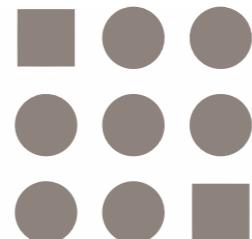


CS 171



Cognition

Hendrik Strobelt





Ceci n'est pas une pipe.

Feedback

- **Eye Biology:**
 - I wasn't sure how much of the eye biology we should know for exams - I understood the structure, but would need to study it further to retain the information.
 - I'm not sure why we spent so much time going over the eye - I don't completely understand a lot of what was said and how exactly it relates to visualization.

Feedback

- **Camera vs. Eye:**
 - Also from the discussion, it seems like camera is better than eyes, which I am not very convinced.
 - I was a little bit confused about the technical details of how an eye and camera work.

Feedback

- It was kind of cool to see a Wes Anderson film screenshot today.

Feedback

- It was kind of cool to see a Wes Anderson film screenshot today.



Who's that?



hendrik.strobelt.com

Text Visualization



letter pie
route the I



cell viewer
animal 15
health 17

CATALOGIES



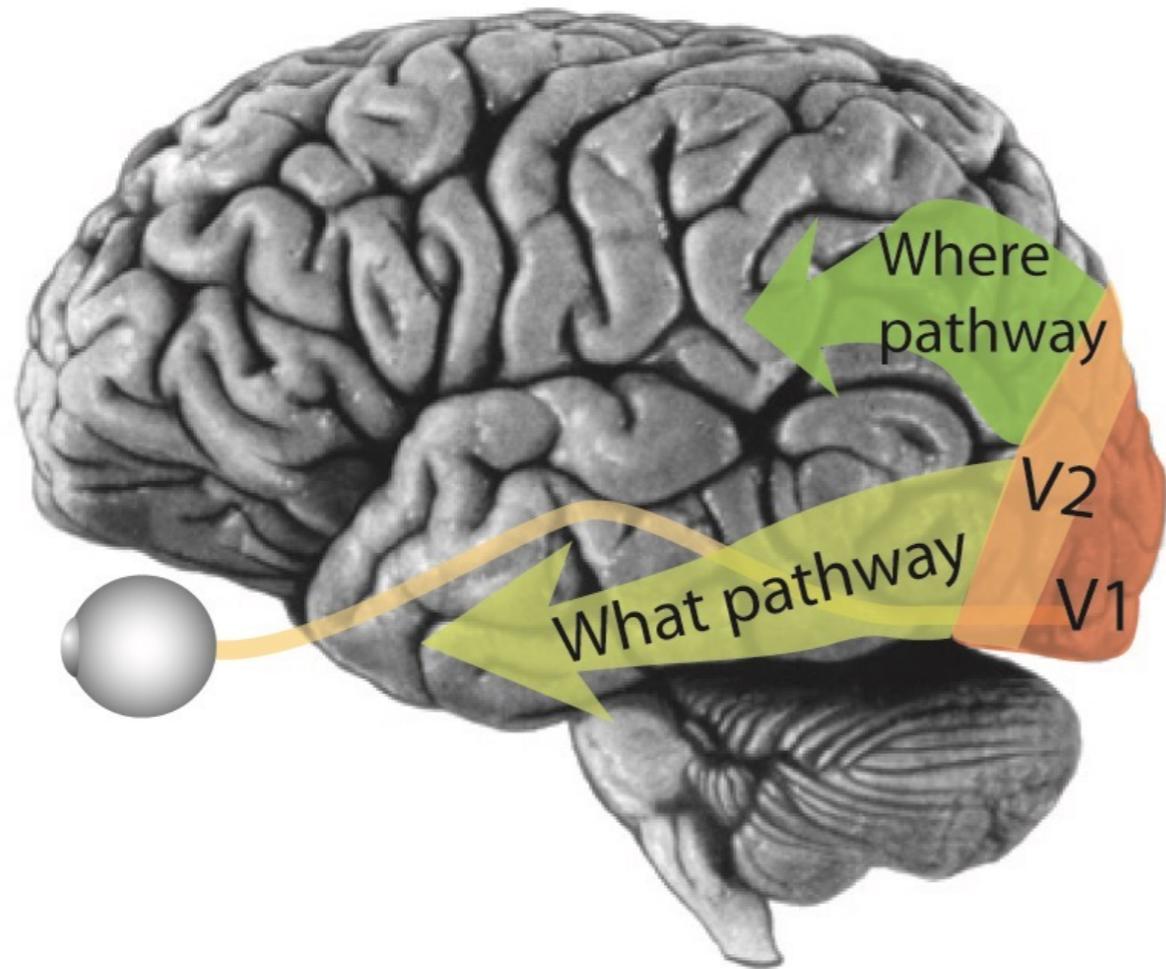
Visualization for Sciences



General Approaches



Principles of Visual Cognition



Perception:
about the nature of the
signals coming in;
what you *see*

Cognition:
about how you
understand and
interpret what you see

Today

Ranking of Visual Channels

Memory, Attention, and their Limits

Gestalt Principles

Ranking of Visual Channels

CS

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Activity

Map the data types to columns in the following table.

- Nominal (Categorical)
- Ordinal
- Quantitative

Dimensions

Order ID	Order Date	Order Priority	Product Container	Product Base Margin	Ship Date
3	10/14/06	5-Low	Large Box	0.8	10/21/06
6	2/21/08	4-Not Specified	Small Pack	0.55	2/22/08
32	7/16/07	2-High	Small Pack	0.79	7/17/07
32	7/16/07	2-High	Jumbo Box	0.72	7/17/07
32	7/16/07	2-High	Medium Box	0.6	7/18/07
32	7/16/07	2-High	Medium Box	0.65	7/18/07
35	10/23/07	4-Not Specified	Wrap Bag	0.52	10/24/07
35	10/23/07	4-Not Specified	Small Box	0.58	10/25/07
36	11/3/07	1-Urgent	Small Box	0.55	11/3/07
65	3/18/07	1-Urgent	Small Pack	0.49	3/19/07
66	1/20/05	5-Low	Wrap Bag	0.56	1/20/05
69	6/4/05	4-Not Specified	Small Pack	0.44	6/6/05
69	6/4/05	4-Not Specified	Wrap Bag	0.6	6/6/05
70	12/18/06	5-Low	Small Box	0.59	12/23/06
70	12/18/06	5-Low	Wrap Bag	0.82	12/23/06
96	4/17/05	2-High	Small Box	0.55	4/19/05
97	1/29/06	3-Medium	Small Box	0.38	1/30/06
129	11/19/08	5-Low	Small Box	0.37	11/28/08
130	5/8/08	2-High	Small Box	0.37	5/9/08
130	5/8/08	2-High	Medium Box	0.38	5/10/08
130	5/8/08	2-High	Small Box	0.6	5/11/08
132	6/11/06	3-Medium	Medium Box	0.6	6/12/06
132	6/11/06	3-Medium	Jumbo Box	0.69	6/14/06
134	5/1/08	4-Not Specified	Large Box	0.82	5/3/08
135	10/21/07	4-Not Specified	Small Pack	0.64	10/23/07
166	9/12/07	2-High	Small Box	0.55	9/14/07
193	8/8/06	1-Urgent	Medium Box	0.57	8/10/06

Nominal

Ordinal

Quantitative

Order ID	Order Date	Order Priority	Product Container	Product Base Margin	Ship Date
3	10/14/06	5-Low	Large Box	0.8	10/21/06
6	2/21/08	4-Not Specified	Small Pack	0.55	2/22/08
32	7/16/07	2-High	Small Pack	0.79	7/17/07
32	7/16/07	2-High	Jumbo Box	0.72	7/17/07
32	7/16/07	2-High	Medium Box	0.6	7/18/07
32	7/16/07	2-High	Medium Box	0.65	7/18/07
35	10/23/07	4-Not Specified	Wrap Bag	0.52	10/24/07
35	10/23/07	4-Not Specified	Small Box	0.58	10/25/07
36	11/3/07	1-Urgent	Small Box	0.55	11/3/07
65	3/18/07	1-Urgent	Small Pack	0.49	3/19/07
66	1/20/05	5-Low	Wrap Bag	0.56	1/20/05
69	6/4/05	4-Not Specified	Small Pack	0.44	6/6/05
69	6/4/05	4-Not Specified	Wrap Bag	0.6	6/6/05
70	12/18/06	5-Low	Small Box	0.59	12/23/06
70	12/18/06	5-Low	Wrap Bag	0.82	12/23/06
96	4/17/05	2-High	Small Box	0.55	4/19/05
97	1/29/06	3-Medium	Small Box	0.38	1/30/06
129	11/19/08	5-Low	Small Box	0.37	11/28/08
130	5/8/08	2-High	Small Box	0.37	5/9/08
130	5/8/08	2-High	Medium Box	0.38	5/10/08
130	5/8/08	2-High	Small Box	0.6	5/11/08
132	6/11/06	3-Medium	Medium Box	0.6	6/12/06
132	6/11/06	3-Medium	Jumbo Box	0.69	6/14/06
134	5/1/08	4-Not Specified	Large Box	0.82	5/3/08
135	10/21/07	4-Not Specified	Small Pack	0.64	10/23/07
166	9/12/07	2-High	Small Box	0.55	9/14/07
193	8/8/06	1-Urgent	Medium Box	0.57	8/10/06
193	8/8/06	1-Urgent	Small Box	0.55	8/10/06

Visual Channels

Name some visual channels.



Visual Channels

Position

Size

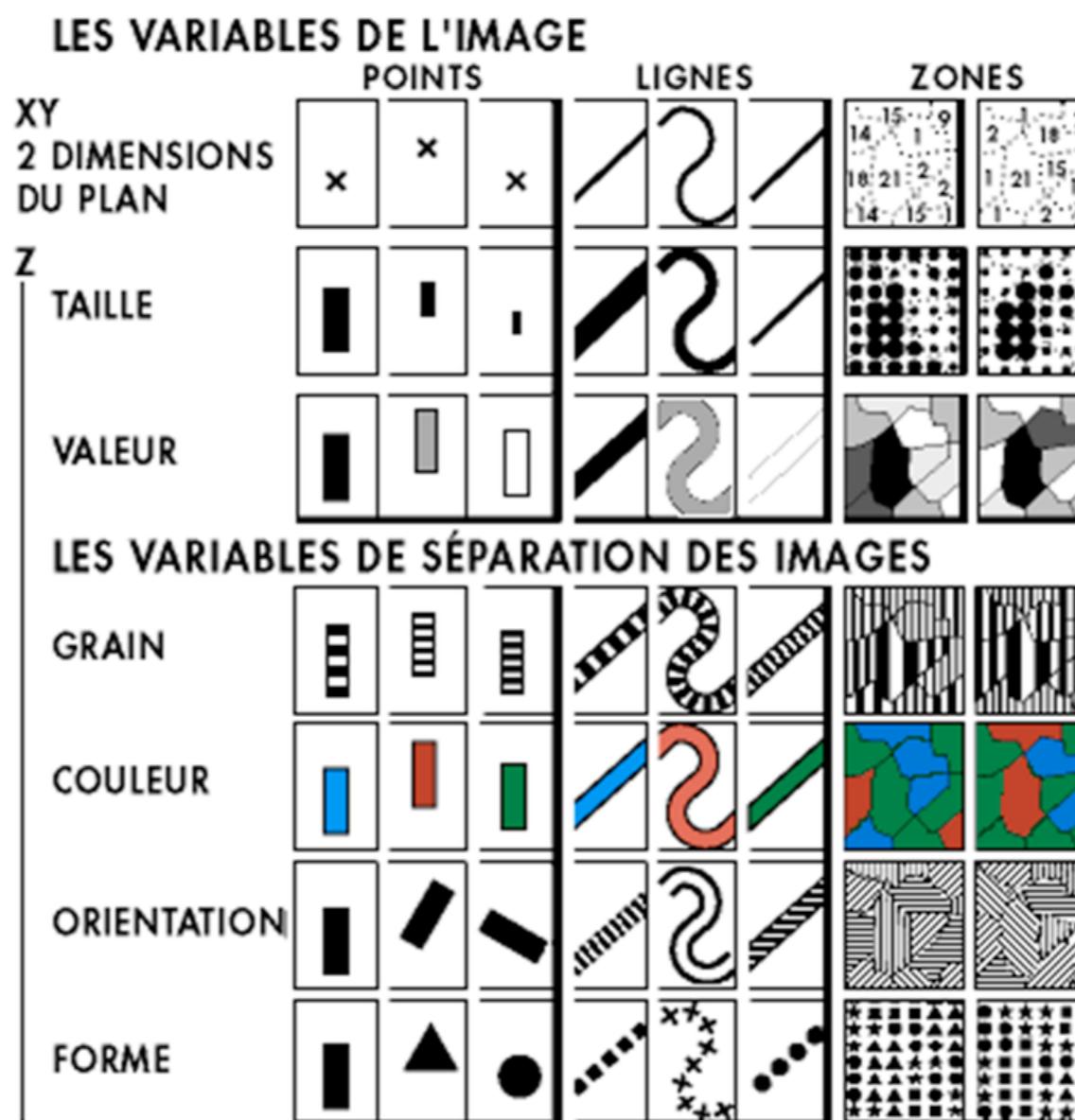
(Grey)Value

Texture

Color

Orientation

Shape

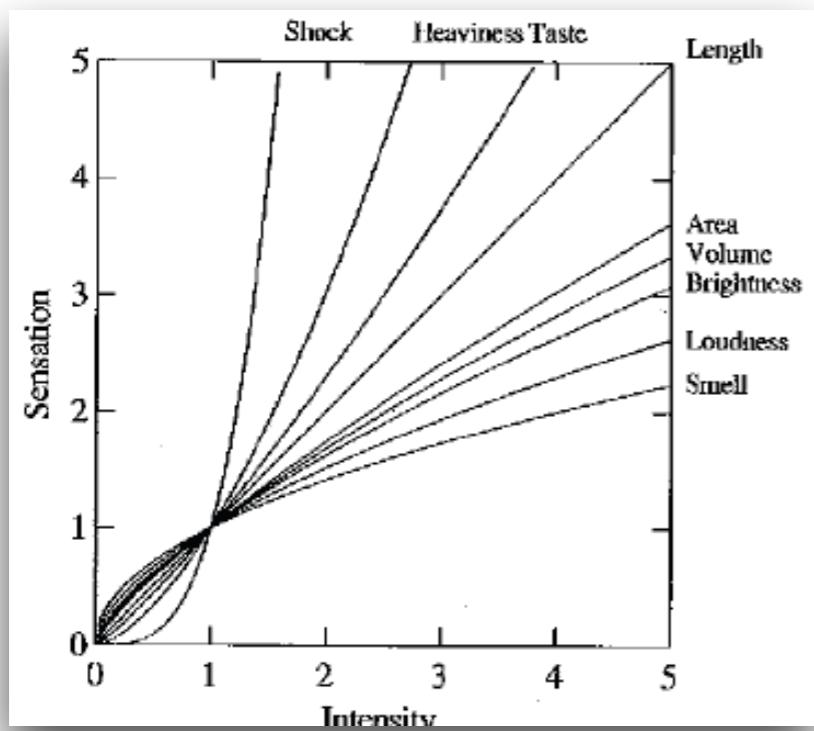


Activity

Please do the following quiz about visual variables/channels. (3min)

hs8.de/cs171

results



Stephen's Power Law, 1961

	Nominal	Ordinal	Quantitative
Position	✓	✓	✓
Size	✓	✓	~
(Grey)Value	✓	✓	~
Texture	✓	~	✗
Color	✓	✗	✗
Orientation	✓	✗	✗
Shape	✓	✗	✗

✓ = Good

~ = OK

✗ = Bad

J. Bertin, 1967

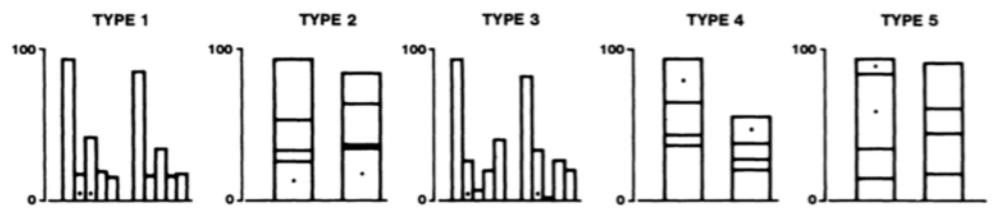


Figure 4. Graphs from position-length experiment.

