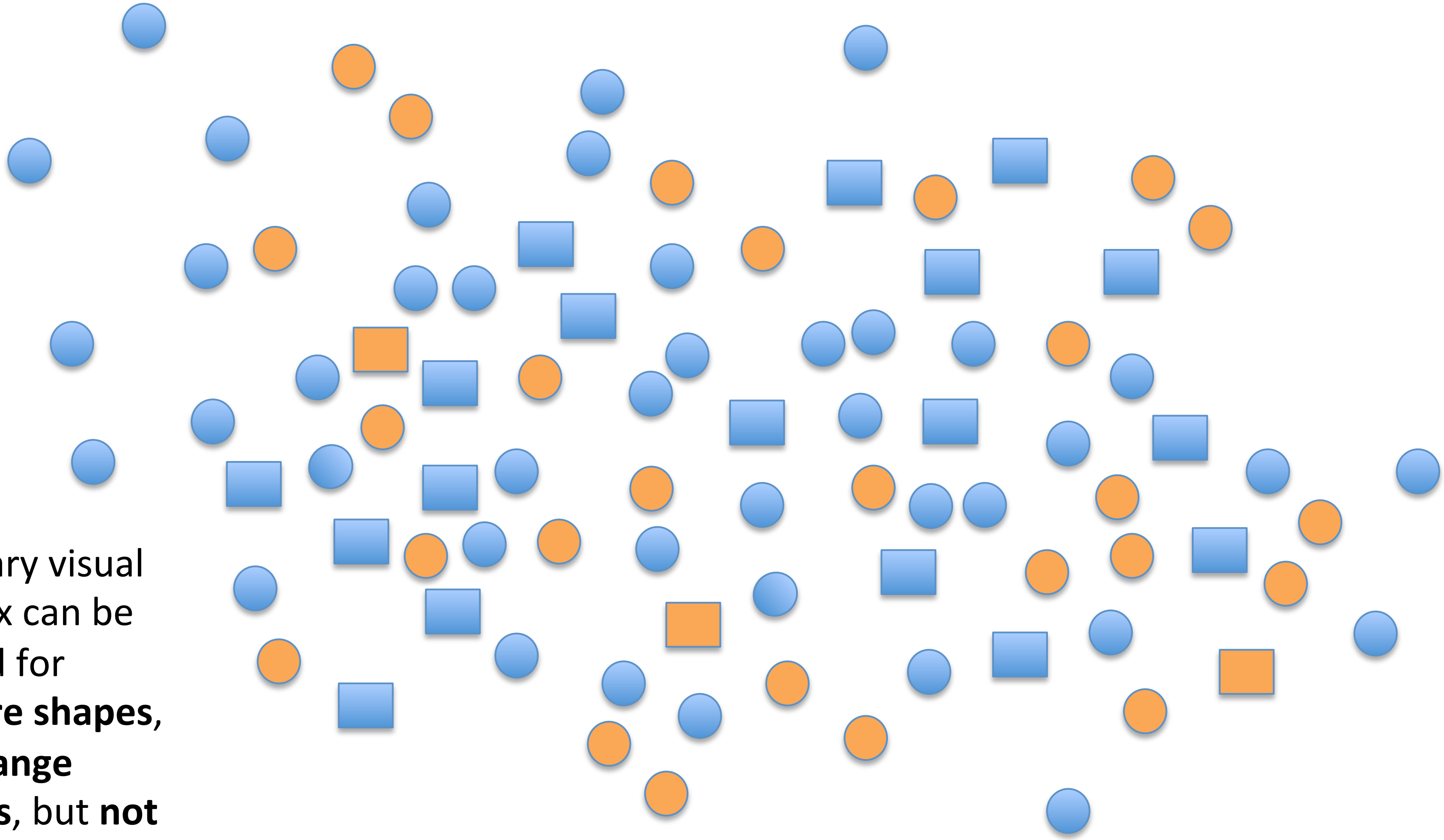
# What stands out: curvature



# What stands out: surround box



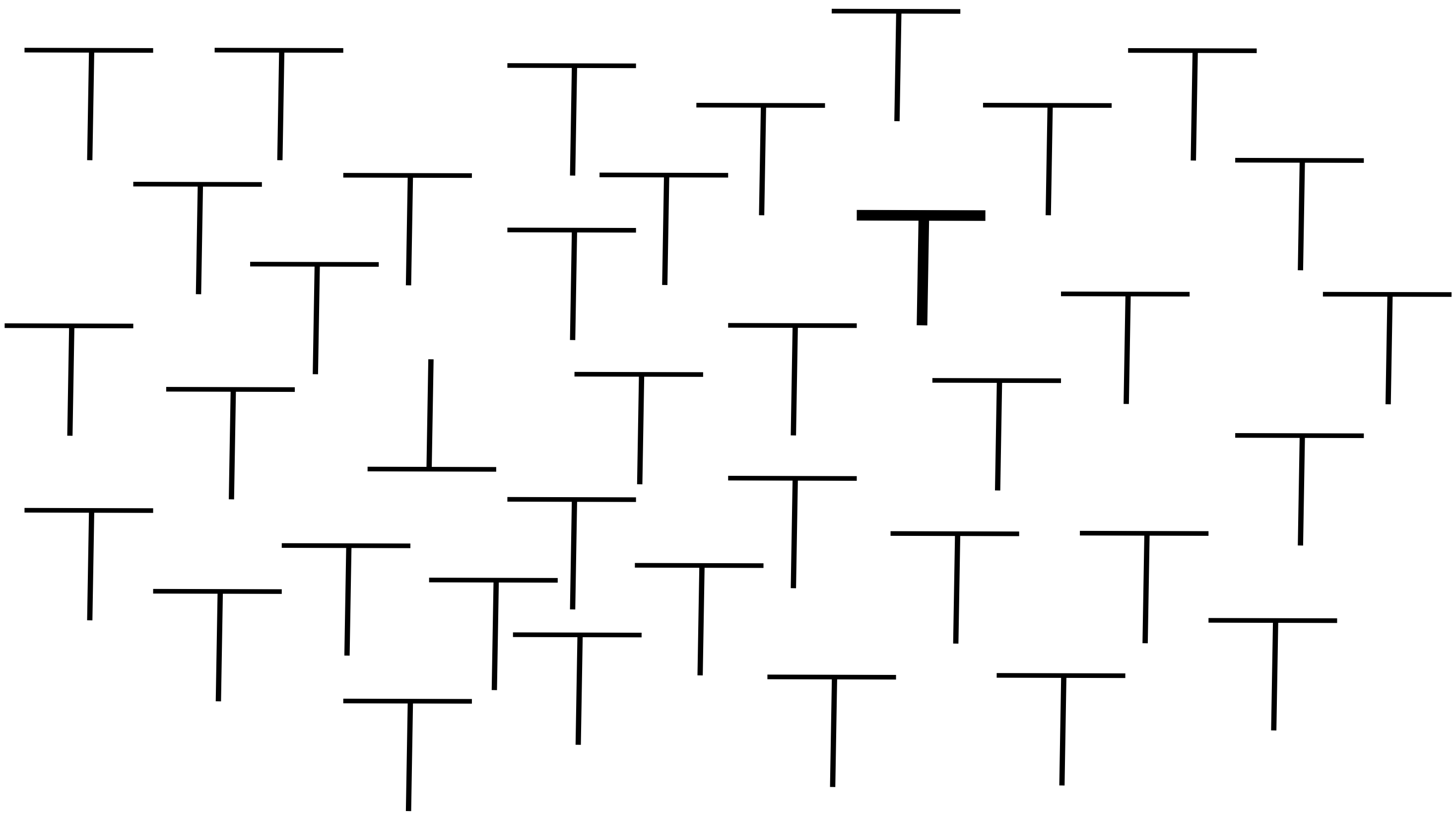
# What does **not** stand out: find the three orange squares

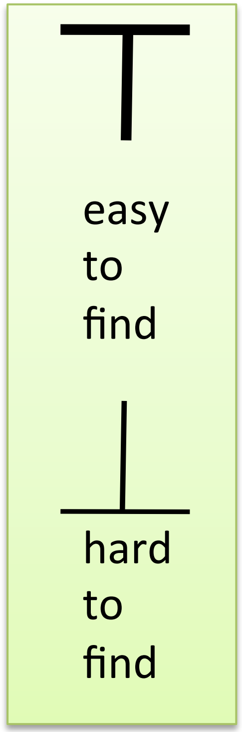


primary visual cortex can be tuned for **square shapes**, or **orange things**, but **not both** at the same time

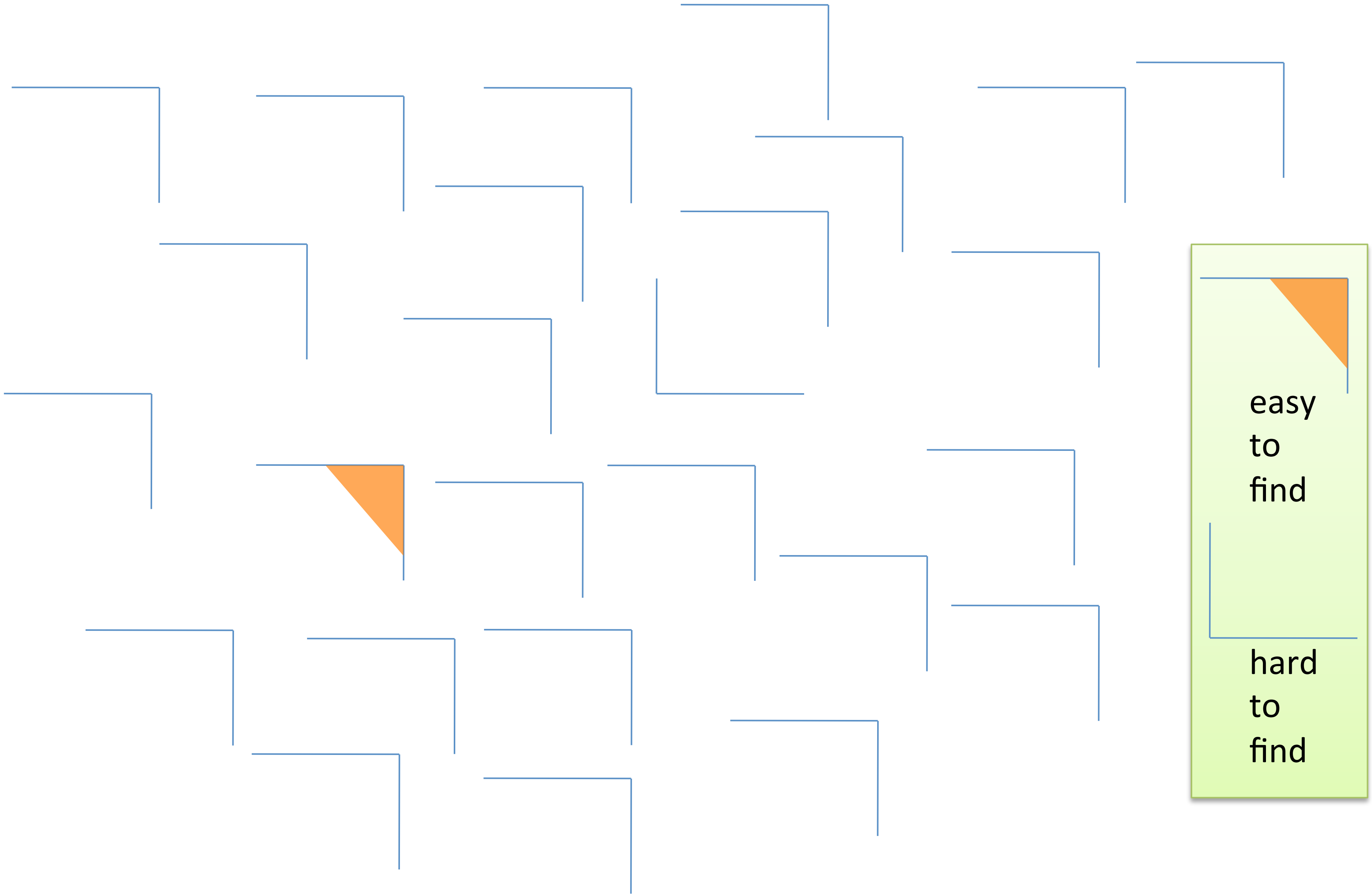
# Visual conjunctive search

- Trying to find a target based on two features
  - most visual conjunctions are hard to see





# Visual conjunctive search



# Feature channels

- The more the background varies in a particular feature channel

    -- color, texture, orientation etc ---

the larger the difference in that channel required to make the feature distinct

# Visual learning

- Finding things quickly is **not a matter of practice**
- it is the way our visual cortex works
  - learning can help with patterns, which are higher up the visual pathway

# Visual learning

- e.g.  find the 6 and the ●

in the text

# Visual learning

- e.g. find the 6 and the ●

in the text

54789342507

10239874●14

32345023931

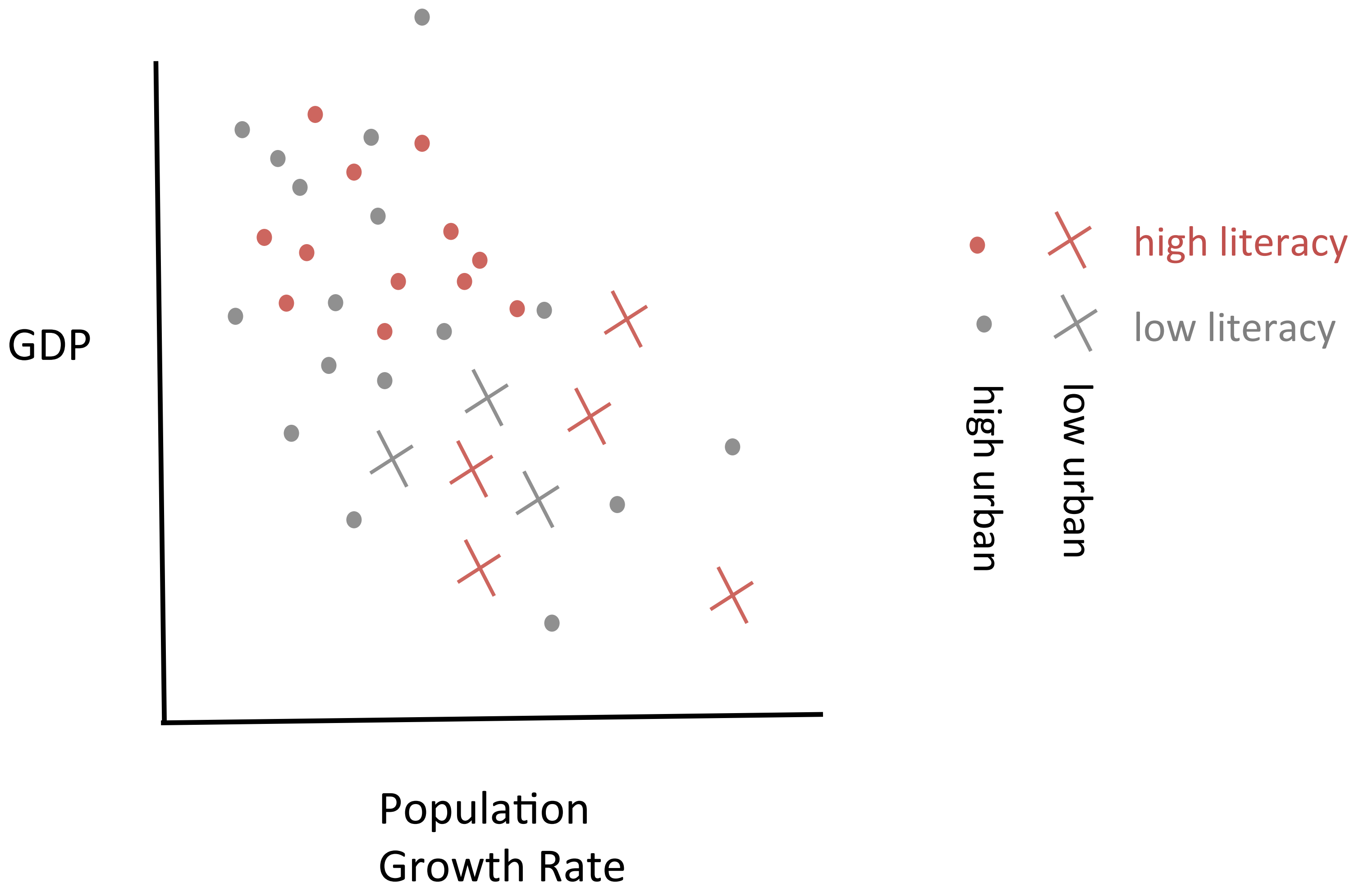
45677908122

12953709809

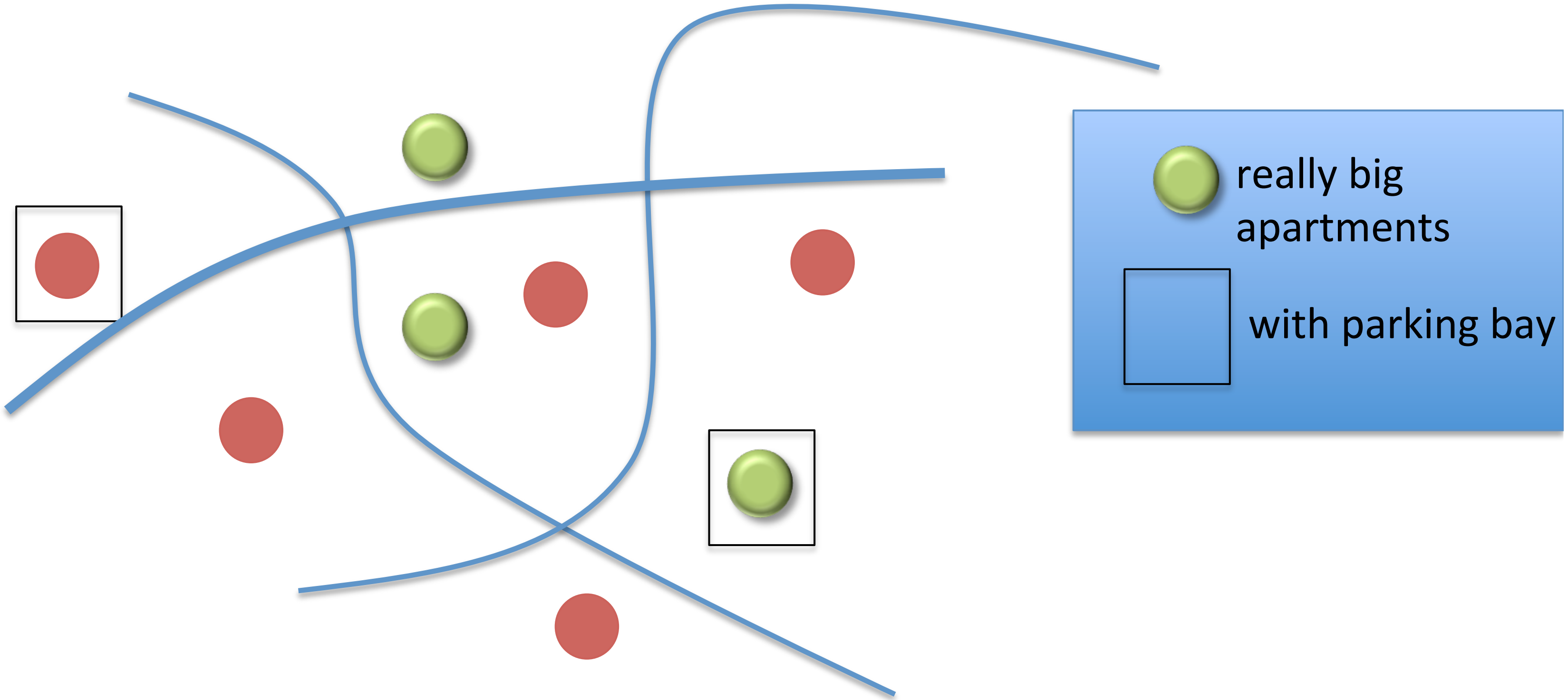
# Lessons for design

- If you want to make something easy to find, make it *different* from its surroundings according to some primary visual channel – size, colour etc.
- A design to support two different kinds of visual query will be most effective if *each query uses a different channel*

# Design example 1#

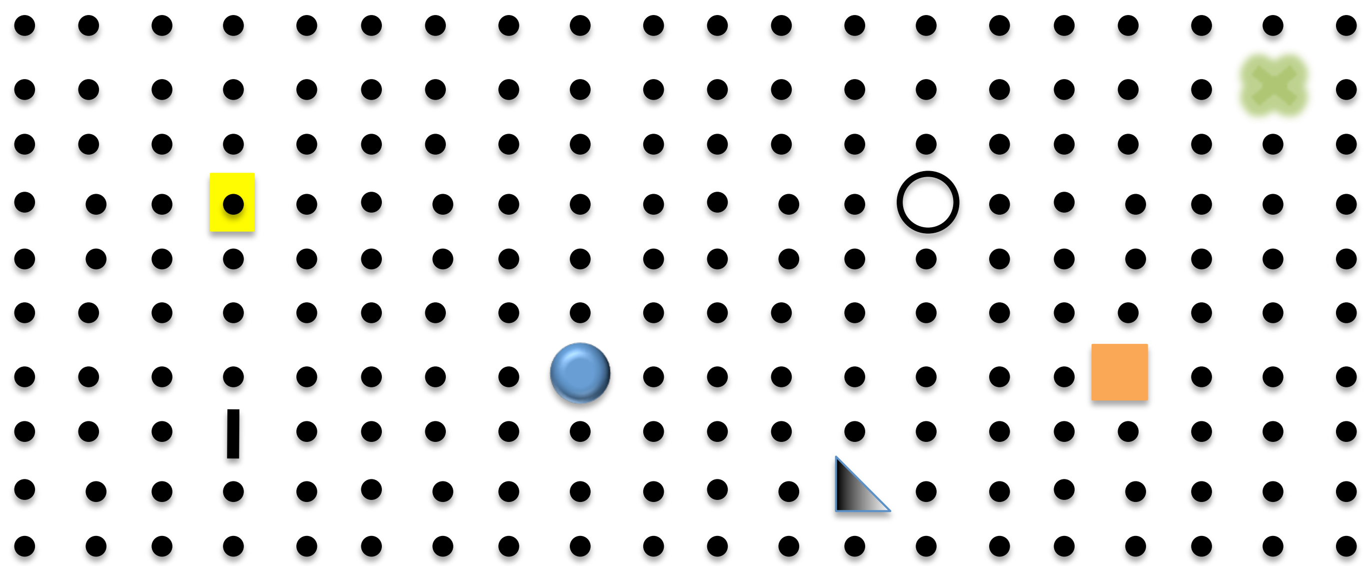


# Divergence on one channel is good, but two channels can make a symbol more distinct



# A set of symbol designed so **all** are independently searchable

- Each differs from the others on more than one channel



attempt to produce **seven symbols** as distinct as possible from each other

# Limitations

- When we aim for pop-out, we only have about three difference steps available on each channel: 3 sizes, colours etc.
- Many kinds of visibility enhancements are not **symmetric**:
  - doubling size of a symbol has more an effect than halving size

# Motion

- Motion in a special class by itself
  - because humans are prey….