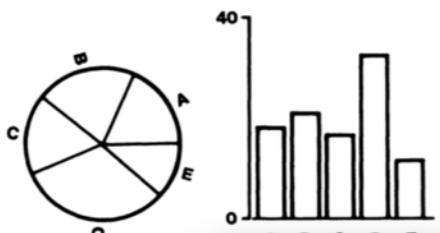
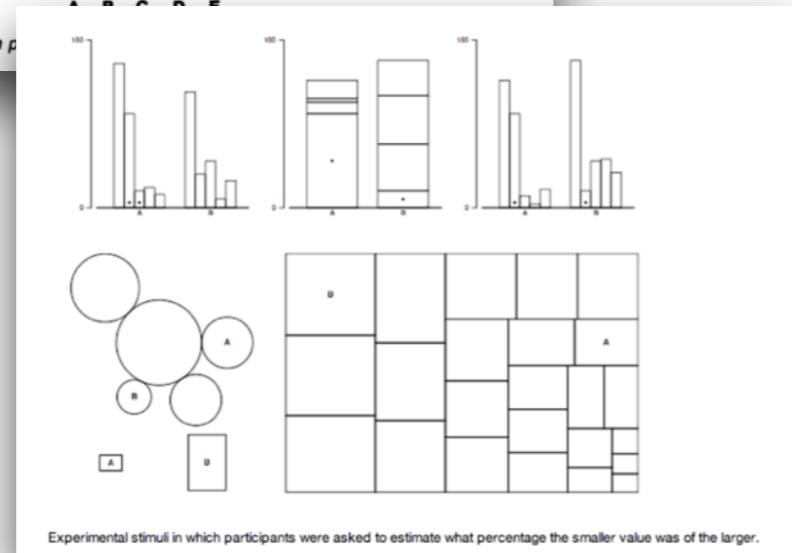
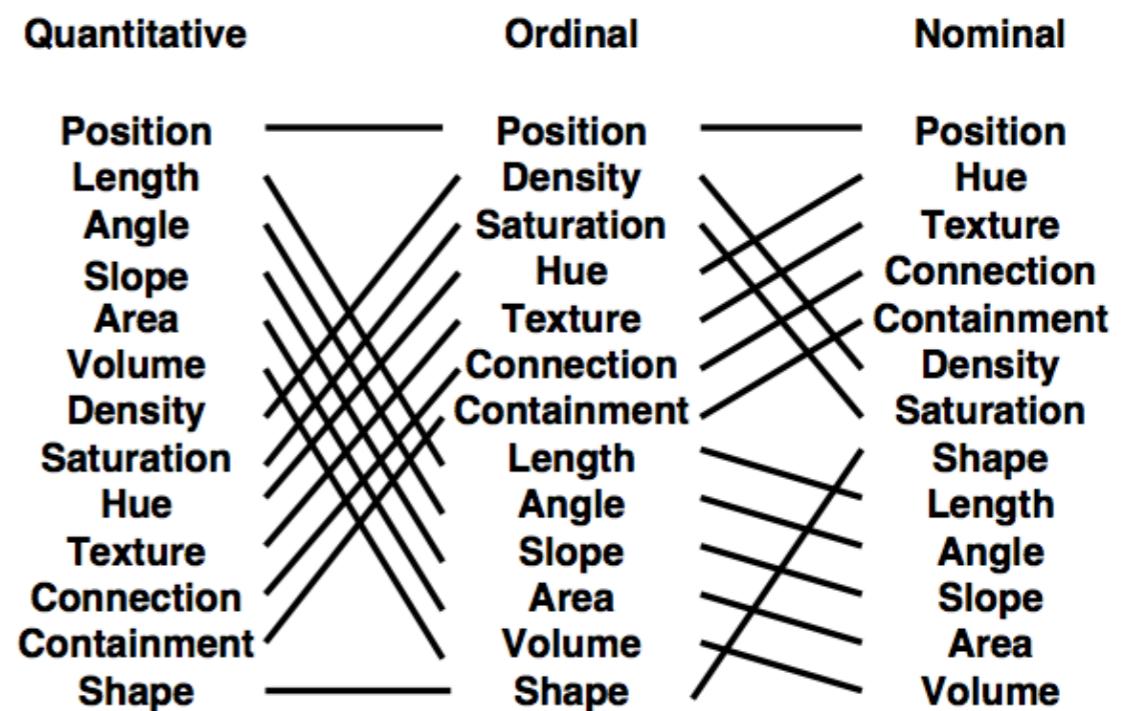


Figure 3. Graphs from position-length experiment.

Cleveland / McGill, 1984



Heer / Bostock, 2010



J. Mackinlay, 1986

Most
Efficient



Position



Length



Slope



Angle



Area



Intensity



Least
Efficient

Color



Shape



Most
Efficient



Position



Length



Slope



Angle



Area



Intensity



Least
Efficient

Color



Shape

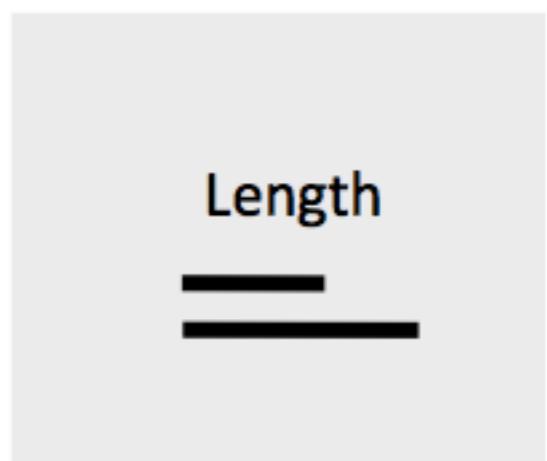
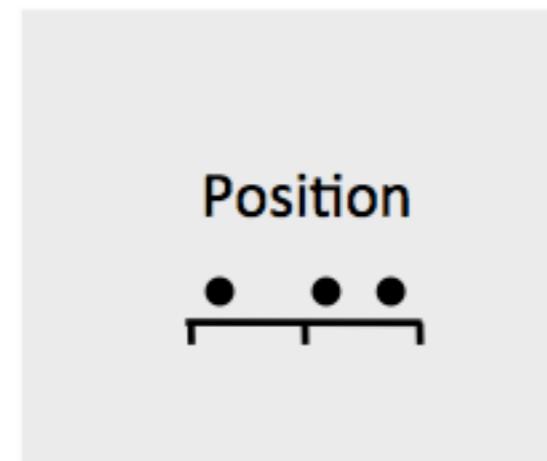
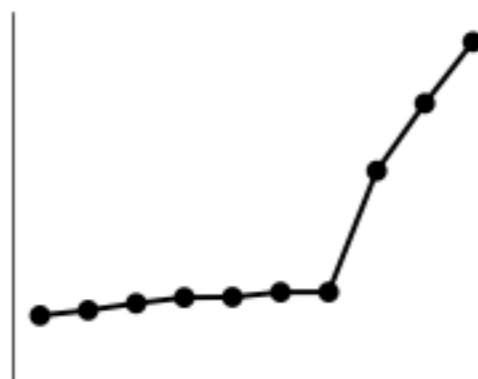


Quantitative

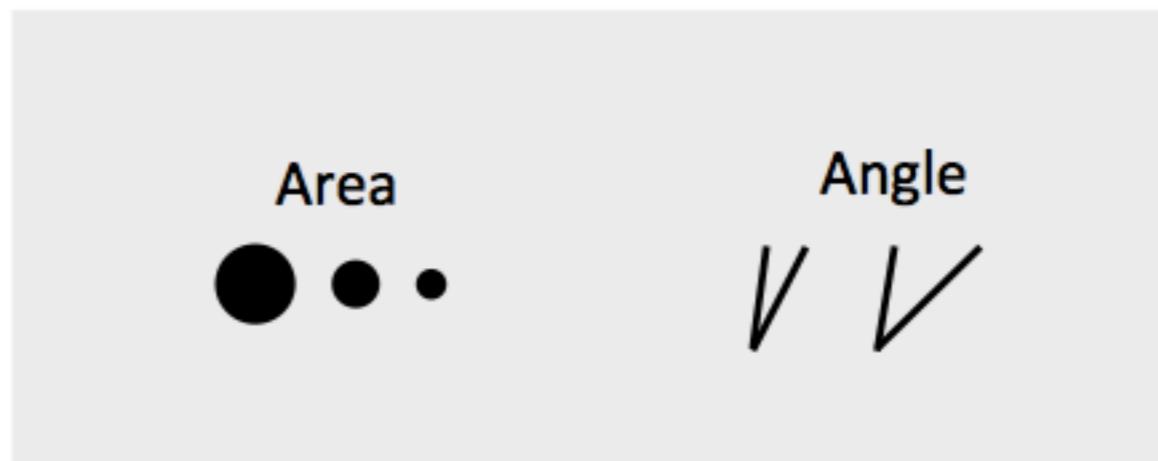
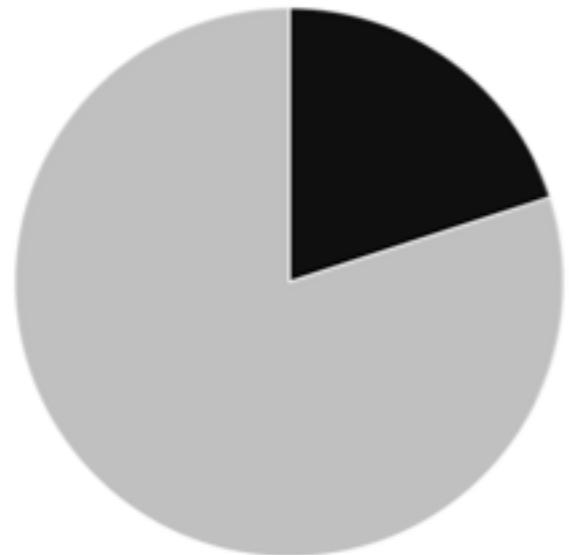
Ordinal

Nominal

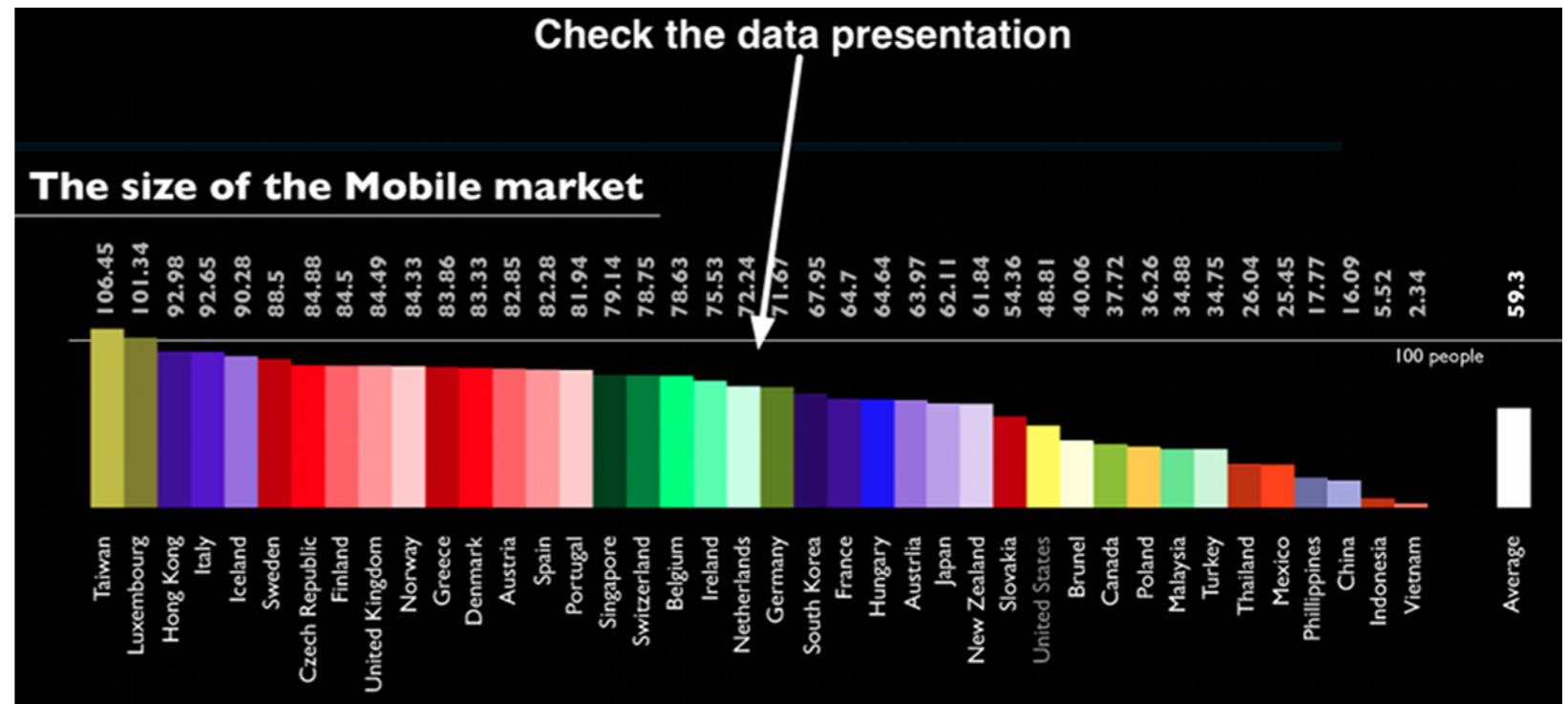
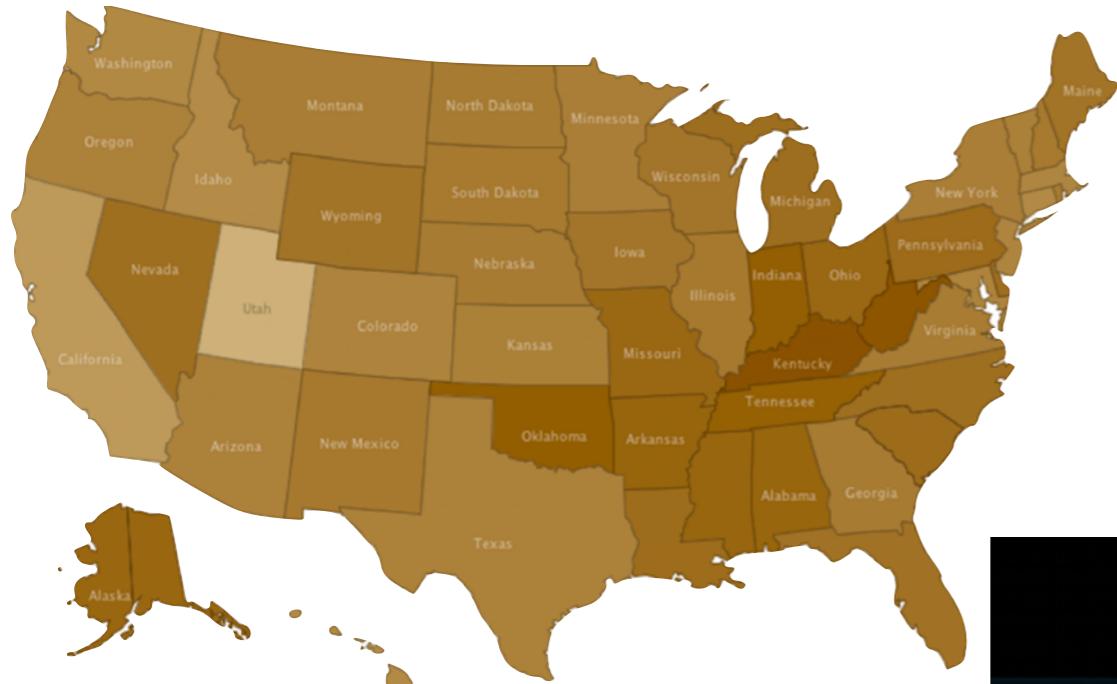
Most Effective



Less Effective

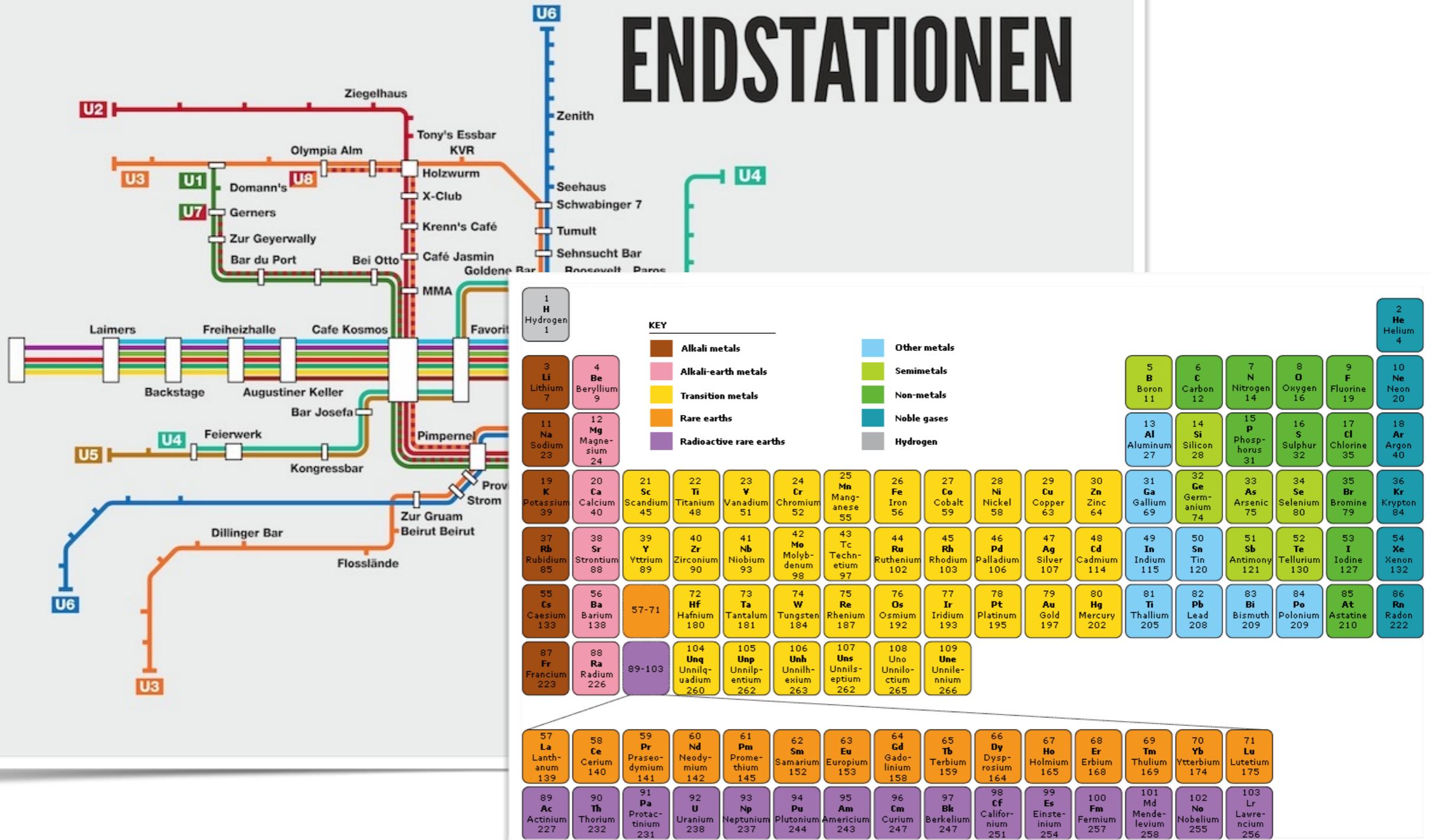


Less Effective



but...