  … we are much more sensitive to motion in our peripheral vision

  motion triggers an **orientation response**

  - strong with high frequency motion- which can be (very) irritating

  especially strong with things that emerge into the visual field

  too much motion is the worst form of visual pollution

# Visual Thinking

## Colour

# Colour Processing

- humans, like other apes, most primates, and birds, have colour vision
  - humans have 3 dimensions of  - we are *trichromat*
    - birds have 4
    - cats have 2 (bichromat)
  - Why the differences?

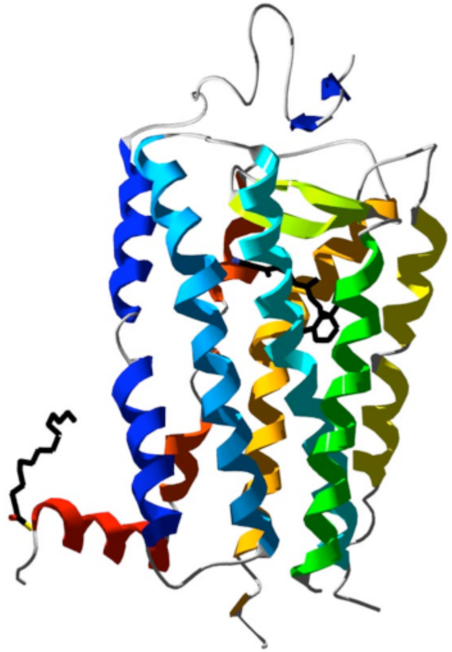
# Colour Processing

- humans, like other apes, most primates, and birds, have colour vision
  - humans have 3 dimensions of  - we are *trichromat*
    - birds have 4
    - cats have 2 (bichromat)

  - Why the differences?
    - fruit eaters require colour vision
    - trichromacy may assist primates in spotting ripe fruits and young leaves
    - bichromacy is better for detecting and catching camoflaged prey

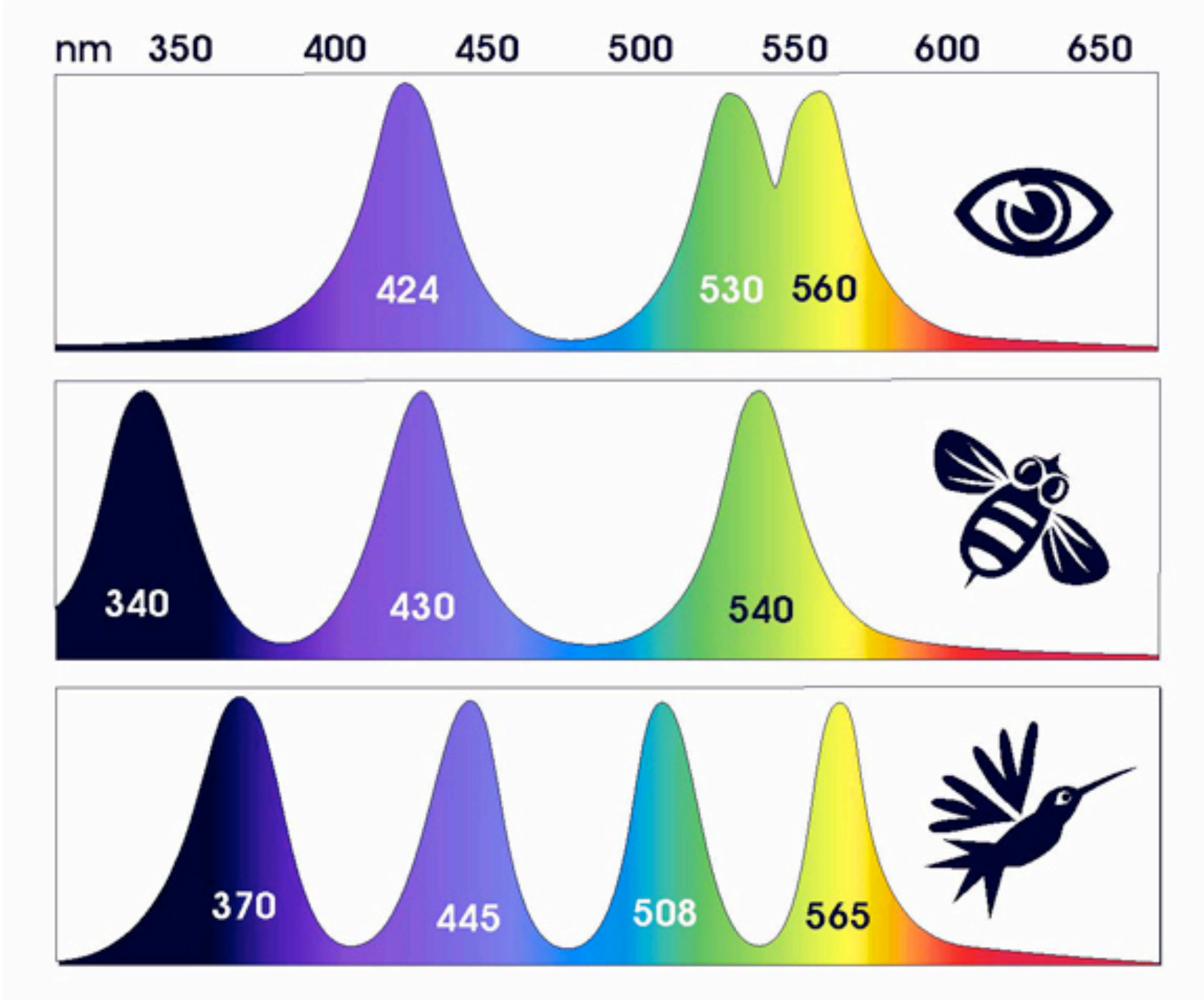
# Colour Processing

- we have two basic receptors on the retina: **rods** and **cones**
- **rods**
  - contain rhodopsin
  - confer high sensitivity to light (night vision)
  - provide a low-resolution (grainy) image
  - wasted on modern humans
- **cones**
  - contain different pigments
  - confer lower sensitivity to light (day vision)
  - provide a high-resolution (sharp) image



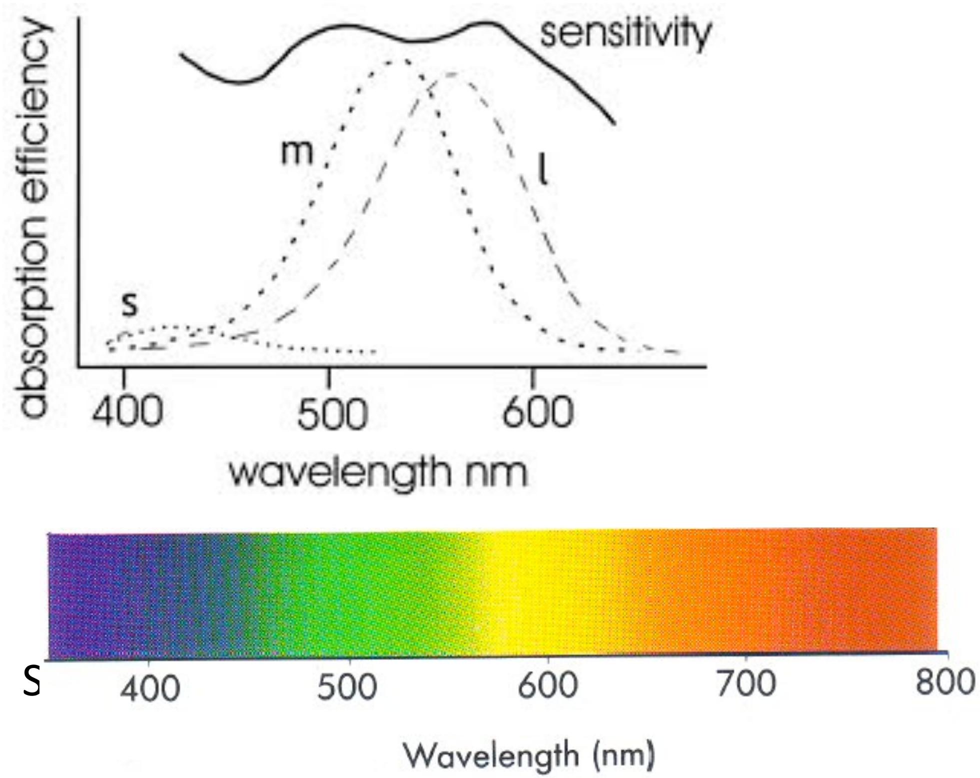
# Colour Processing

- cones confer color vision, if more than one type of cone



# Colour Processing

- humans have far fewer short wavelength (blue) cones than long or medium wavelength cones



# Colour processing

SO don't show small blue text on a dark background

- Insufficient luminance contrast

- Related problem for yellow:
  - pure yellow excites many middle and long-range cones, making it the lightest of all hues

yellow looks terrible on white

but great on black

# Colour processing

- Because cones only have to differentiate between light and dark, we find it much easier to see detail in **black and white** than when the differences are purely chromatic.

# Opponent process theory

- In the V1 cortical region, neural networks add and subtract cone signals to transform them into 3 *colour-opponent channels:*

  1. red-green
     - represents **difference** between middle and long-wave sensitive regions
     - we are highly sensitive to red-green contrasts

# Opponent process theory

- In the V1 cortical region, neural networks add and subtract cone signals to transform them into 3 *colour-opponent channels:*

  2. **yellow-blue**
     - represents **difference** between luminance and short-wave (blue cone) regions

# Opponent process theory

- In the V1 cortical region, neural networks add and subtract cone signals to transform them into 3 *colour-opponent channels:*

    3. black-white or luminance
        - combines middle and long-wave sensitive regions

# Channel properties

Most of the important principals for effectively using **colour** in **design**

come from an understanding of the

red-green,

**yellow-blue** and

black-white

colour channels

# Colour blindness

- People who are colour blind (8% men, 1% women) are missing red-green channel
  - hVE 2D (not 3D ) colour space
  - can still distinguish yellow and blue, and the grayscale
- Yellow-blue colour blindness is very uncommon

# Brightness Contrast

Simultaneous contrast phenomenon occurs in each of the channels.

This is a distortion of the appearance of a patch of colour in a way that increases the difference between a colour an its surroundings.

Called lightness or brightness contrast for black and white channel, or chromatic contrast for red-green or yellow-blue channel

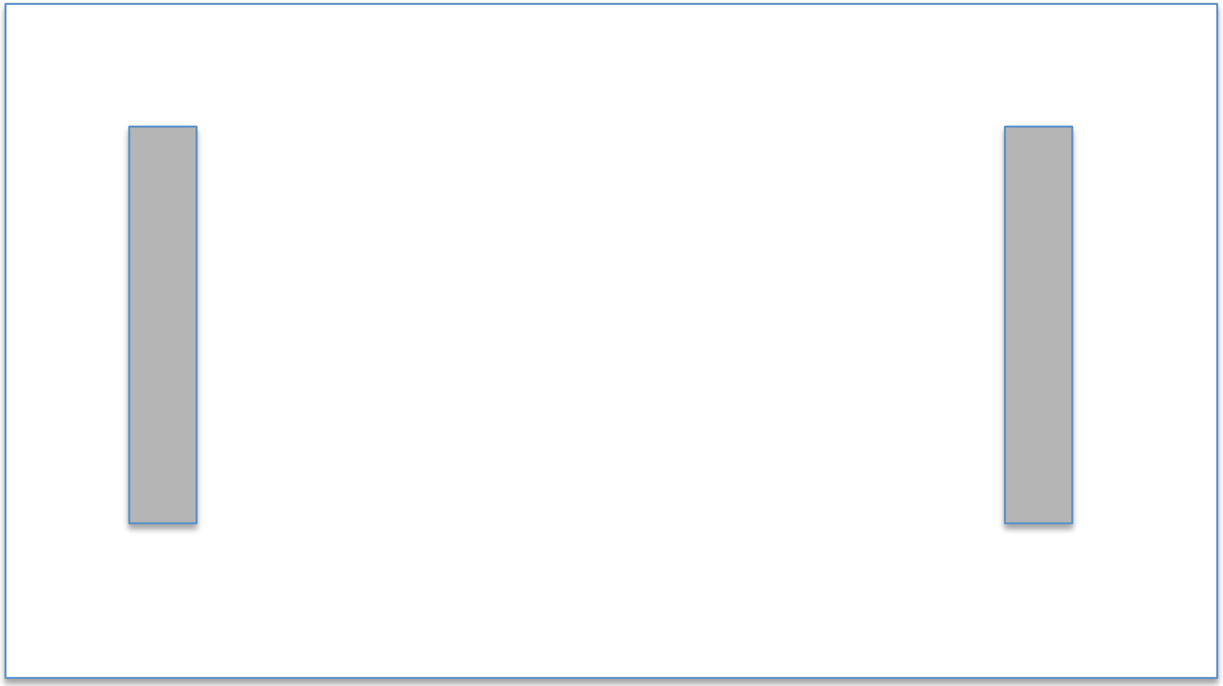
Two grey bars above are exactly the same shade!

# Brightness Contrast

Simultaneous contrast phenomenon occurs in each of the channels.

This is a distortion of the appearance of a patch of colour in a way that increases the difference between a colour an its surroundings.

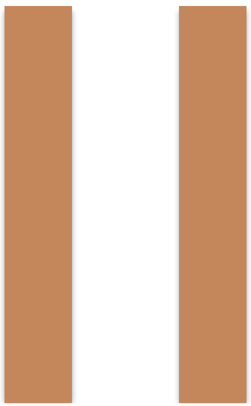
Called lightness or brightness contrast for black and white channel, or chromatic contrast for red-green or yellow-blue channel



Two grey bars above are exactly the same shade!

# Chromatic Contrast

Contrast occurs because the visual system is better at determining **differences** between light than absolute values of light

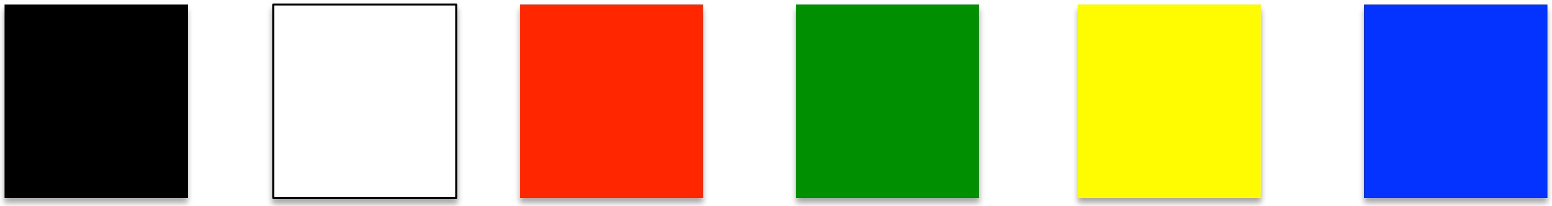


Two bars above are exactly the same shade!

# Resources

- http://purveslab.net/see-for-yourself/

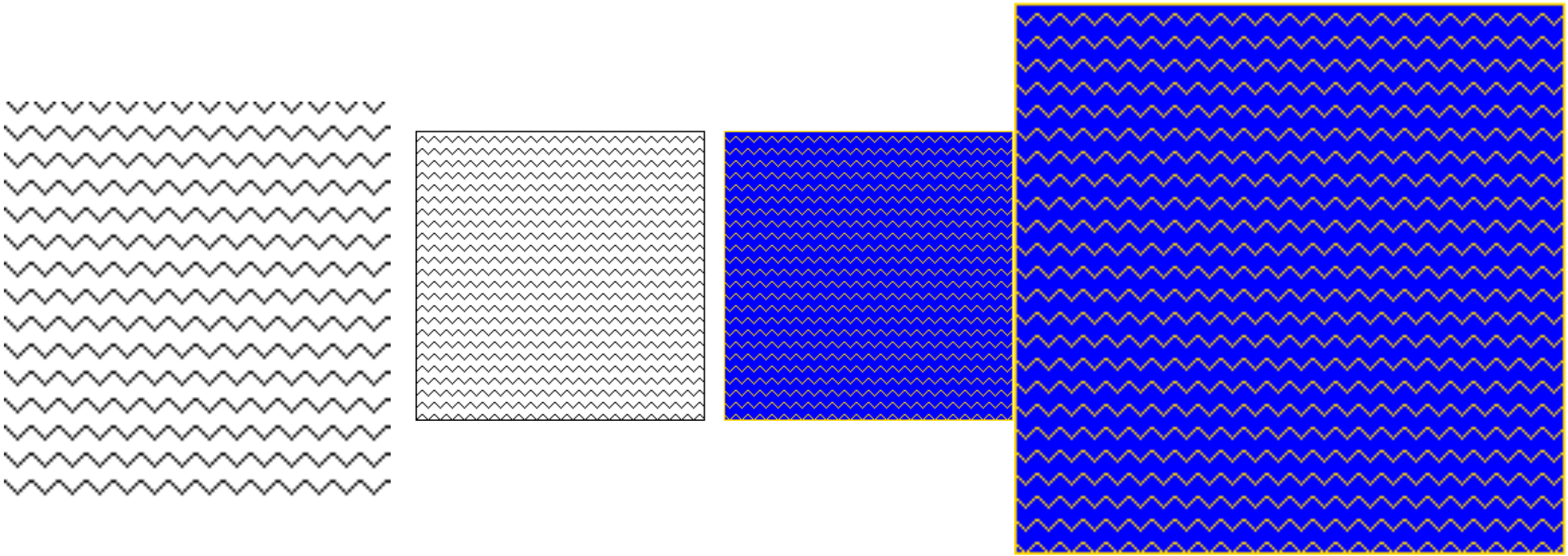
# Unique hues for humans



- these special colour have a strong signal on one of the channels and a neutral signal on the others

# Sensitivity to spatial detail

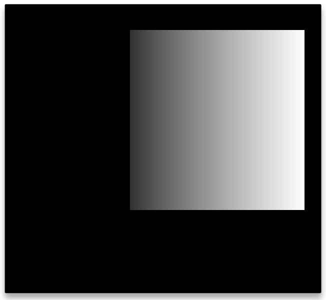
- Luminance channel greater capacity to convey detailed information than the chromatic  channels – fine pattern is harder to see with chromatic differences

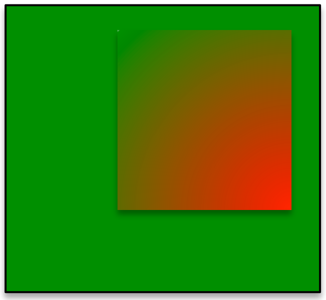


# Motion

luminance channel conveys motion much more effectively

- When moving shapes are shown only in red and green, their motion appears to slow down, or stop



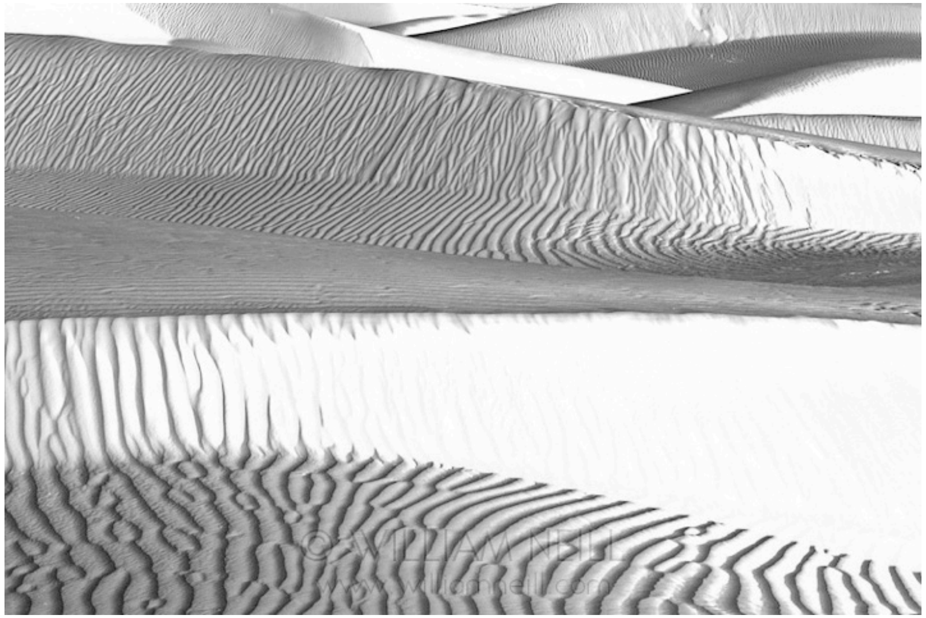


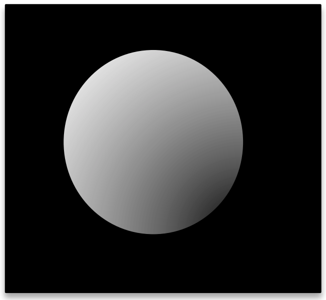
To demonstrate this effect, the colours have to have equal luminance and the transition between the colours needs to be gradual.