ENDSTATIONEN



Activity

What visual information do we get at a glance? Pay attention and remember the following picture.



Activity

What visual information do we get at a glance? Pay attention and remember the following picture.



Ready?

Activity

What did you see?

- Indoor / outdoor?
- Size of the space? how many people?
- Age of people?
- Color of dresses?
- Color of carpet?



Memory & Gist

CS
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Activity

Nine photographs will be shown for half a second each. Your task is to memorize all of these pictures.





















Memory Test

- Which of the following pictures have you seen?
- If you have seen the image clap your hands once
- If you have not seen the image do nothing

Have you seen this picture?



Have you seen this picture?



Have you seen this picture?



Have you seen this picture?



Have you seen this picture?



Have you seen this picture?



Have you seen this picture?



Have you seen this picture?



Have you seen this picture?



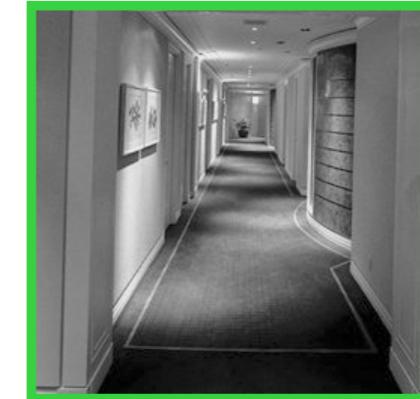
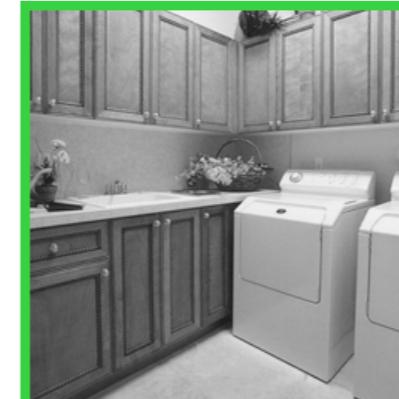
Have you seen this picture?



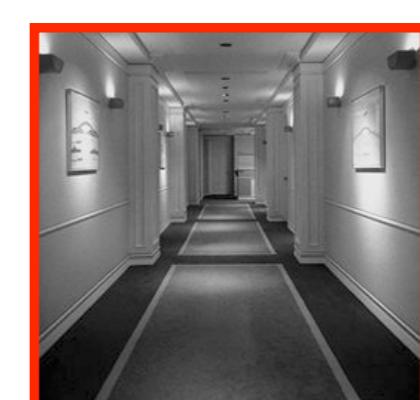
Memory Confusion

- The images have the same spatial layout

Shown



Tested



Memory Confusion

- The details of some objects have been forgotten

Shown

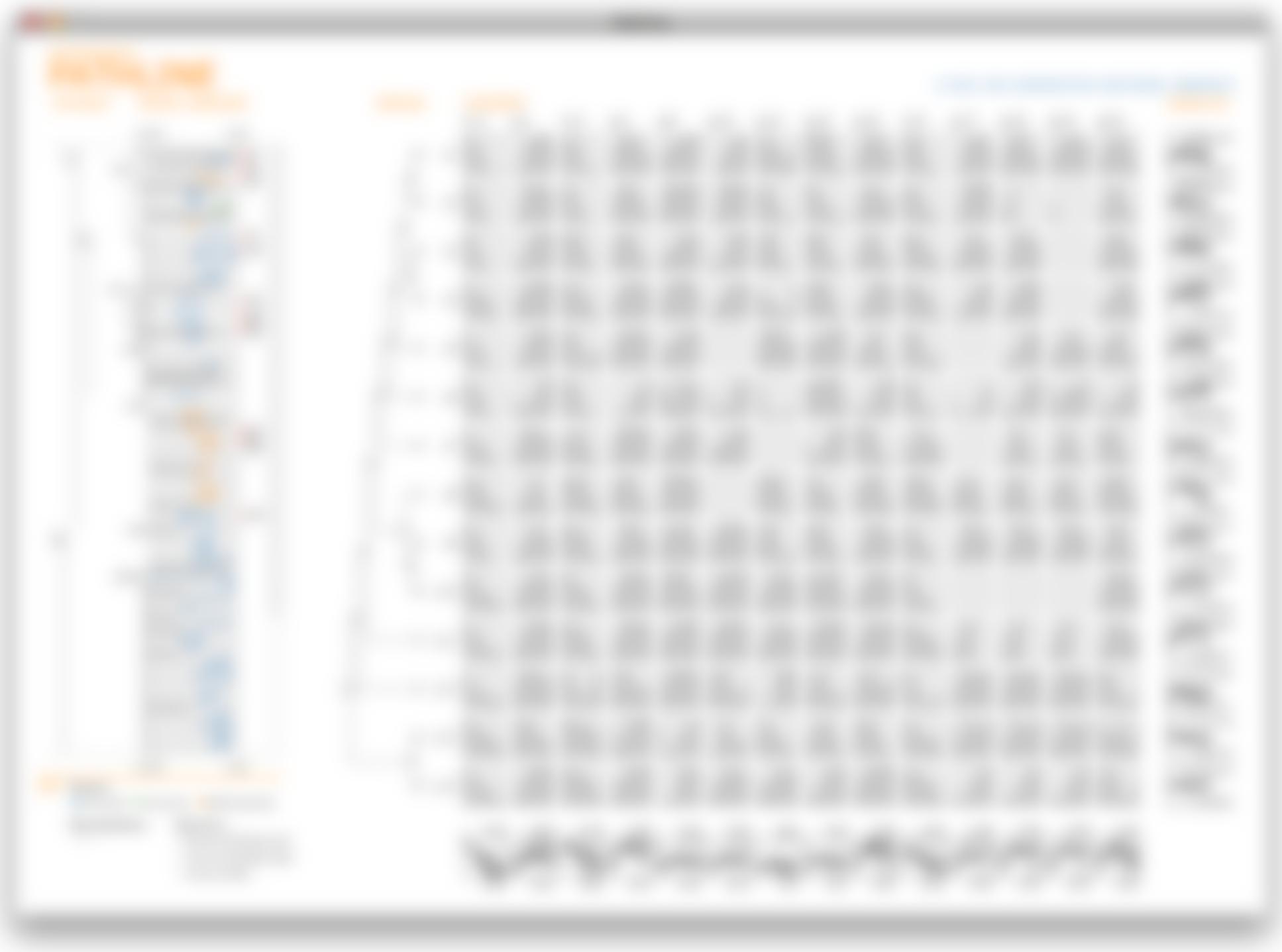


Tested

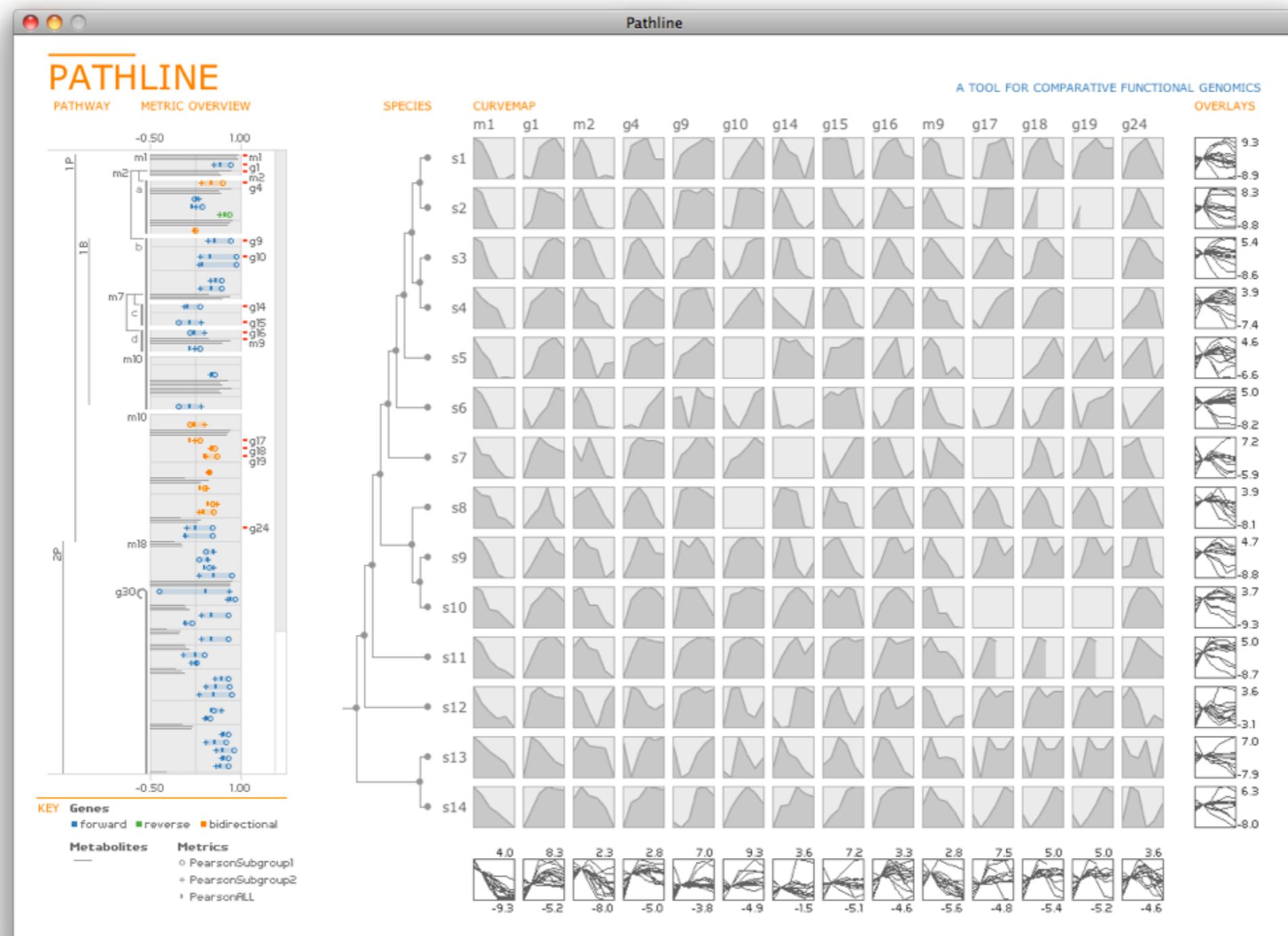


The Gist

- Image gist gives you layout
- Can give you general categorization info but lacks details
- Attention is required to get specific details
- Later, we make use of the gist to know where to focus our attention
- ‘Simulate’ gist: squint your eyes to get a blurred image of your vis



M. Meyer, B. Wong, M. Styczynski and H. Pfister. "Pathline: A Tool For Comparative Functional Genomics", Computer Graphics Forum, 2010



M. Meyer, B. Wong, M. Styczynski and H. Pfister. "Pathline: A Tool For Comparative Functional Genomics", Computer Graphics Forum, 2010



6 reasons to visualize your data

People are suffering information OVERLOAD
Long wordy reports & boring DIY charts take too much effort to interpret.
Does this sound like your business?

ABC + 8 = data viz
(data visualization or infographics)

83% of learning occurs visually

Images are easier to digest
Infographics transform plain facts into visuals that are easy to understand.
What data are you not explaining clearly?

Images are more appealing

4 Clever infographics attract your eye, arouse interest, appeal to your curiosity, make you smile & compel you to absorb data.
Does your data need to be more appealing?

5 Clever infographics are shared on websites, blogs & social media.
Print versions are shared in newspapers & magazines. This all generates valuable brand awareness (& boosts your SEO).
Would you like to go viral?

6 Make you an industry leader
No matter how boring your industry, data viz can help **EVERY** business look like the leader.
How could you use data viz in your business?

100% awesome

Created by www.j6design.com.au

Sources: <http://www.marketingprofs.com/marketing-infographics/>
<http://www.dol.gov/dol/osteo/presenting-effective-presentations-with-visual-aids.pdf>, "Presenting Effective Presentations with Visual Aids," U.S. Department of Labor, OSHA Office of Training and Education, May 1998.

Long wordy reports & boring DIY charts take too much effort to interpret.
Does this sound like your business?

ABC + 8 = data viz
(data visualization or infographics)

83% of learning occurs visually

people remember only 20% of what they read

3 Images are memorable
Colour, contrast, rhythm & shapes make complex data in graphics easily remembered. Same reason why you remember TV ads.
Would you like people to remember your message but not have to pay big \$\$\$ for a TV ad?

4 Images are easier to digest
Infographics transform plain facts into visuals that are easy to understand.
What data are you not explaining clearly?

5 Images are more appealing

6 Infographics get shared
Clever infographics are shared on websites, blogs & social media.
Print versions are shared in newspapers & magazines. This all generates valuable brand awareness (& boosts your SEO).
Would you like to go viral?

100% awesome

Copyright 2011 j6 design

Activity

Which picture did you see last week?



-A-

-B-

Activity

Which picture did you see last week?

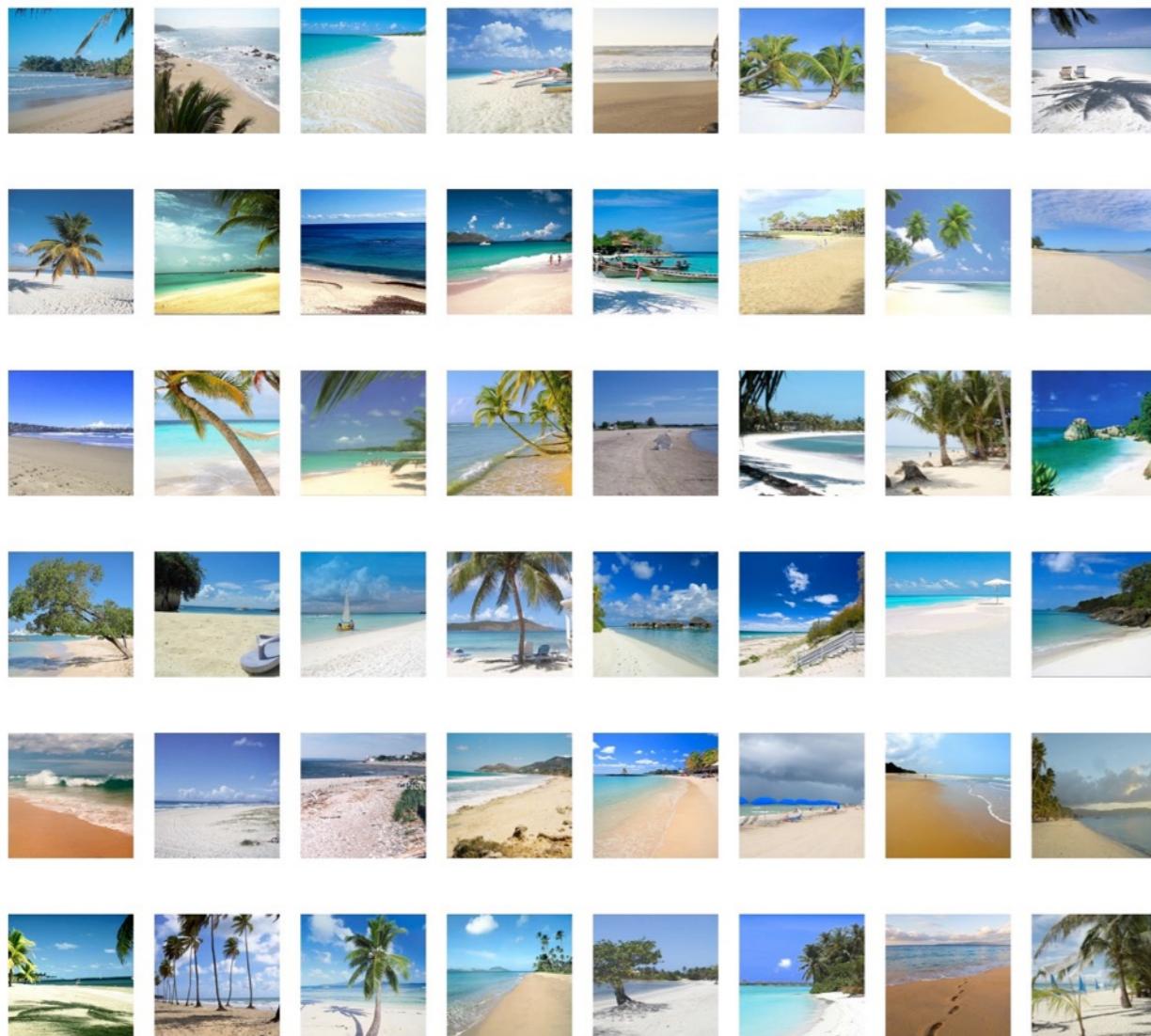


-A-



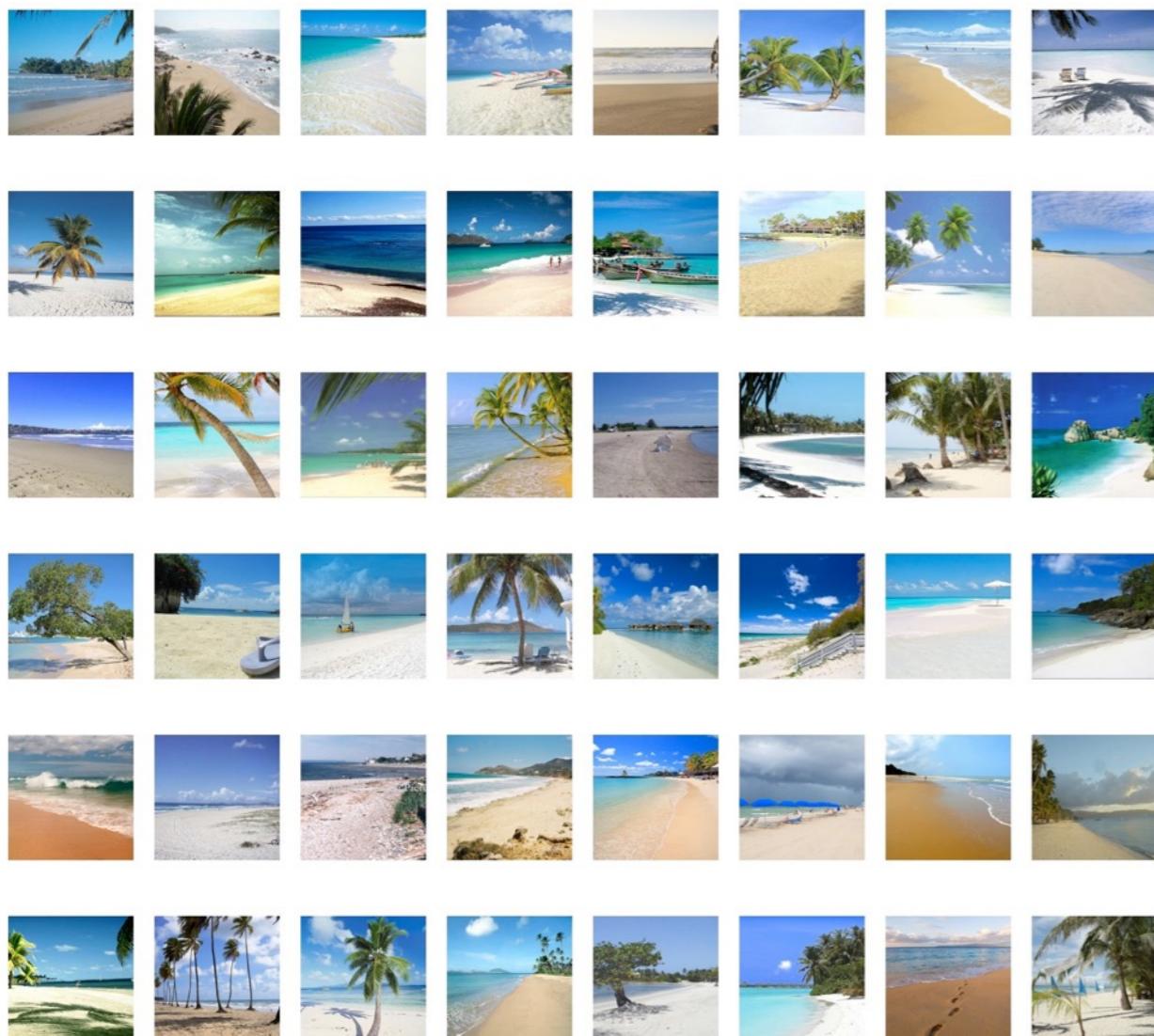
-B-

Schema



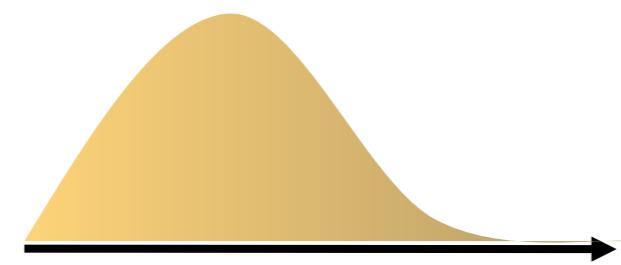
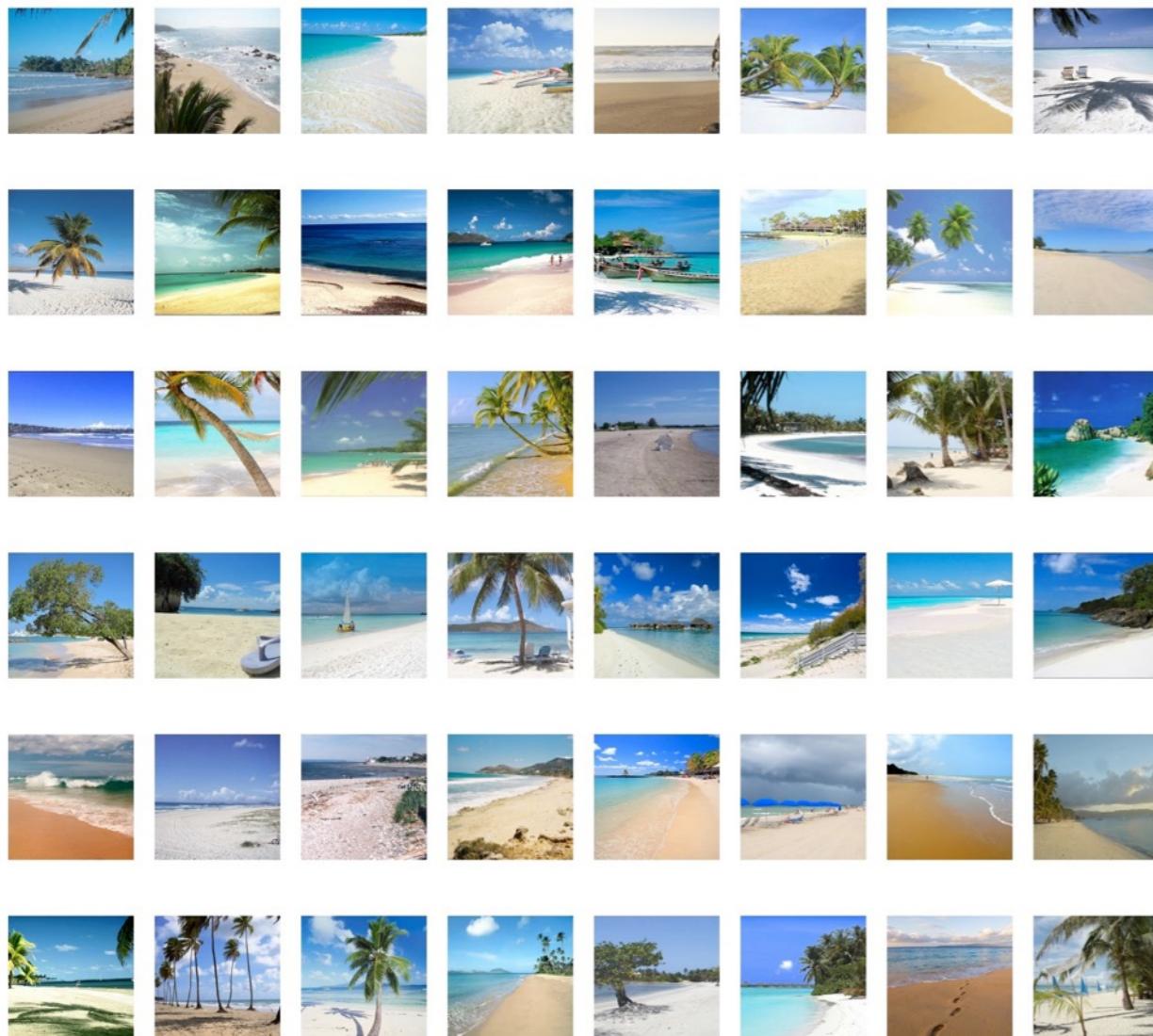
Schema

beach “schema”

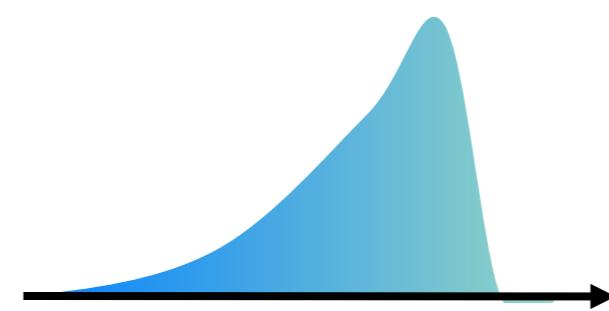


Schema

beach “schema”



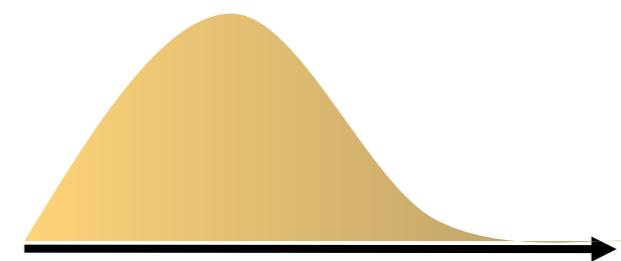
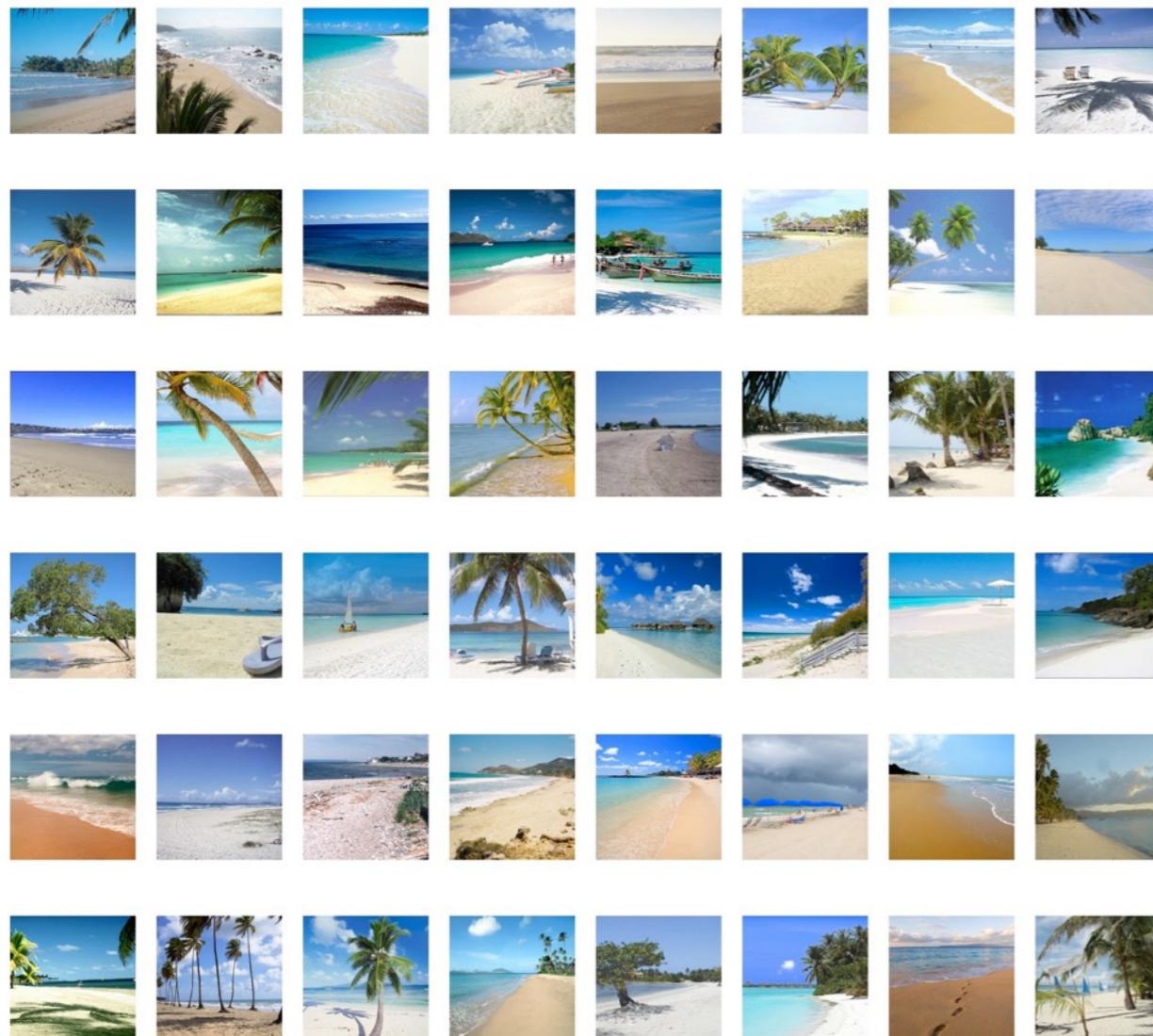
sand



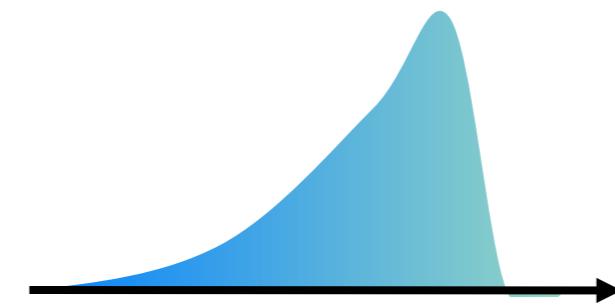
water

Schema

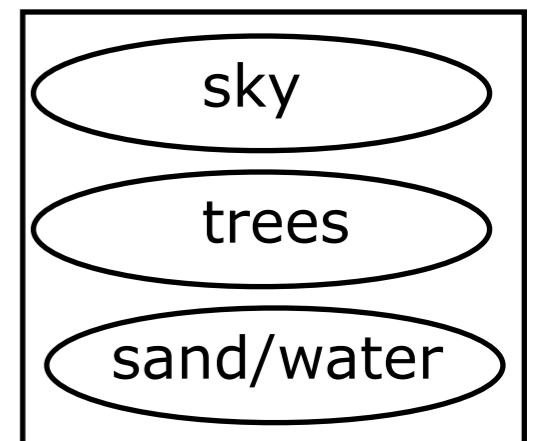
beach “schema”