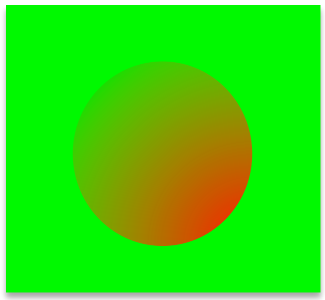
It is difficult to get equiluminance and smooth transitions without specialized monitors and control programs

# Stereoscopic Depth

- Brain's processing of stereoscopic depth occurs through the luminance channel
- We can only see shape-from-shading in the luminance channel

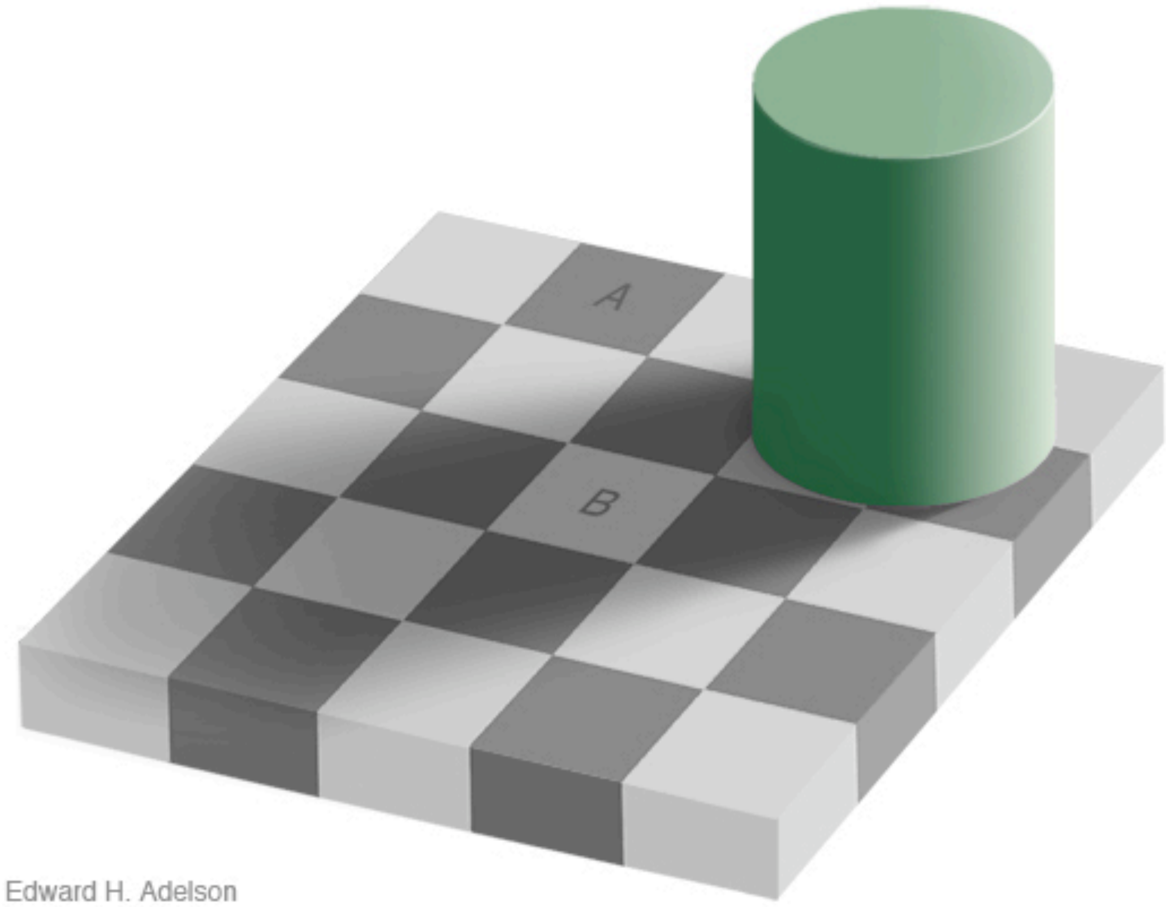






# Colour appearance

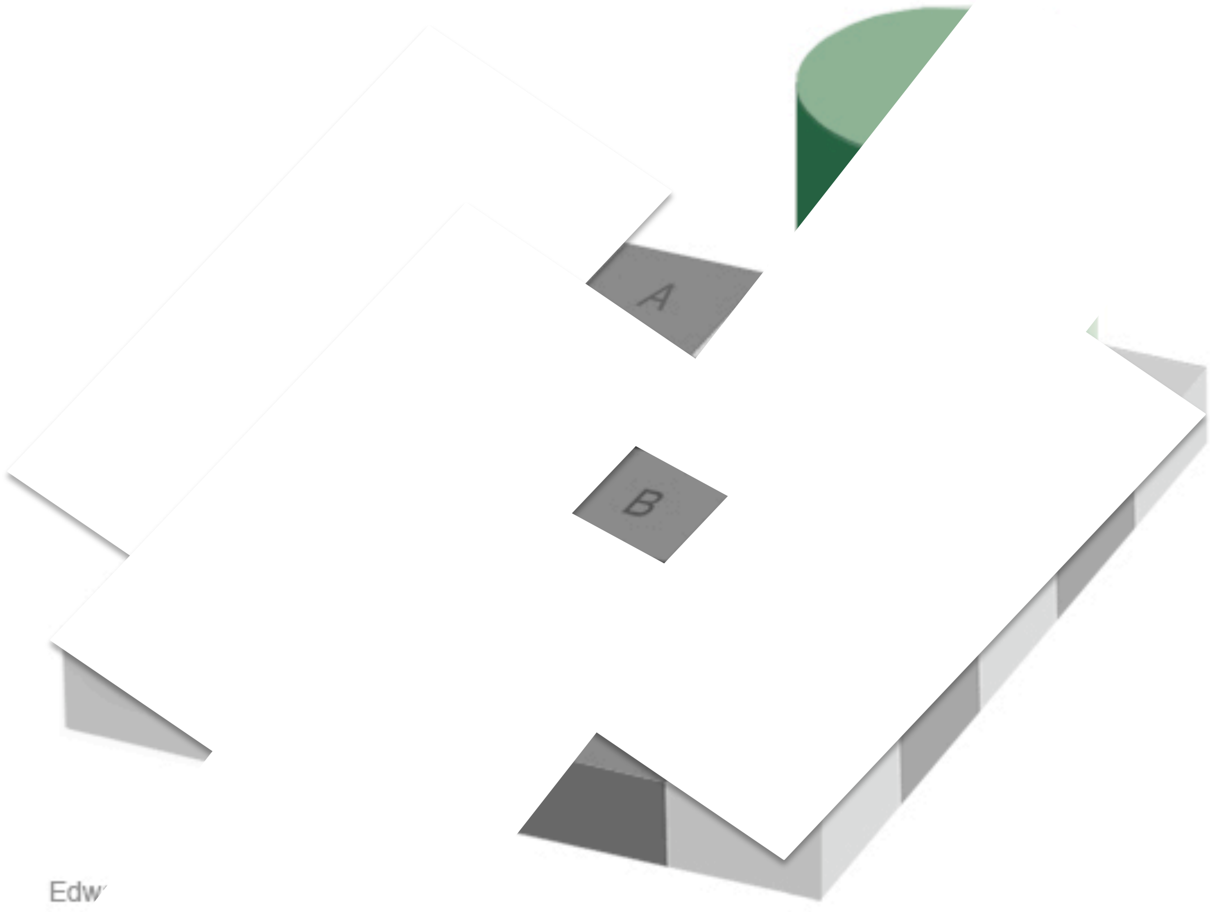
- The [checkerboard illusion] of Edward Adelson.




The squares marked A and B are the same shade of gray.

# Colour appearance

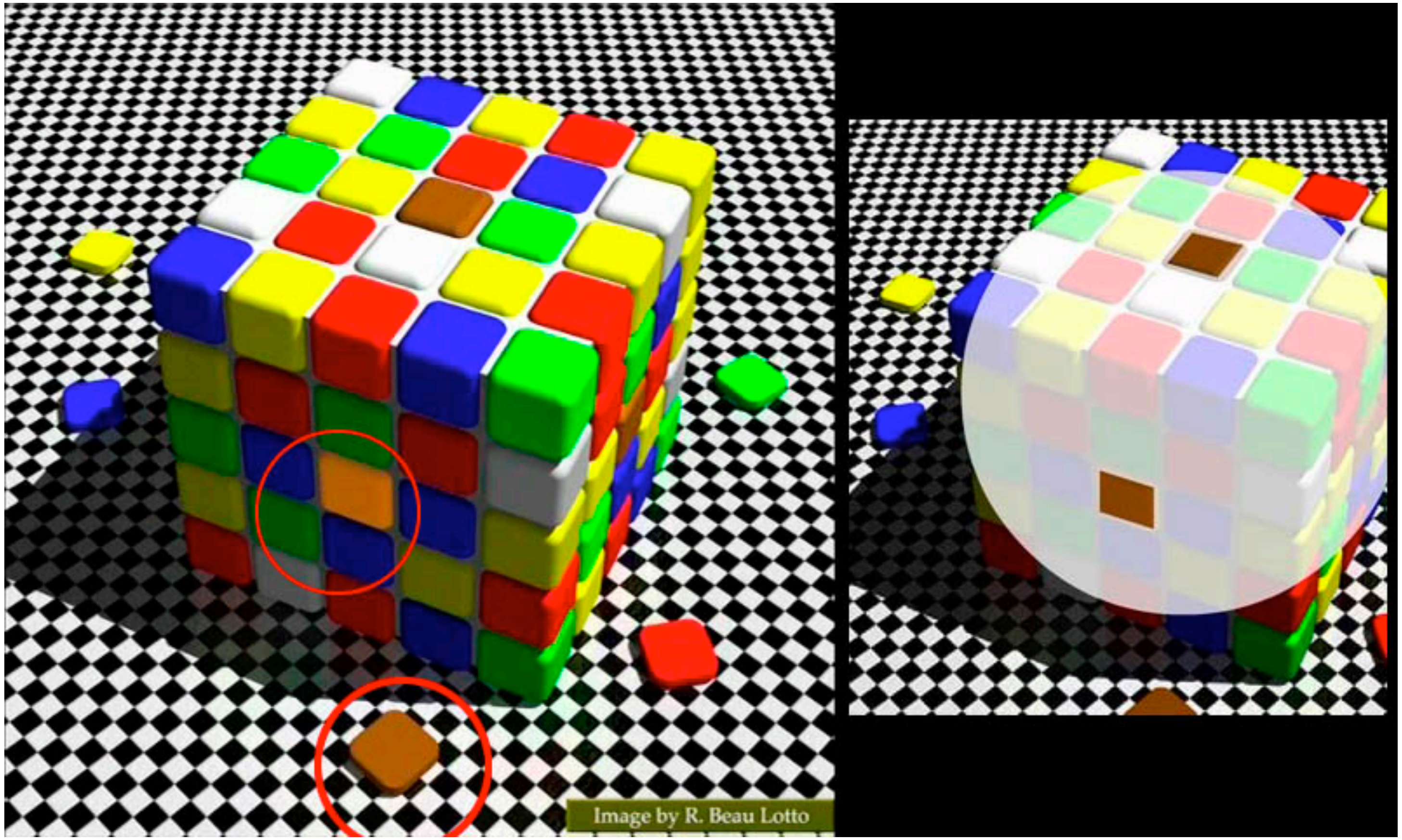
- The checkerboard illusion of Edward Adelson.




The squares marked A and B are the same shade of gray.

# Colour appearance

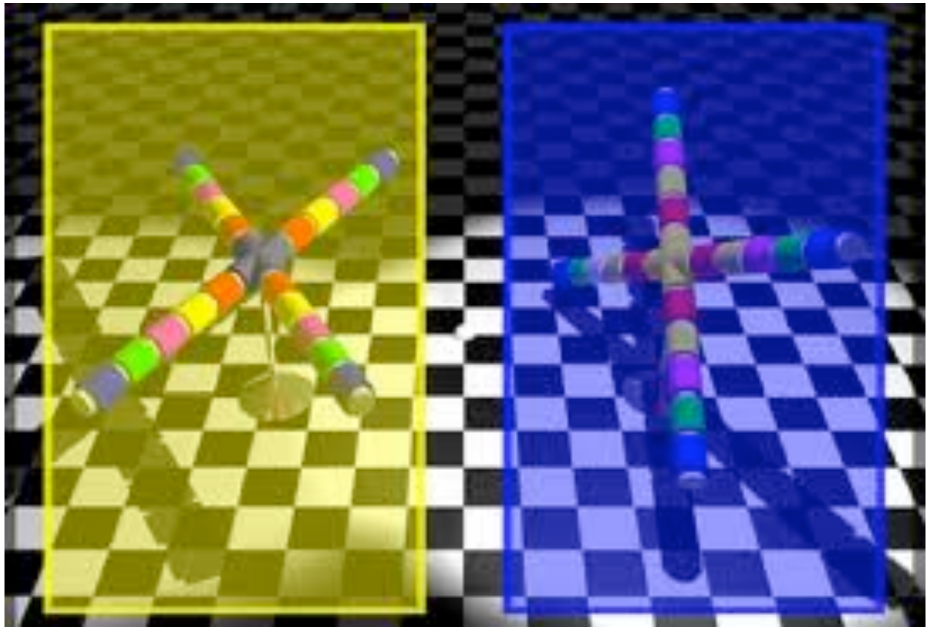
- The cube illusion of R. Beau Lotto. C.




The orange and brown squares are actually the same colour! We **see** the same image colour as being dark brown in the context of strong lighting, and light orange where the same image colour appears in a deeply shaded context.

# Colour appearance

- The cross-piece illusion of R . Beau Lotto



The colour at the intersection of the two rods is actually an identical colour (grey) in both cases, but in the context of apparently yellow illumination on the left and blue illumination on the right, this is judged, **and seen**, to be the reflectance of a blue-grey object and a yellow object respectively.

# Colour appearance

- The cross-piece illusion of R . Beau Lotto

The colour at the intersection of the two rods is actually an identical colour (grey) in both cases, but in the context of apparently yellow illumination on the left and blue illumination on the right, this is judged, **and seen**, to be the reflectance of a blue-grey object and a yellow object respectively.

# Principles for design

- A set of principles for the use of colour in design, emphasizing clarity and support for visual tasks

1. When small **detail** is important, luminance contrast is necessary:
   - black on white
   - dark blue on white
   - yellow on black

When text is small, it is essential that there is luminance contrast with the background colour. Notice how the text is hardest to read where the contrast is lowest.

ISO recommends a luminance ratio of at least 3:1 between text and background

# 2. Colour-coding information

- The most important use of colour is to indicate categories of information
- When designing colour codes need to be concerned with:
  - **visual distinctness**, to support visual search queries
  - **learnability**, so colours come to stand for particular entities
    - for learnability, it is important that unique hues are used first – **red, green, yellow, blue**, - followed by colours that have relatively consistent names: **pink, brown, orange, grey and purple**

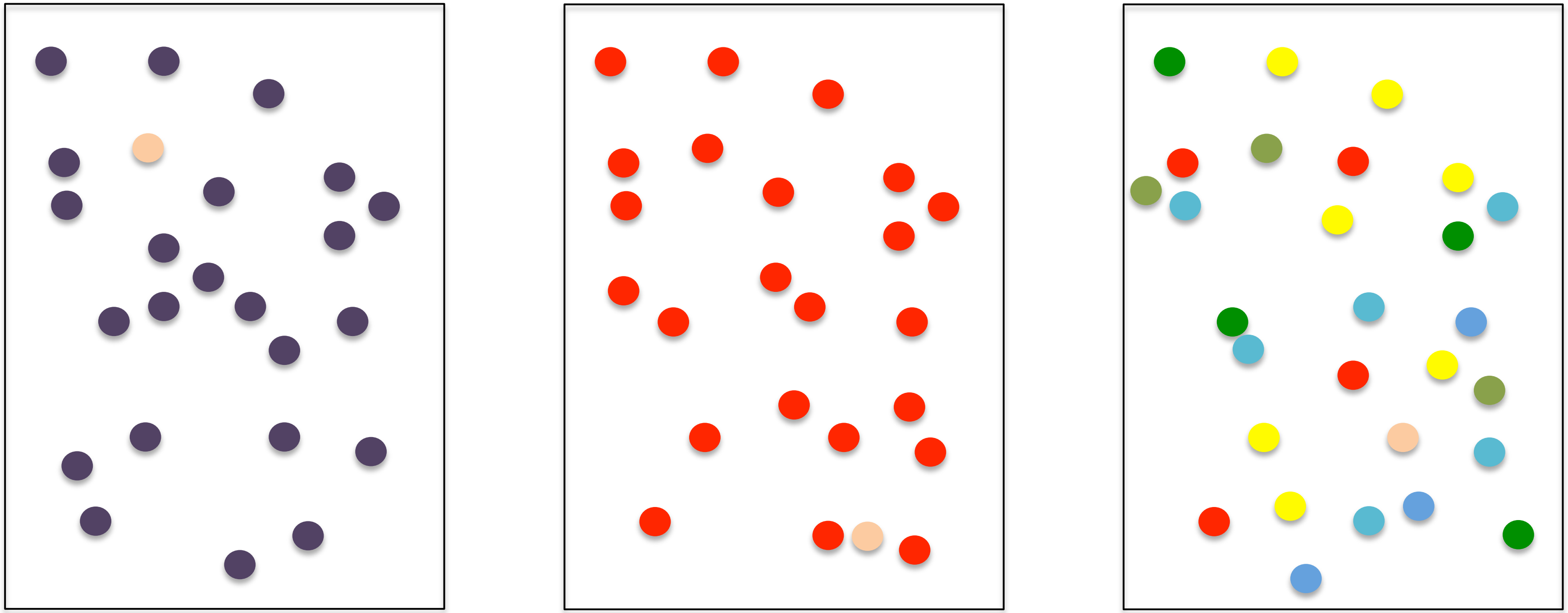
# Colour names

What colours are these?

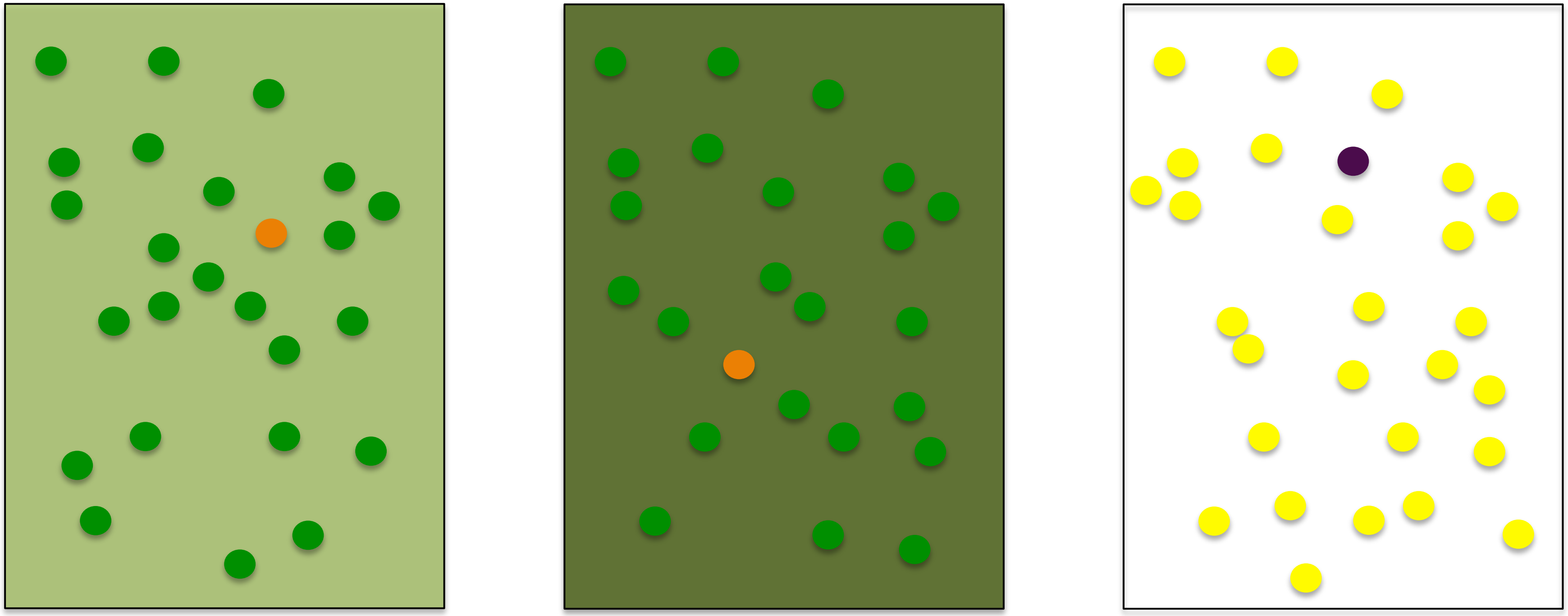
- teal
- mauve
- khaki
- puce
- ochre
- terracotta

# 2. Colour-coding information

- If a design is complex and symbols are quite small, no more than a **dozen codes** can be used reliably
  - backgrounds can distort a patch of colour
  - ease of a visual search depends both on the colour and on the background colour
  - small areas should be strongly coloured and have black-white channel differences from large areas to be distinct
  - large areas can have more subdued colours
    - use low saturation colours for large areas



- the larger the chromatic difference between the target symbol and other symbols the easier the search
- when there are many non-target symbol colours, the search is much more difficult



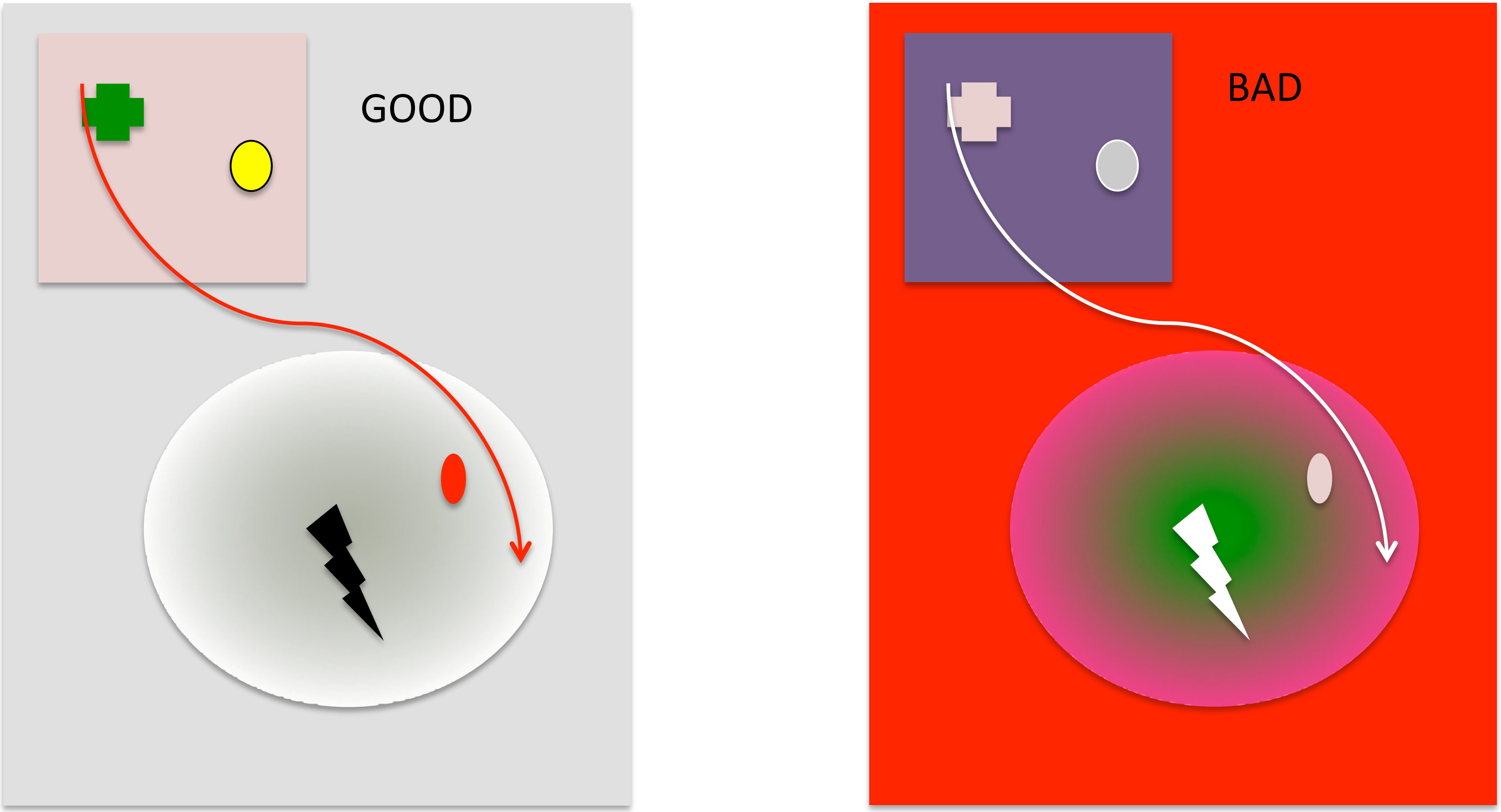
- When non-target symbols are similar to the background, they are easy to exclude from the visual search
- A luminance difference plus a chromatic difference from the other symbols and the background leads to the easiest search
- a dark target on a light background with light target symbols can be as effective as the reverse

# Emphasis and highlighting

- To use orange for highlights would be a mistake – why?