sand

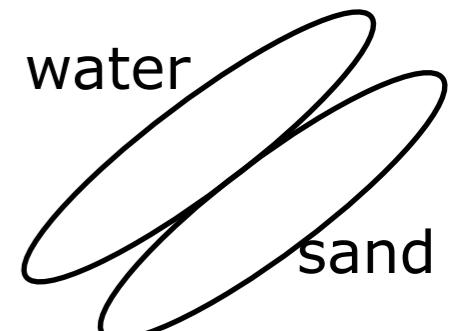
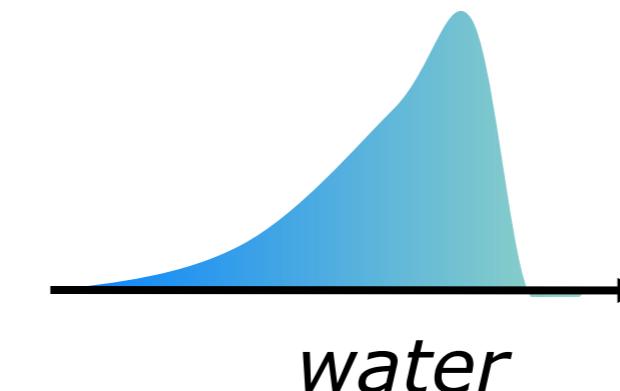
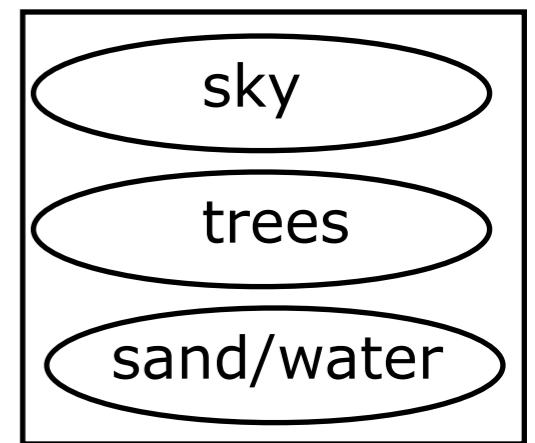
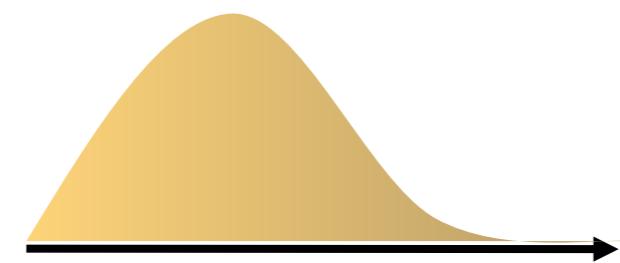
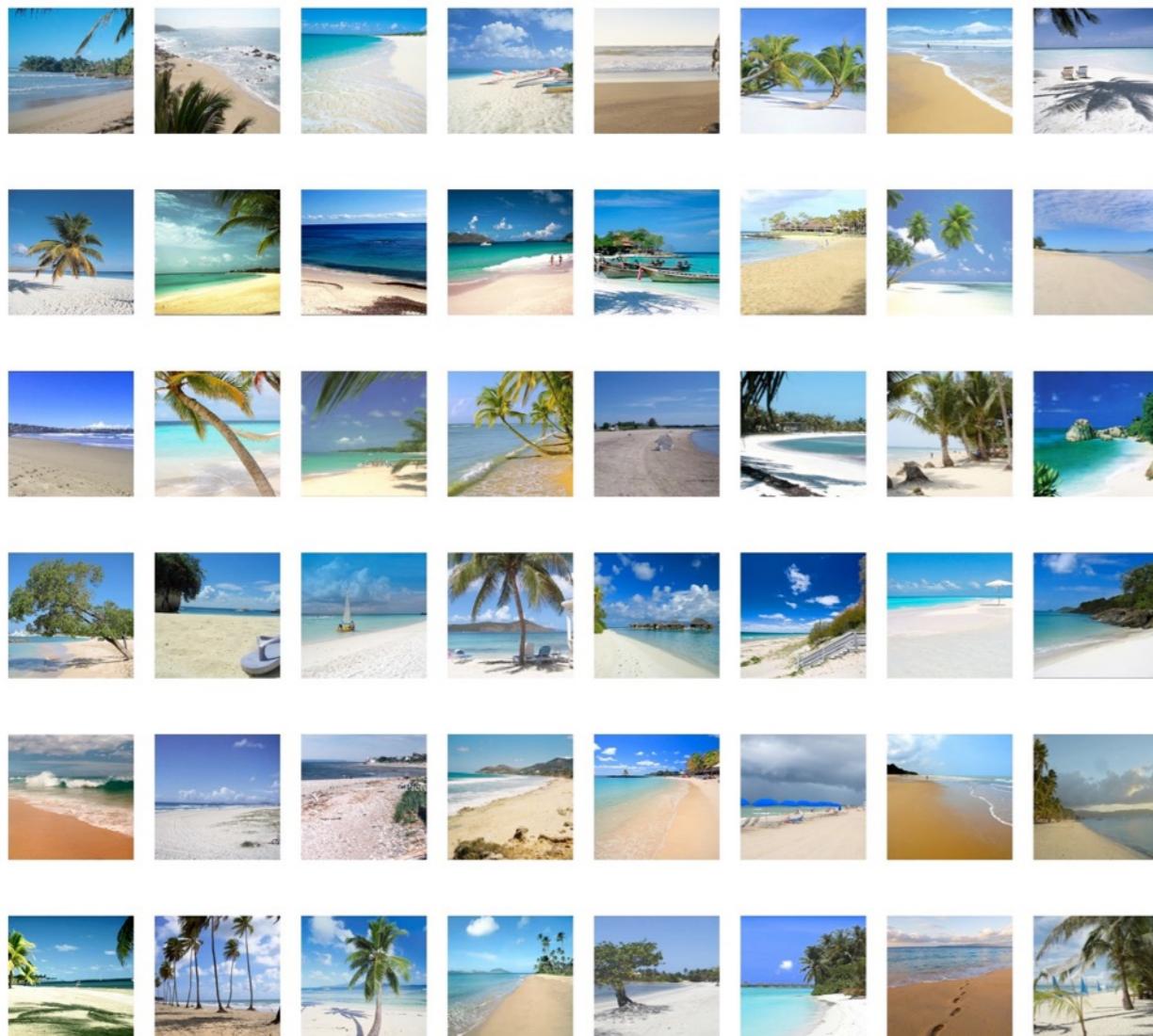


water

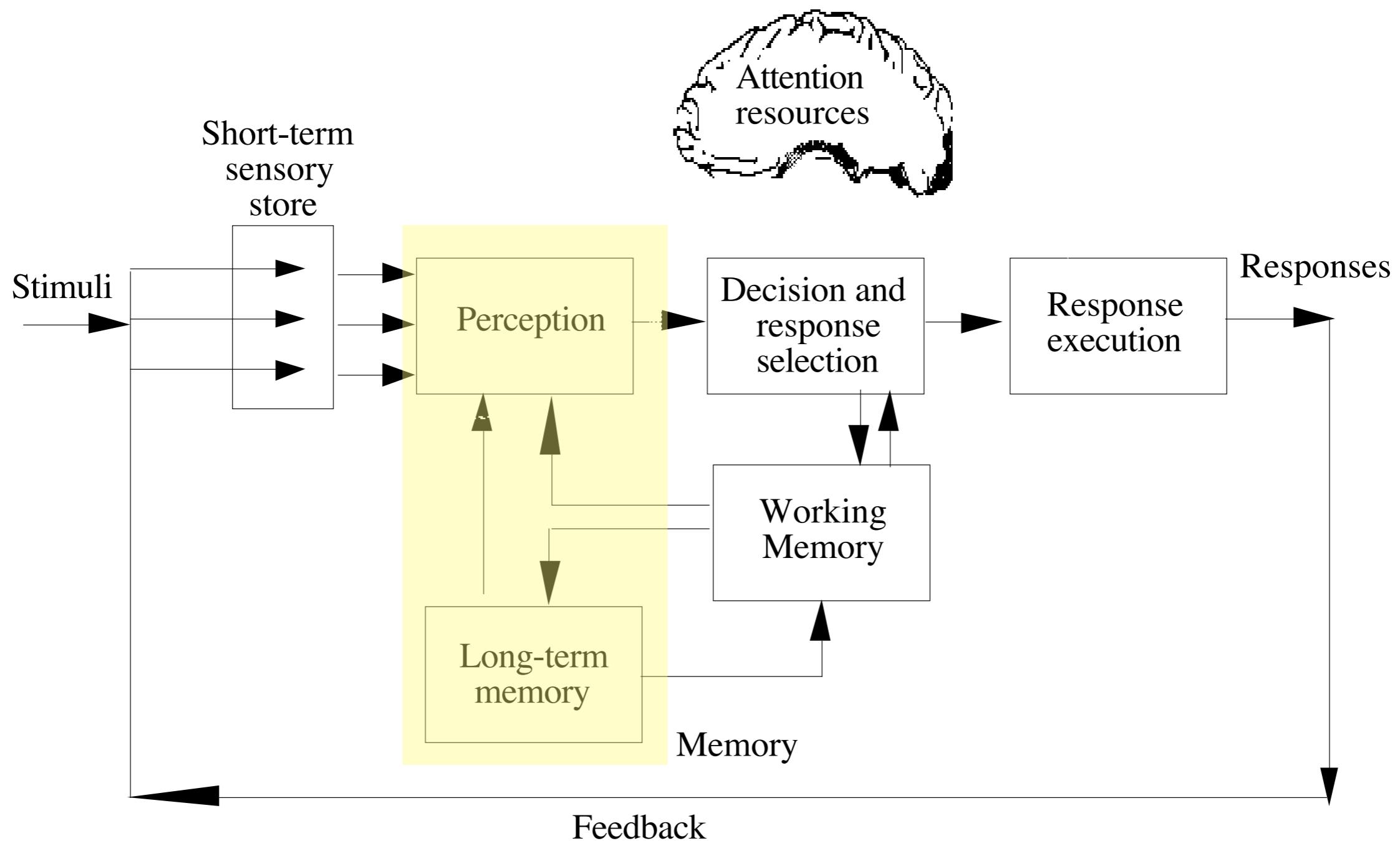


Schema

beach “schema”



Gist & Long Term Memory



Visual Working Memory

CS

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Activity

Remember the following picture.

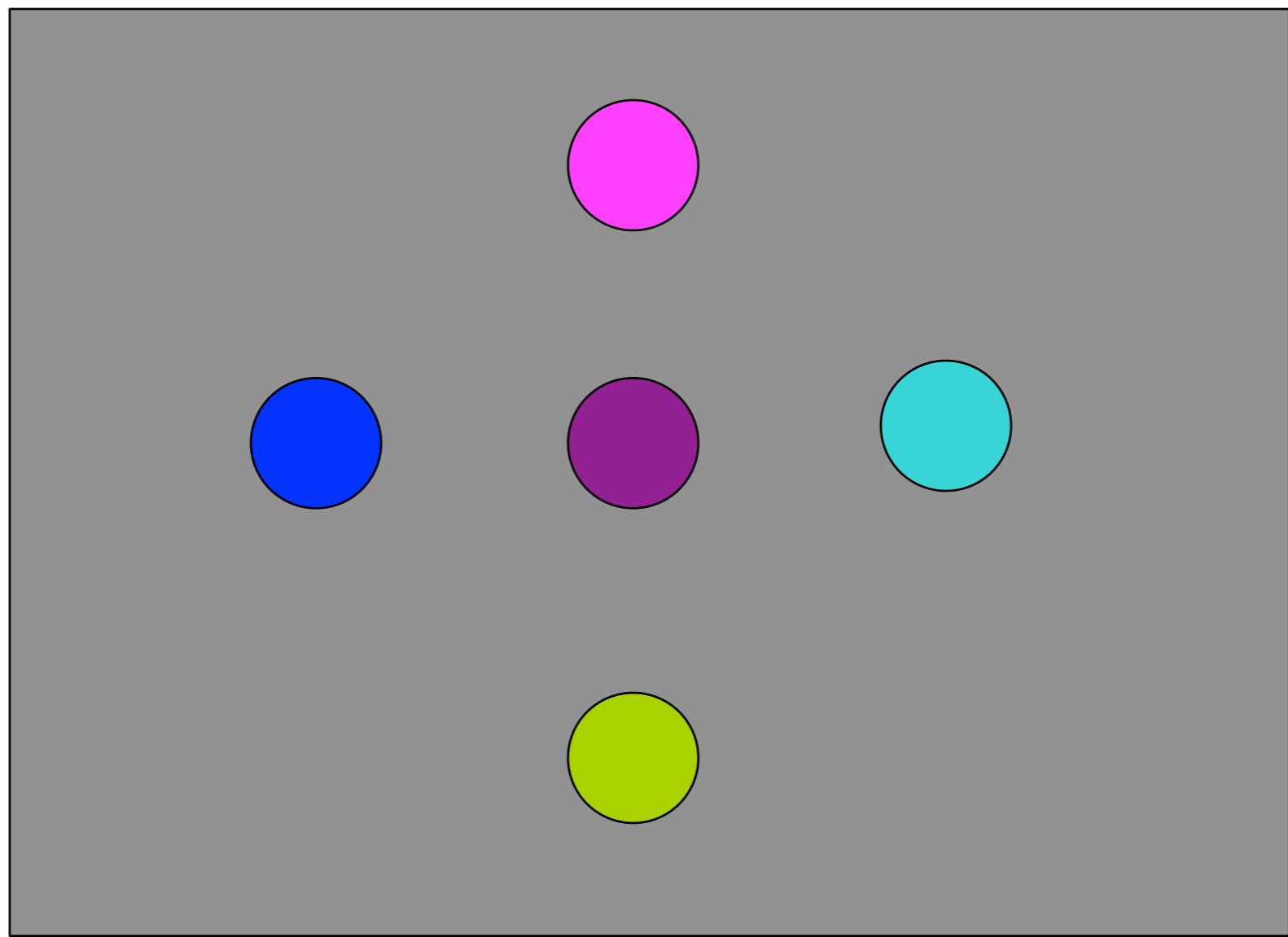


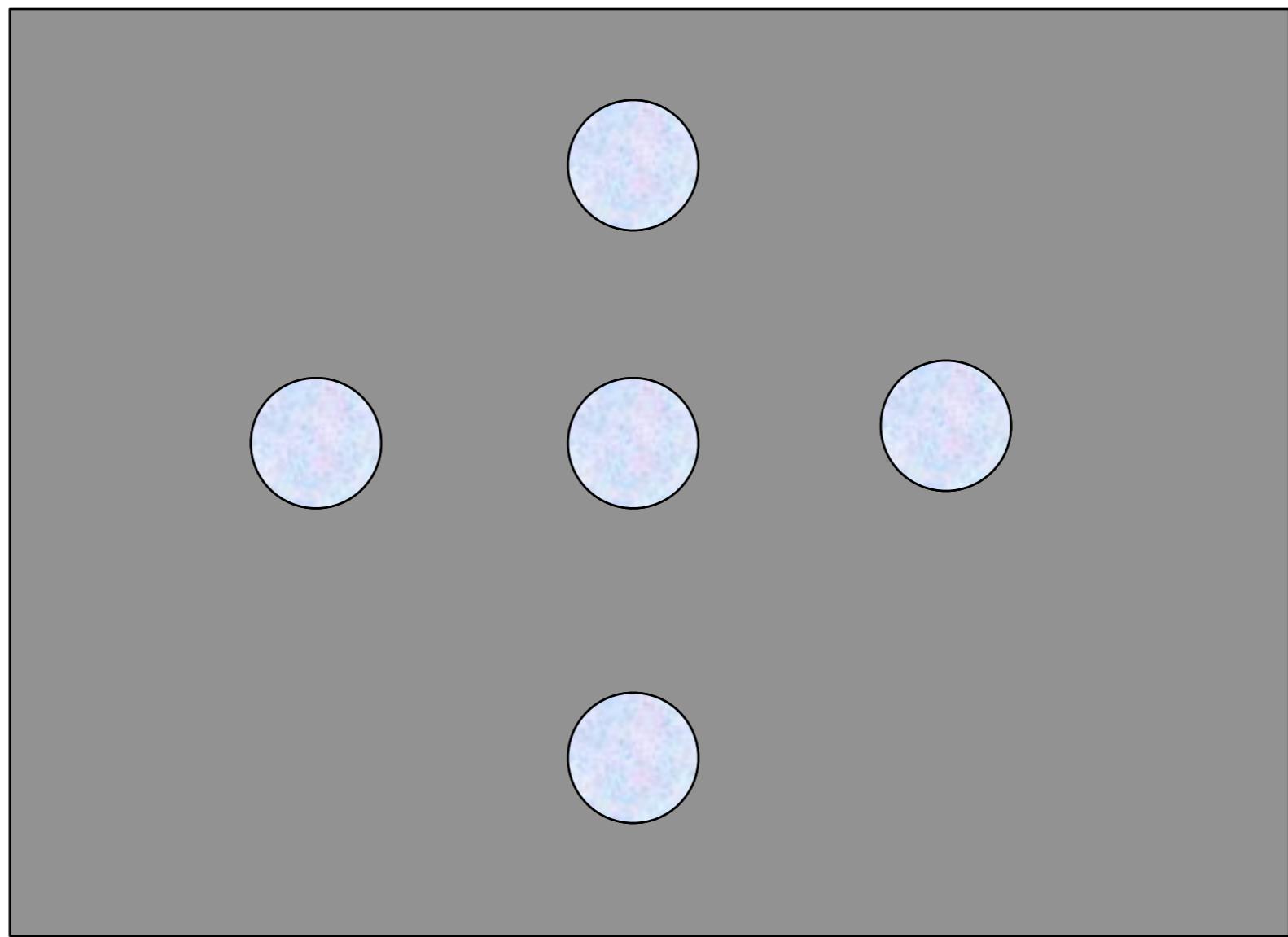
Activity

Remember the following picture.