# Emphasis and highlighting

- To use orange for highlights would be a mistake – why?
  - luminance contrast with background is reduced, so less distinct
  - more **effective** to reduce the contrast of the **other text**, but not so much that you loose **clarity**




- The good example uses high saturation colours for small areas, such as symbols and lines. Larger background areas are all light and low saturation
- A black border is used for the yellow circle to separate it from the background.
- In the (hideous) bad example, this approach is reversed

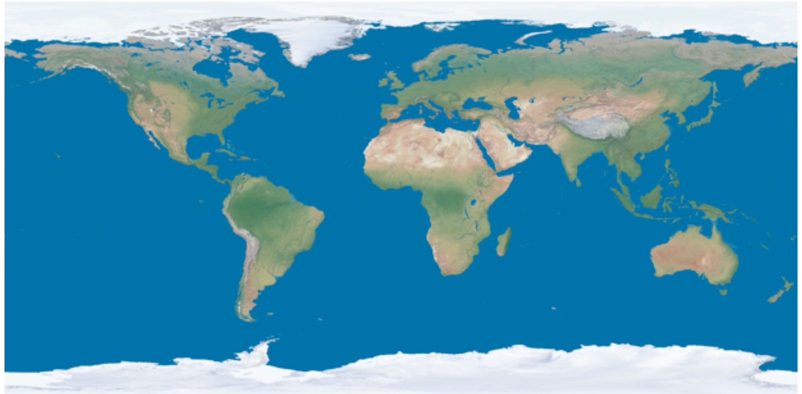
# Colour Sequences

colour sequences in maps allow perception of patterns – ridges- valleys, hills – and reading of quantitative data – heights

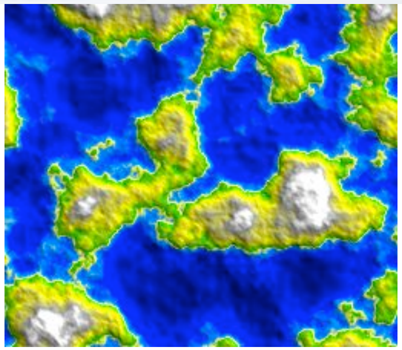
colour sequences which vary in luminance will be most helpful for revealing patterns in data

dark-light contrast is essential for detail

however, for reading values, grey scales are very inaccurate – rather use difference in colours

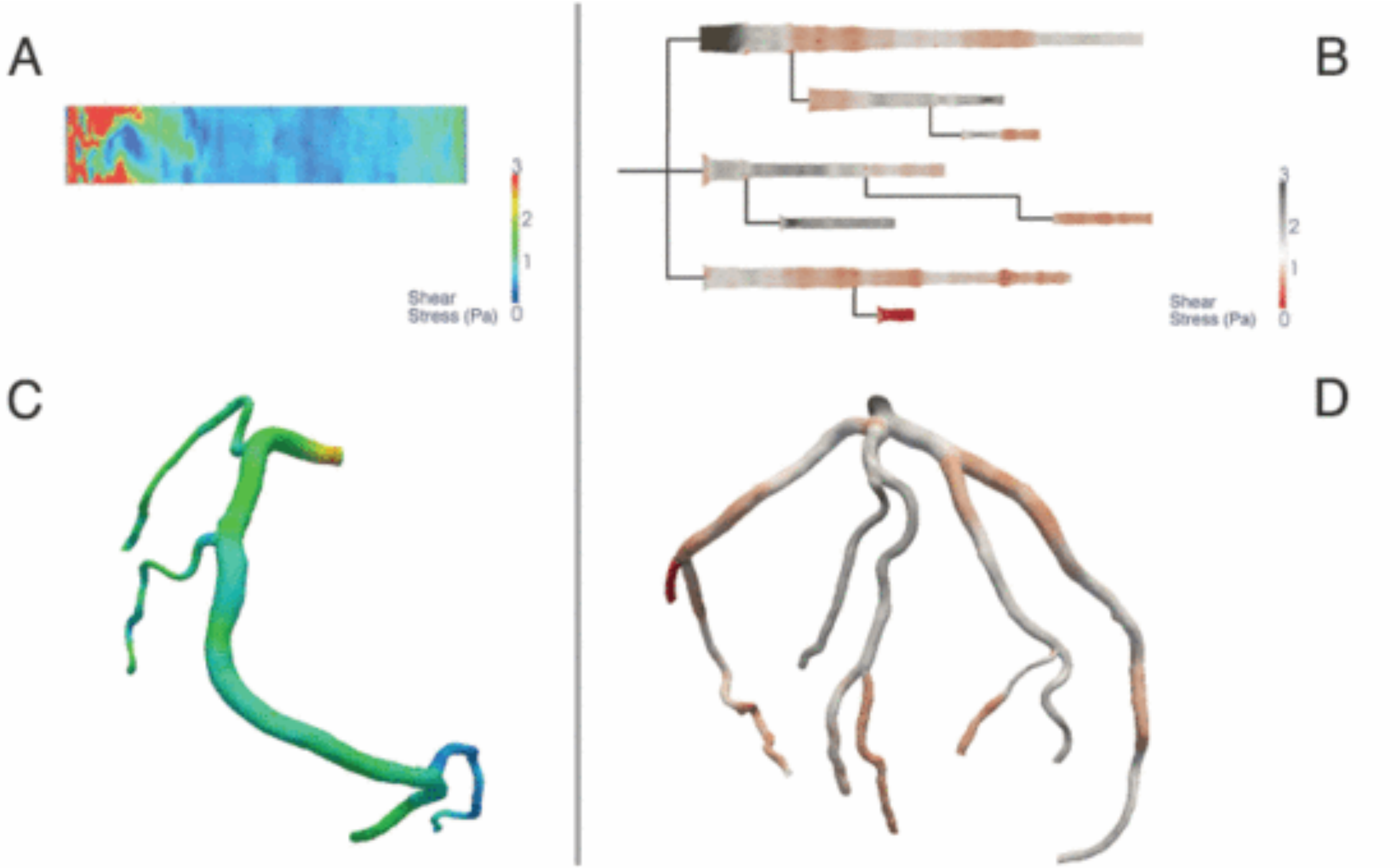


- some maps have well defined colour sequences, which you should not tamper with
  - e.g. height of land in maps : green, light – dark brown, white at peaks



# HemoVis

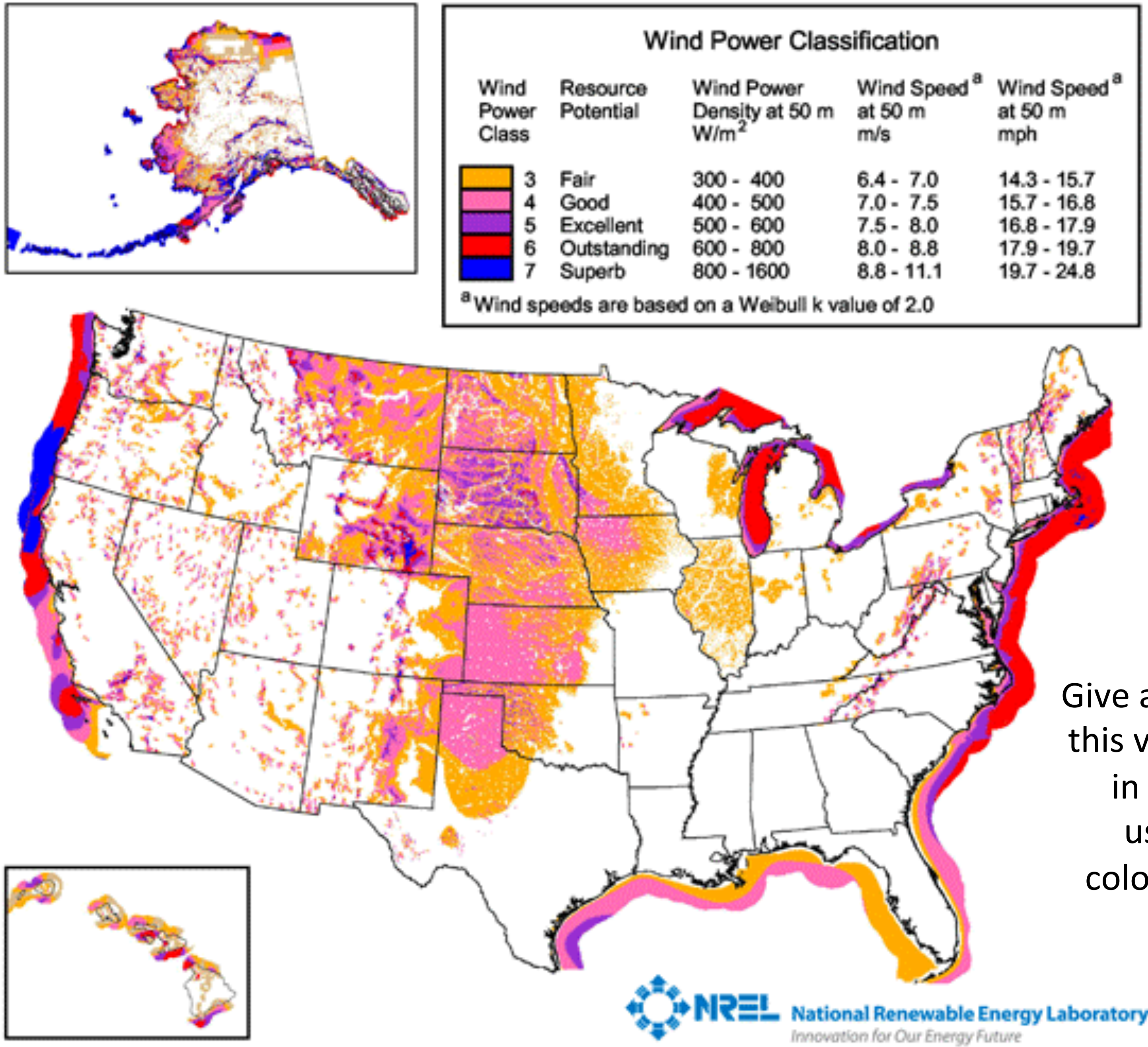
Rainbow color schemes are very common in scientific visualizations, despite the well documented fact that the coloring is not well attuned to the human visual system. A gradient from black to red is more effective for diagnosing heart disease in visualizations of arteries.