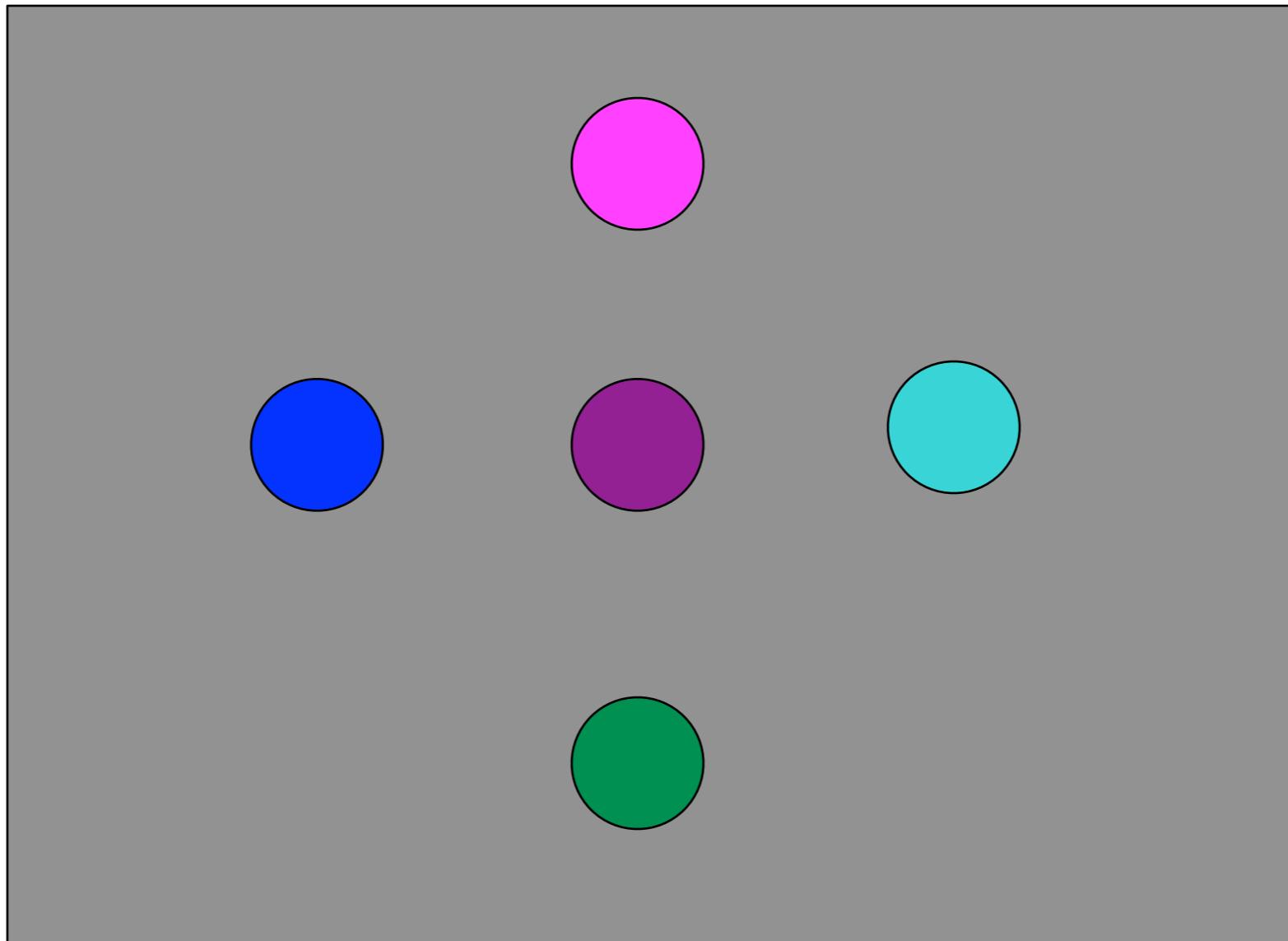


Ready?

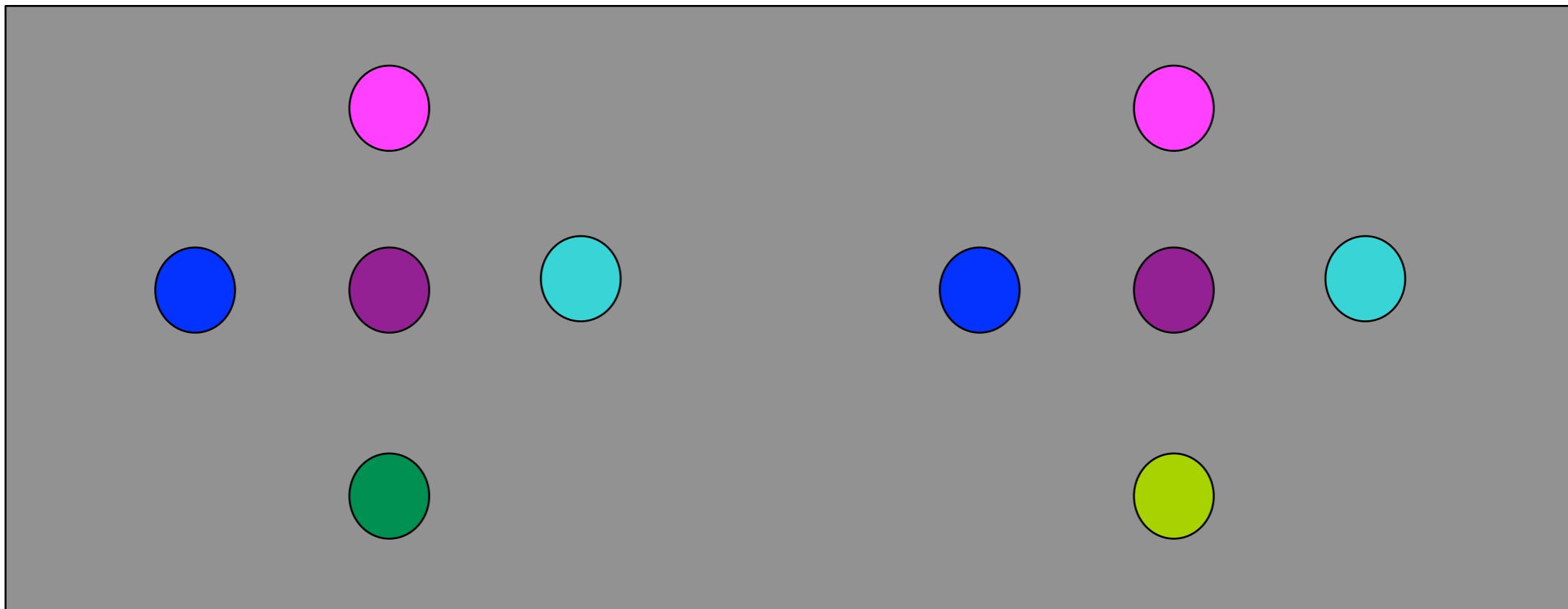




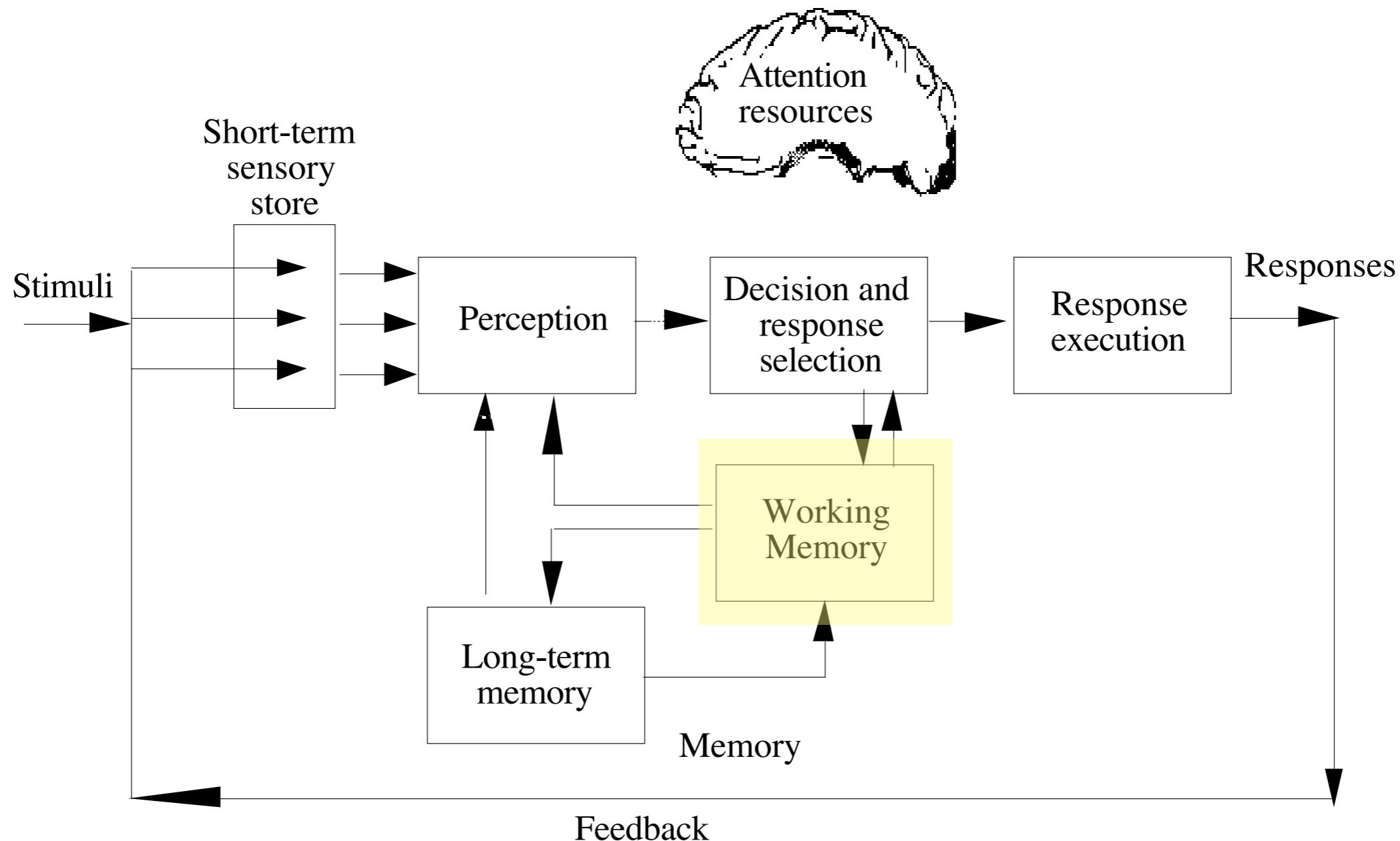
Same or different?



Eyes Over Memory



Visual Working Memory



Working memory is very limited

George Miller's 7 ± 2 rule

Cowen: 3-4 visual objects

Working memory is very limited



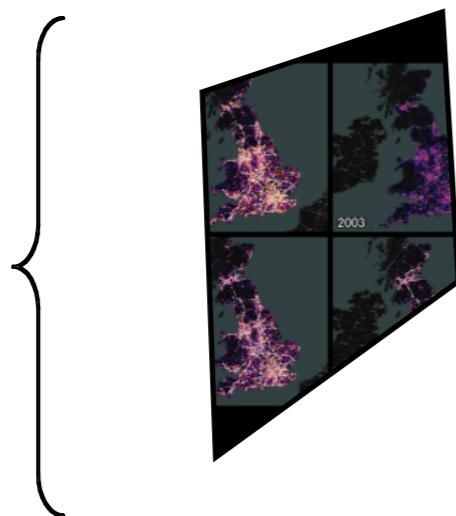
Working memory is very limited

display



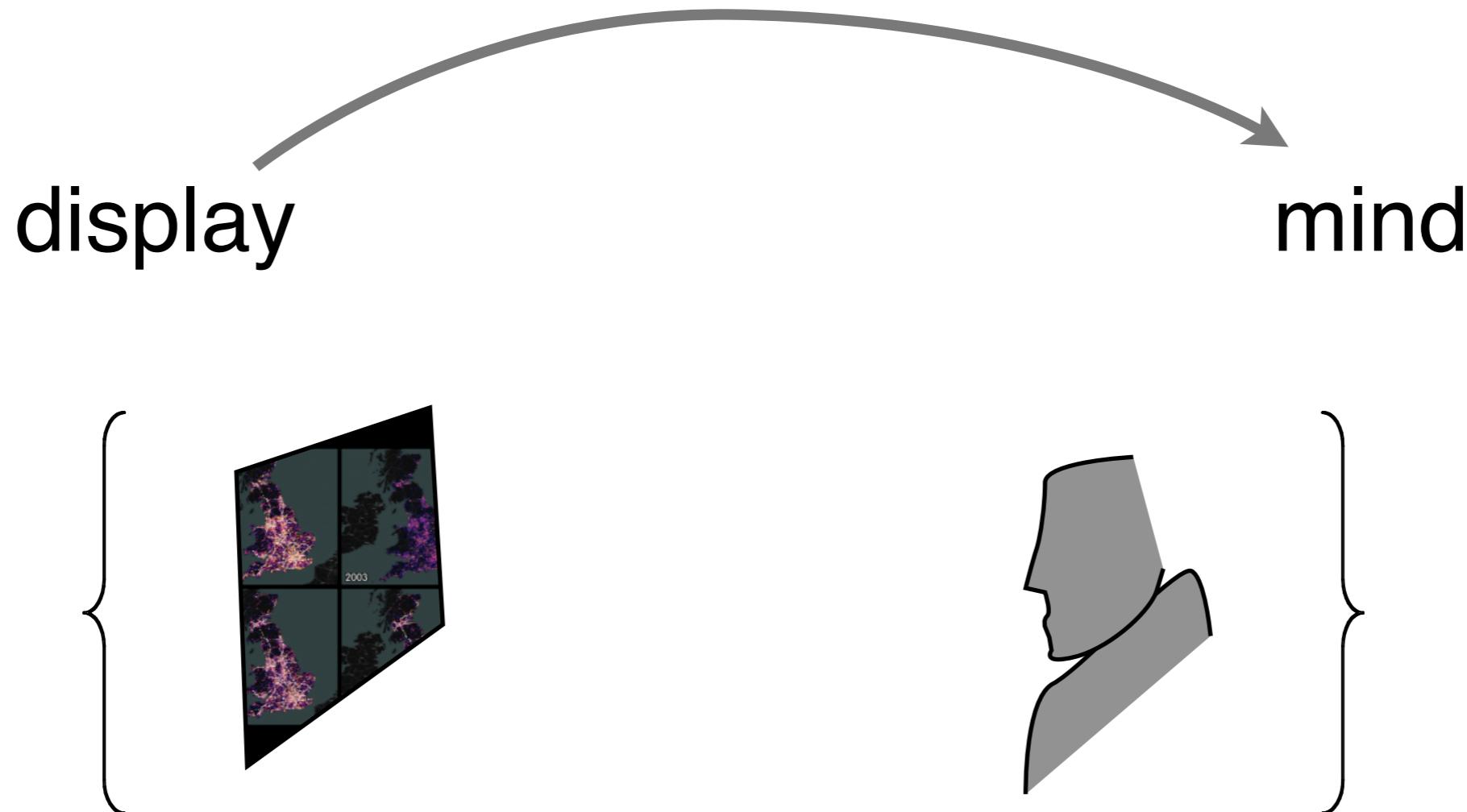
Working memory is very limited

display

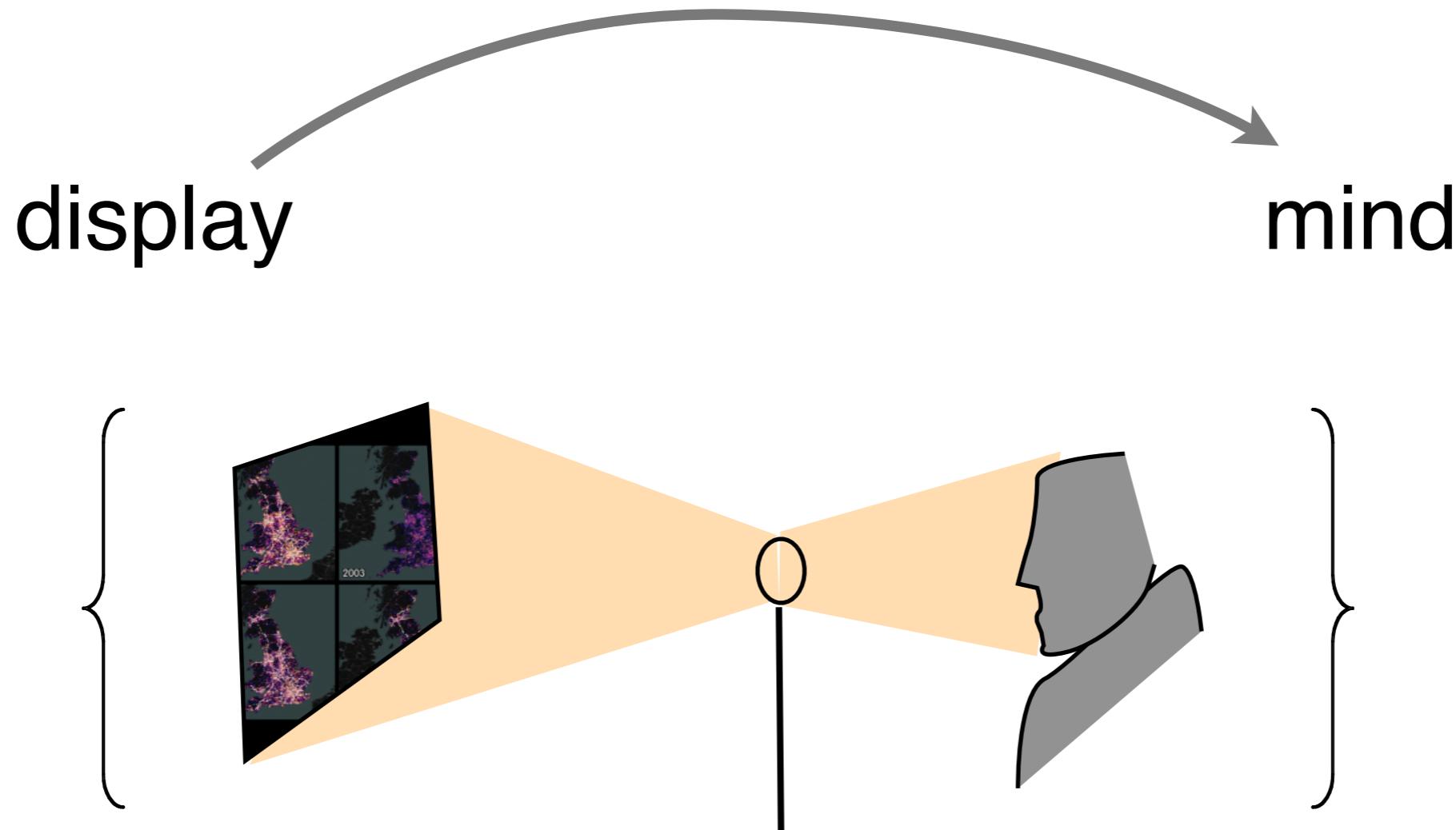


mind

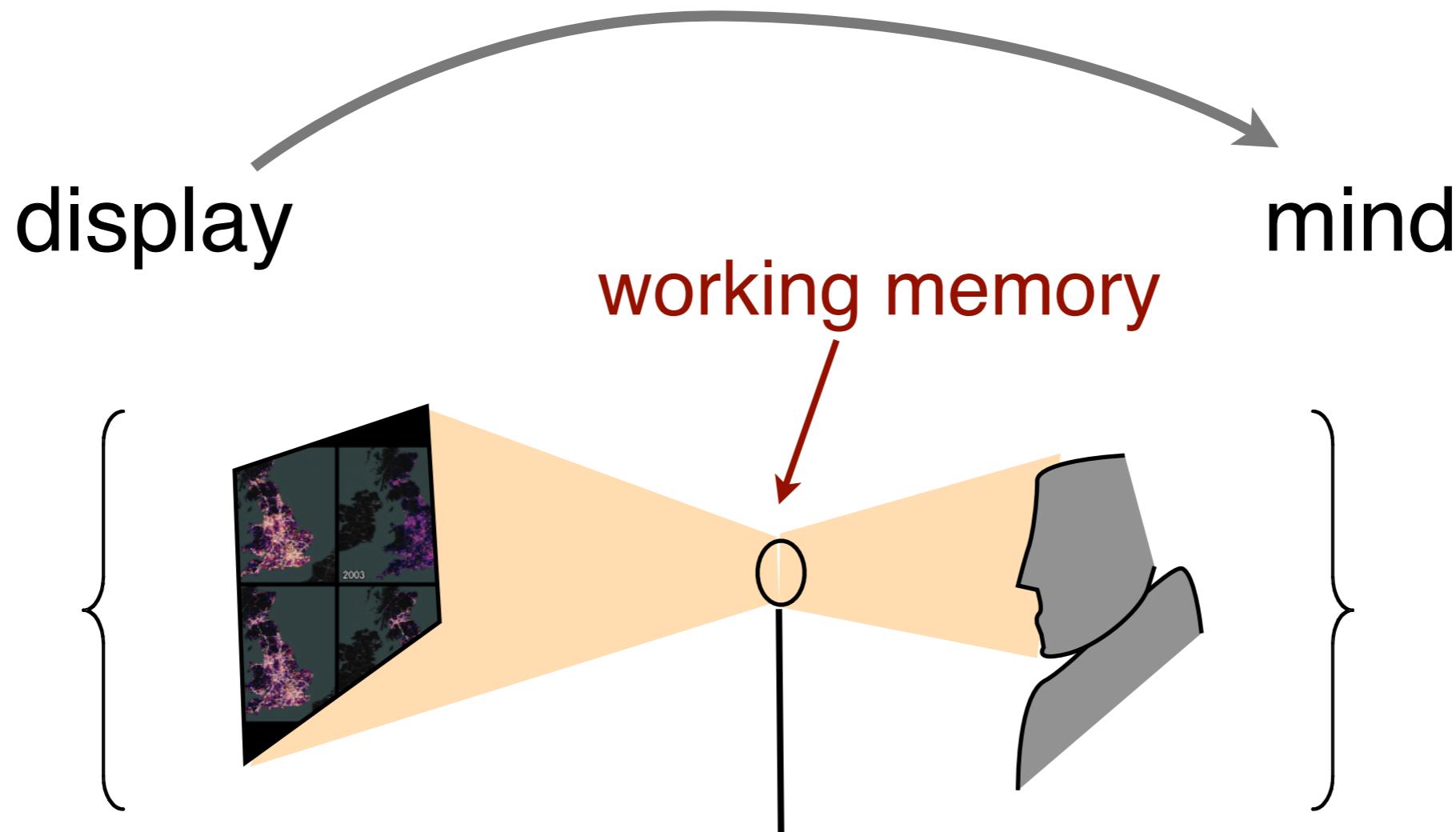
Working memory is very limited



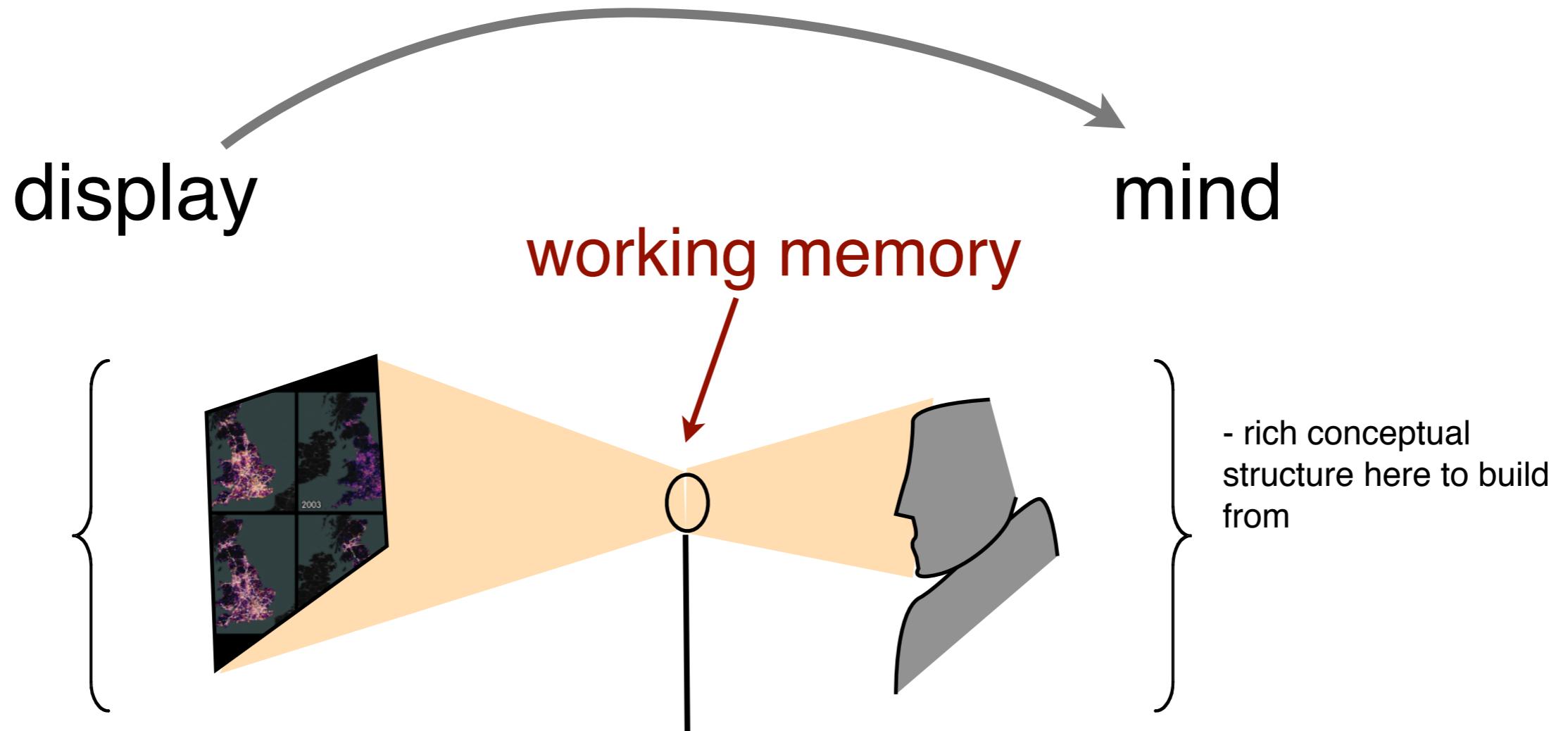
Working memory is very limited



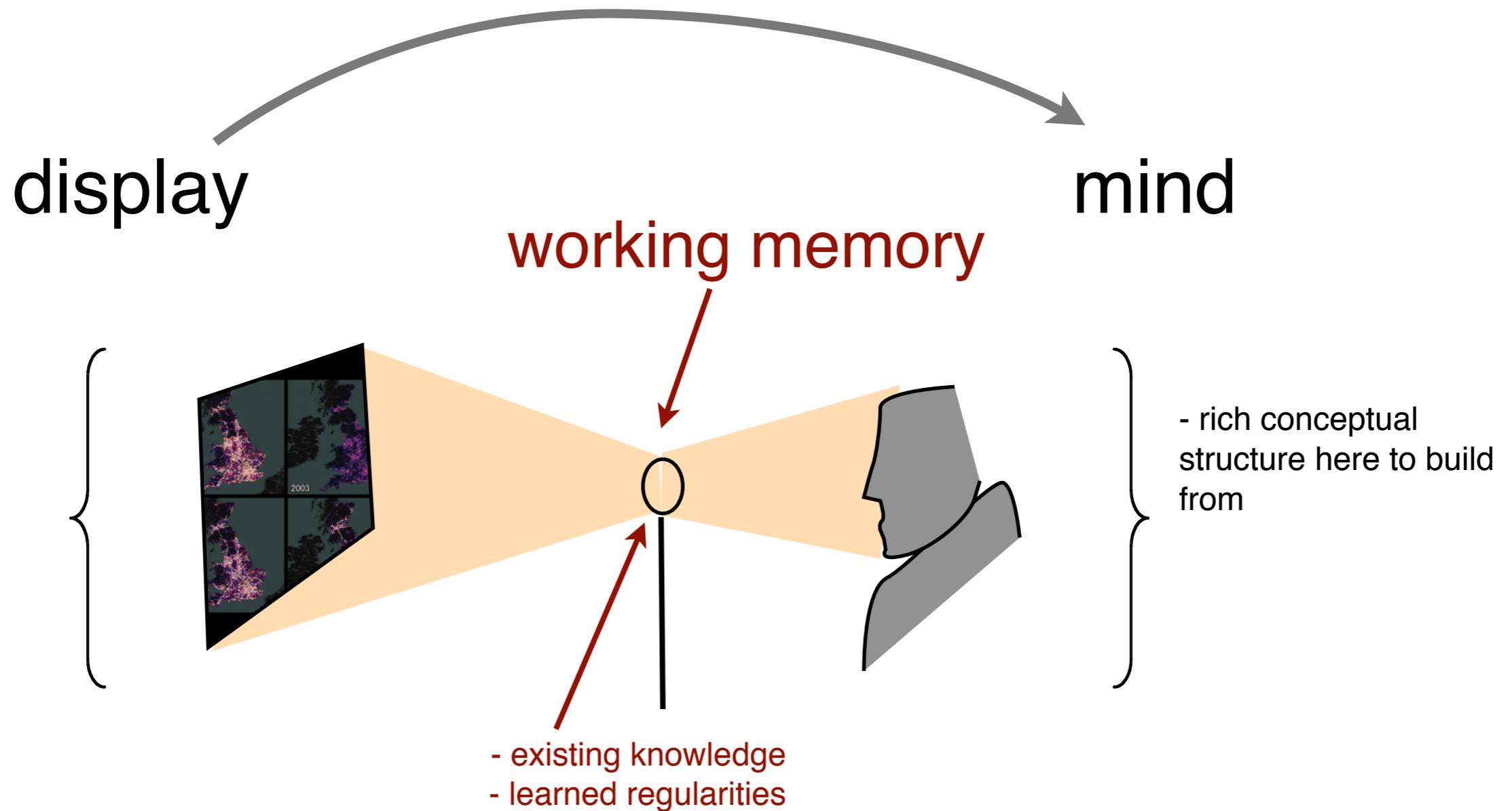
Working memory is very limited



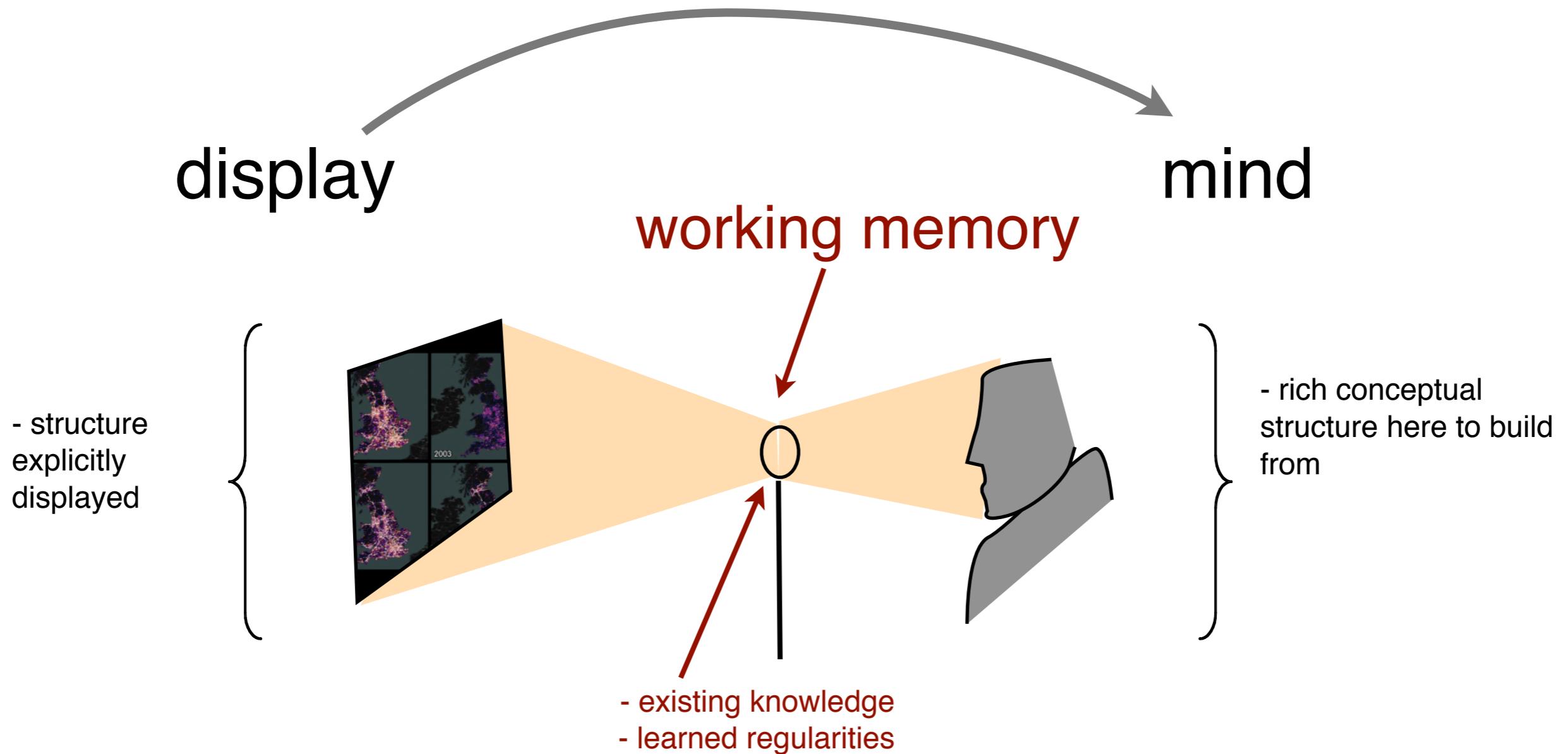
Working memory is very limited



Working memory is very limited



Working memory is very limited



Activity

Remember these letters

x f b i c i a y m i t n b c z

Activity

Remember these letters



“Chunking”

x f b i c i a y m i t n b c z

“Chunking”

x f b i c i a y m i t n b c z

x f b i c i a y m i t n b c z

Application of chunking: 10-digit phone numbers



+1 (917) 746-6951

Un-chunked List

Bread
Ice cream
Milk
Tomatoes
Eggs
Butter
Apples
English muffins
Frozen vegetables
Bagels
Lettuce
Cream
Banana

Un-chunked List

Bread
Ice cream
Milk
Tomatoes
Eggs
Butter
Apples
English muffins
Frozen vegetables
Bagels
Lettuce
Cream
Banana