Left: Traditional 2D projection (A) of a single artery, and 3D representation (C) of a right coronary artery tree with a rainbow color map. Right: 2D tree diagram representation (B) and equivalent 3D representation (D) of a left coronary artery tree with a diverging color map.

Evaluation of Artery Visualizations for Heart Disease Diagnosis, Borkin, M. ; Gajos, K. ; Peters, A. ; Mitsouras, D. ; Melchionna, S. ; Rybicki, F. ; Feldman, C. ; Pfister, H.

Visualization and Computer Graphics, IEEE Transactions on 17:12, 2479 - 2488



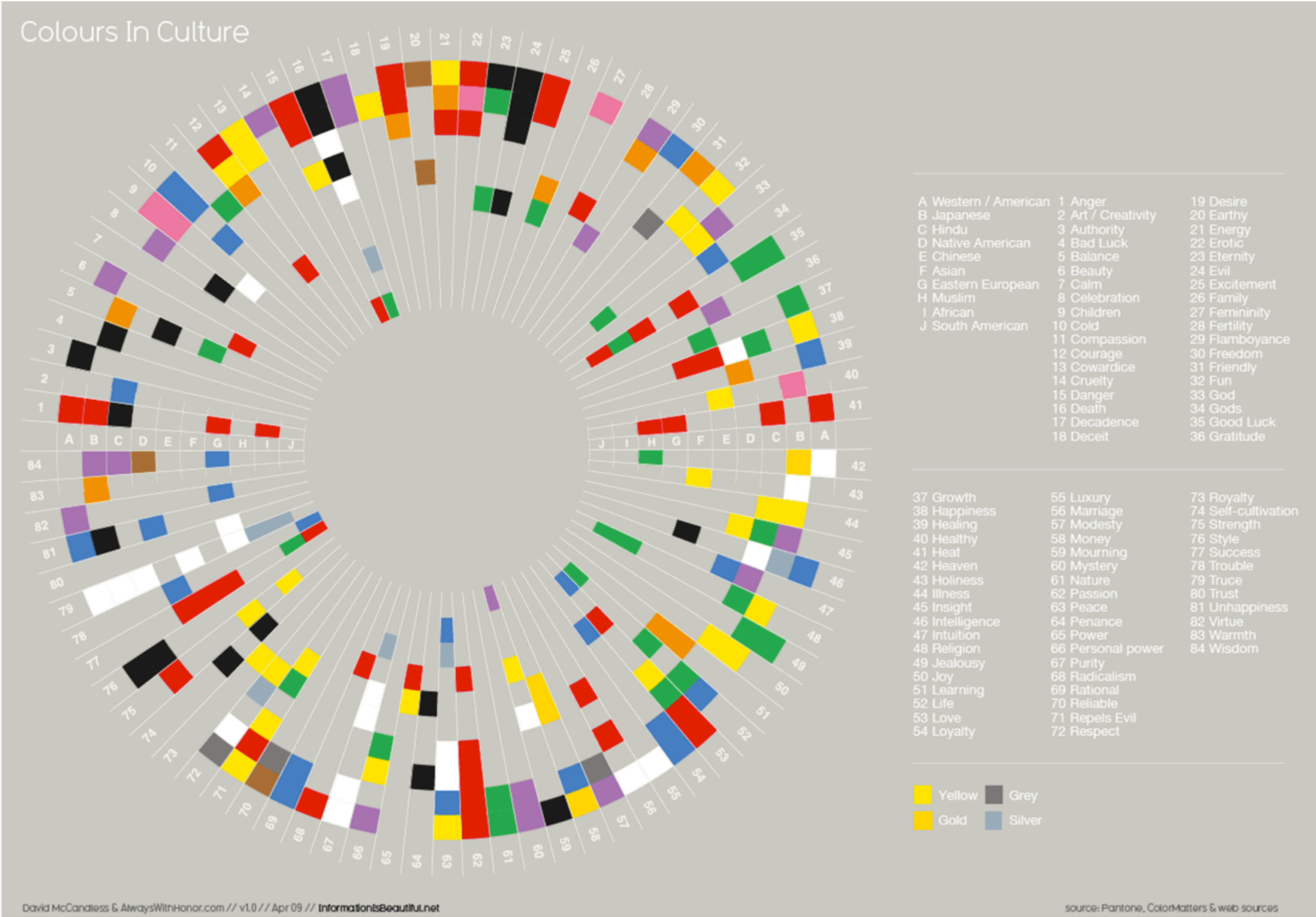

Give a critique of this visualization in terms of its use of space, colour, texture.

# Semantics of colour

- colours are often used symbolically
- these are not universal
- in western culture:
    - red:
    - green:
    - blue:
    - white:

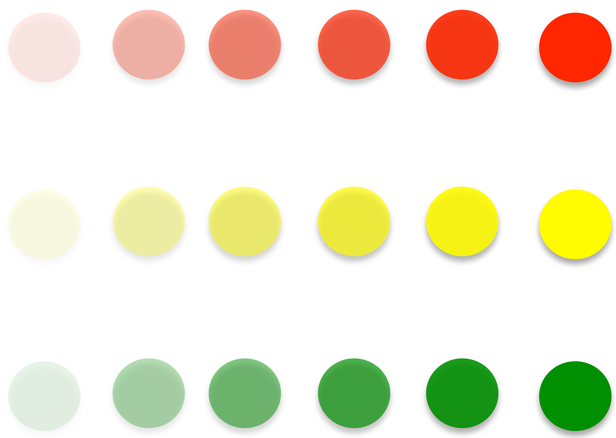
# Semantics of colour

- colours are often used symbolically
- these are not universal
- in western culture:
  - red: danger, heat and stop (china: good fortune and renewal)
  - green: go, safety (china: can mean death)
  - blue: cold
  - white: purity (mourning in most of Asia)


Colours In Culture
A Western / American
B Japanese
C Hindu
D Native American
E Chinese
F Asian
G Eastern European
H Muslim
I African
J South American
1 Anger
2 Art / Creativity
3 Authority
4 Bad Luck
5 Balance
6 Beauty
7 Calm
8 Celebration
9 Children
10 Cold
11 Compassion
12 Courage
13 Cowardice
14 Cruelty
15 Danger
16 Death
17 Decadence
18 Deceit
19 Desire
20 Earthy
21 Energy
22 Erotic
23 Eternity
24 Evil
25 Excitement
26 Family
27 Femininity
28 Fertility
29 Flamboyance
30 Freedom
31 Friendly
32 Fun
33 God
34 Gods
35 Good Luck
36 Gratitude
37 Growth
38 Happiness
39 Healing
40 Healthy
41 Heat
42 Heaven
43 Holiness
44 Illness
45 Insight
46 Intelligence
47 Intuition
48 Religion
49 Jealousy
50 Joy
51 Learning
52 Life
53 Love
54 Loyalty
55 Luxury
56 Marriage
57 Modesty
58 Money
59 Mourning
60 Mystery
61 Nature
62 Passion
63 Peace
64 Penance
65 Power
66 Personal power
67 Purity
68 Radicalism
69 Rational
70 Reliable
71 Repels Evil
72 Respect
73 Royalty
74 Self-cultivation
75 Strength
76 Style
77 Success
78 Trouble
79 Truce
80 Trust
81 Unhappiness
82 Virtue
83 Warmth
84 Wisdom
Yellow
Grey
Gold
Silver
David McCandless & AlwaysWithHonor.com // v1.0 // Apr 09 // InformationIsBeautiful.net
source: Pantone, ColorMatters & web sources

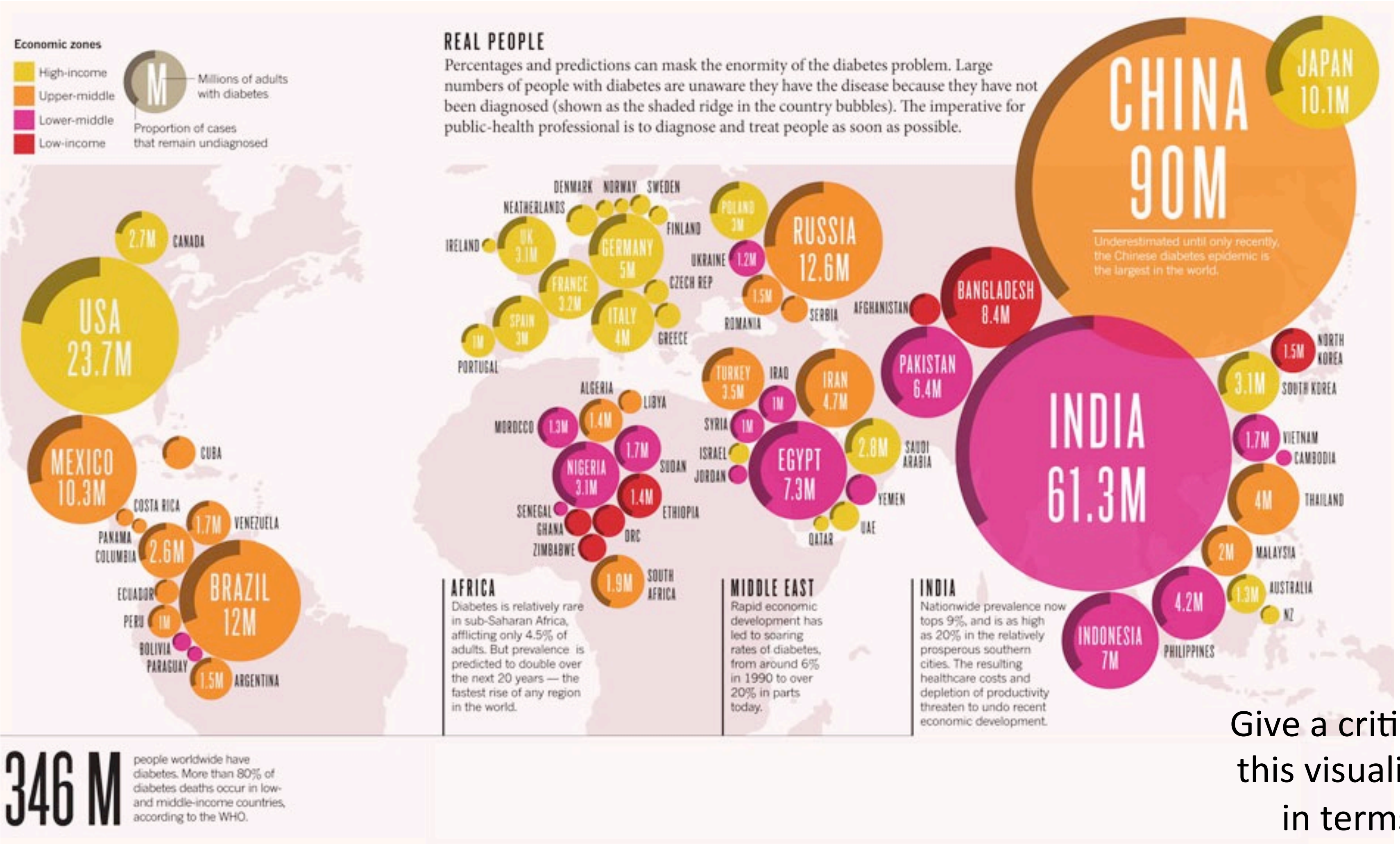
# Semantics of colour

- some mappings are more universal
  - more saturated colours represent greater quantity



# Conclusions

- choice of colour is a complex problem which requires tradeoffs
- every piece of information can't be made maximally distinct
  - most common and most important visual queries should be given the most weight




Give a critique of this visualization in terms of its use of colour.