Chunked List

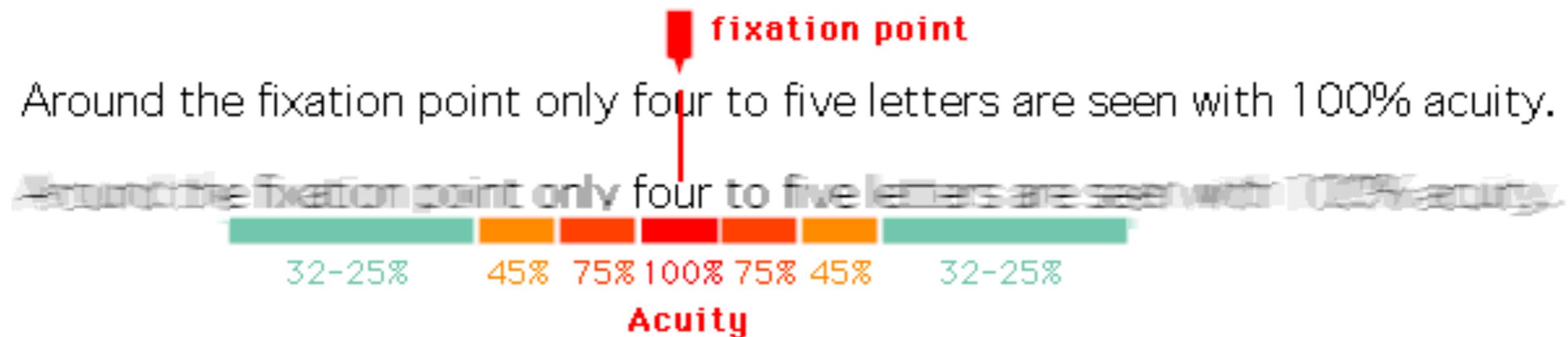
Frozen foods
Ice cream
Frozen peas

Diary
Milk
Eggs
Cream
Butter

Bakery
English muffins
Bread
Bagels

Fruits and Vegetables
Lettuce
Banana
Tomatoes
Apples

reading is saccadic movement from chunk to chunk



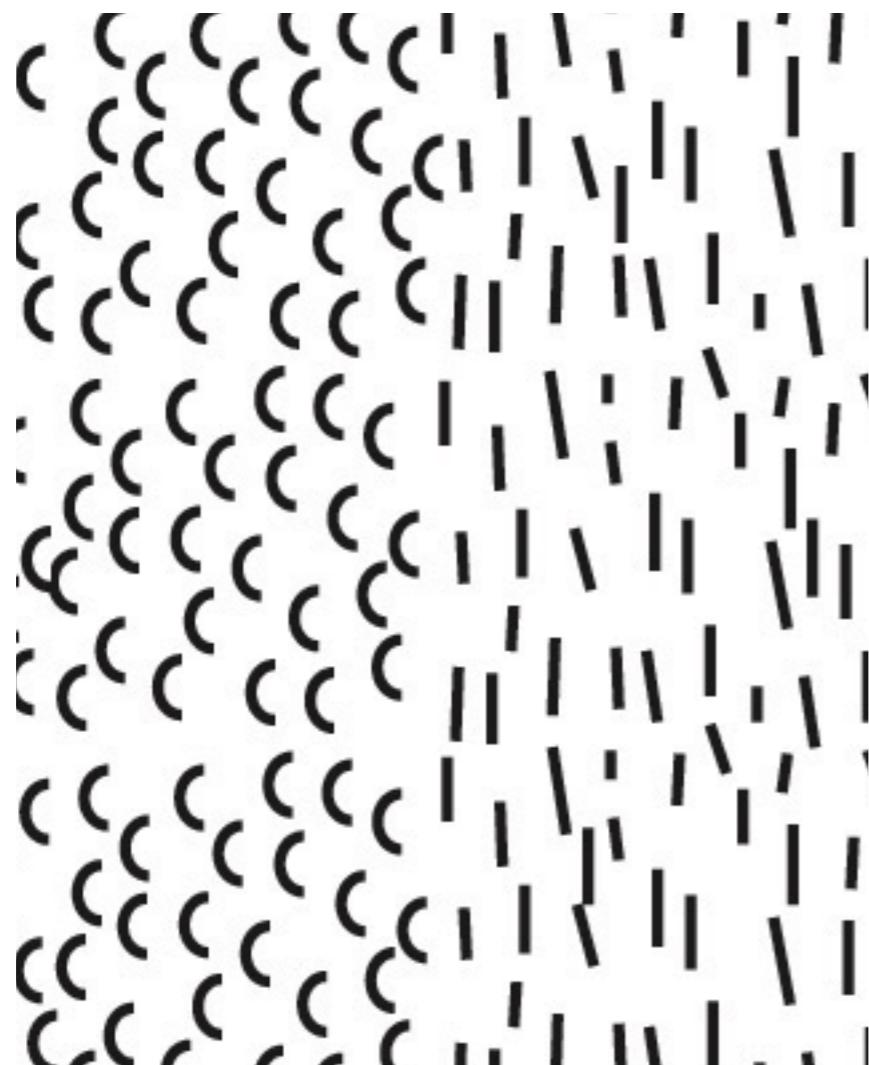
Hierarchical Design

CS

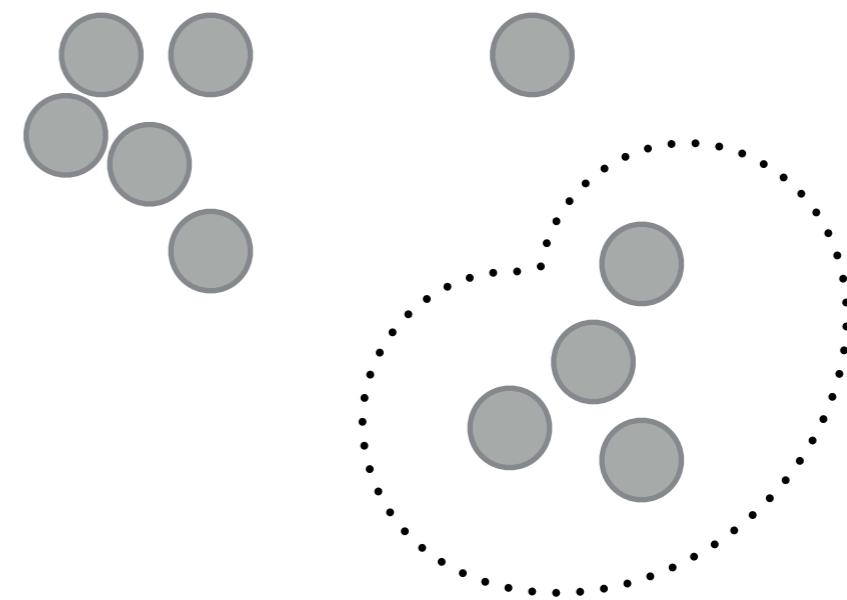
171



Multiple Objects



Textures



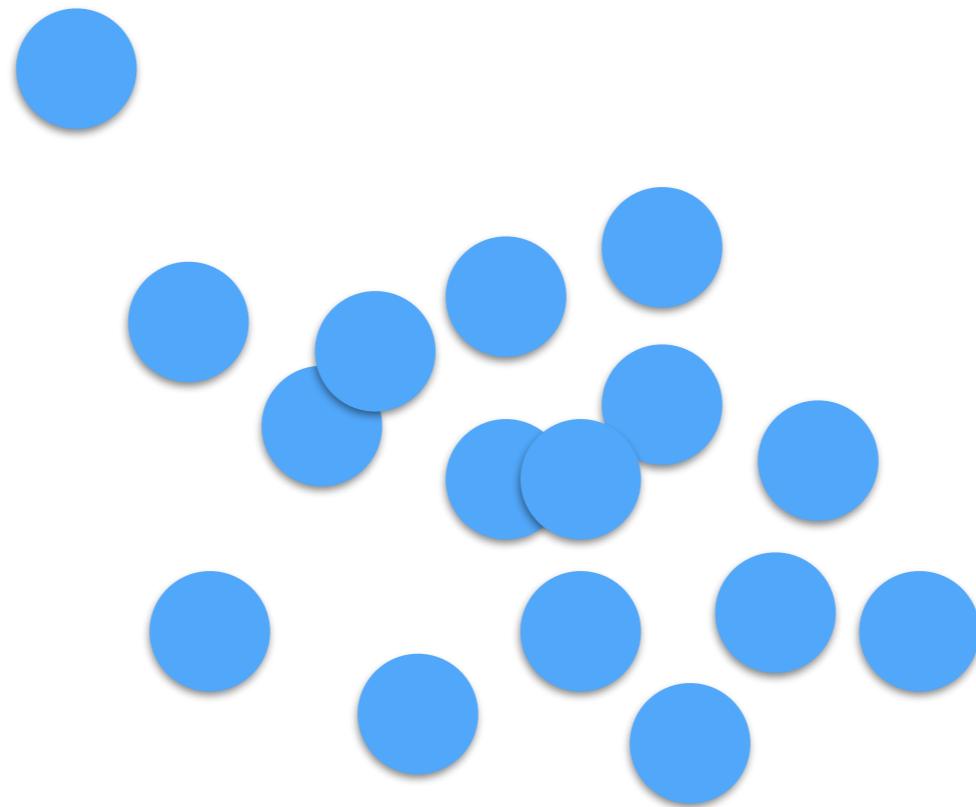
Layout

Activity

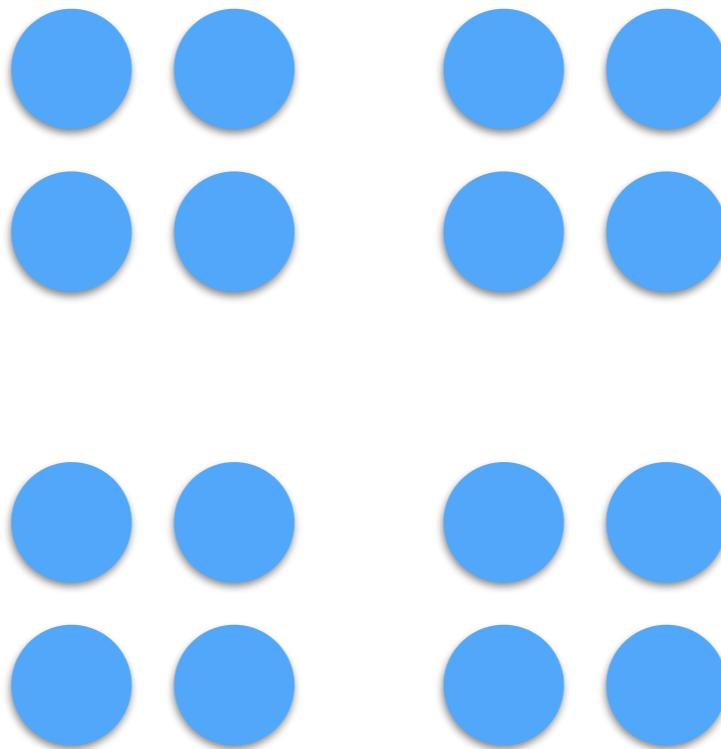
count the dots and shout as soon as you have the correct number



How many dots ?

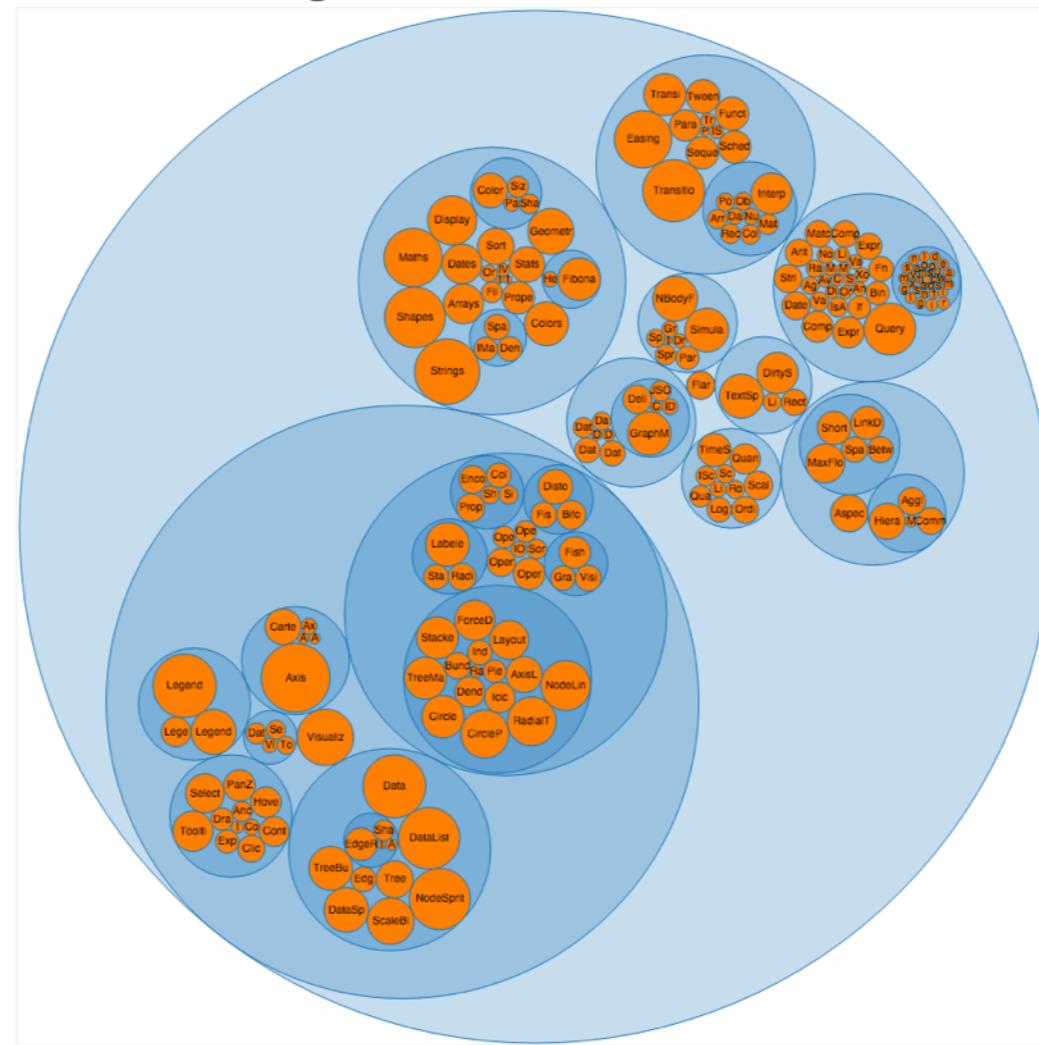


How many dots?



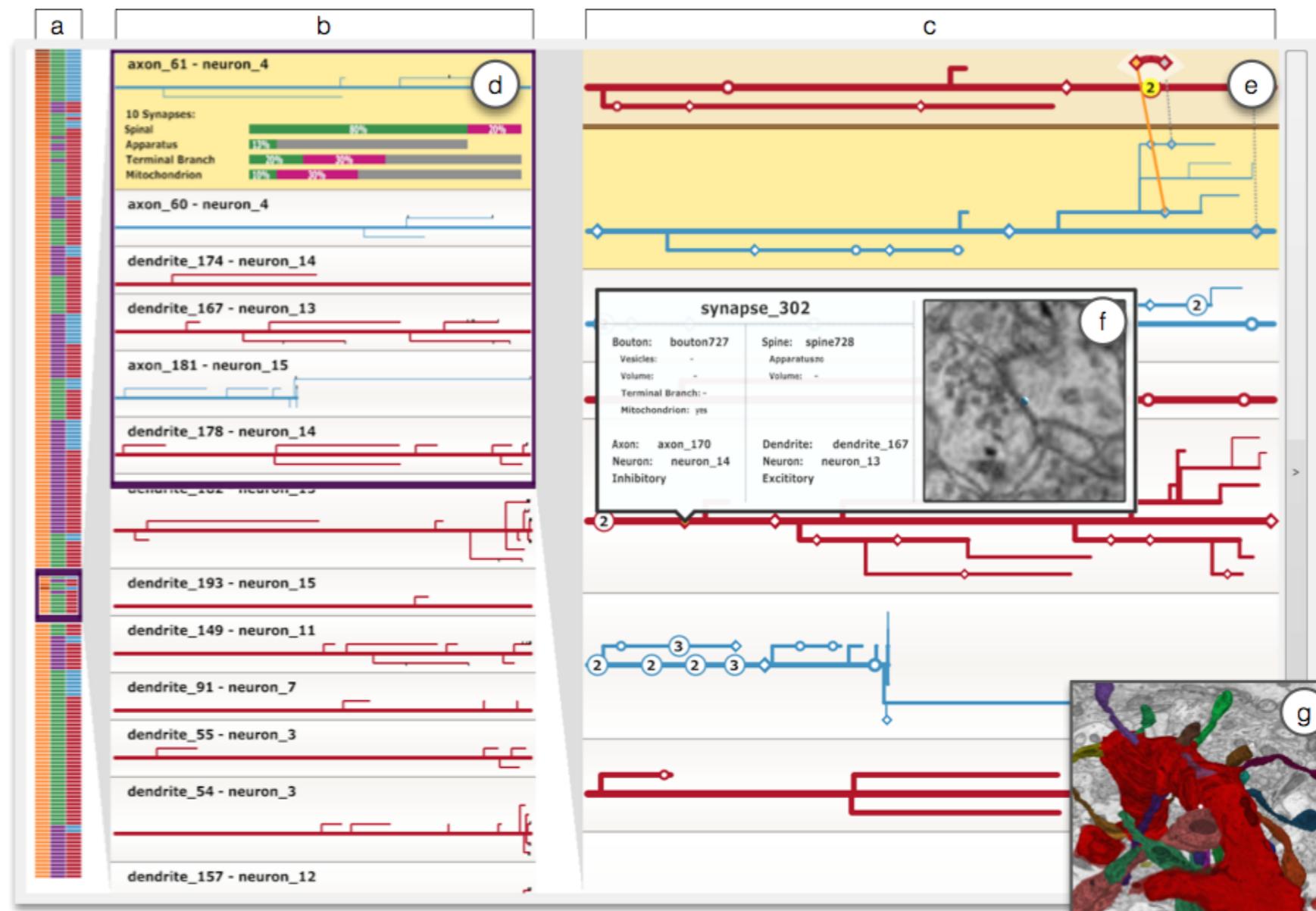
Hierarchical Design

Circle Packing



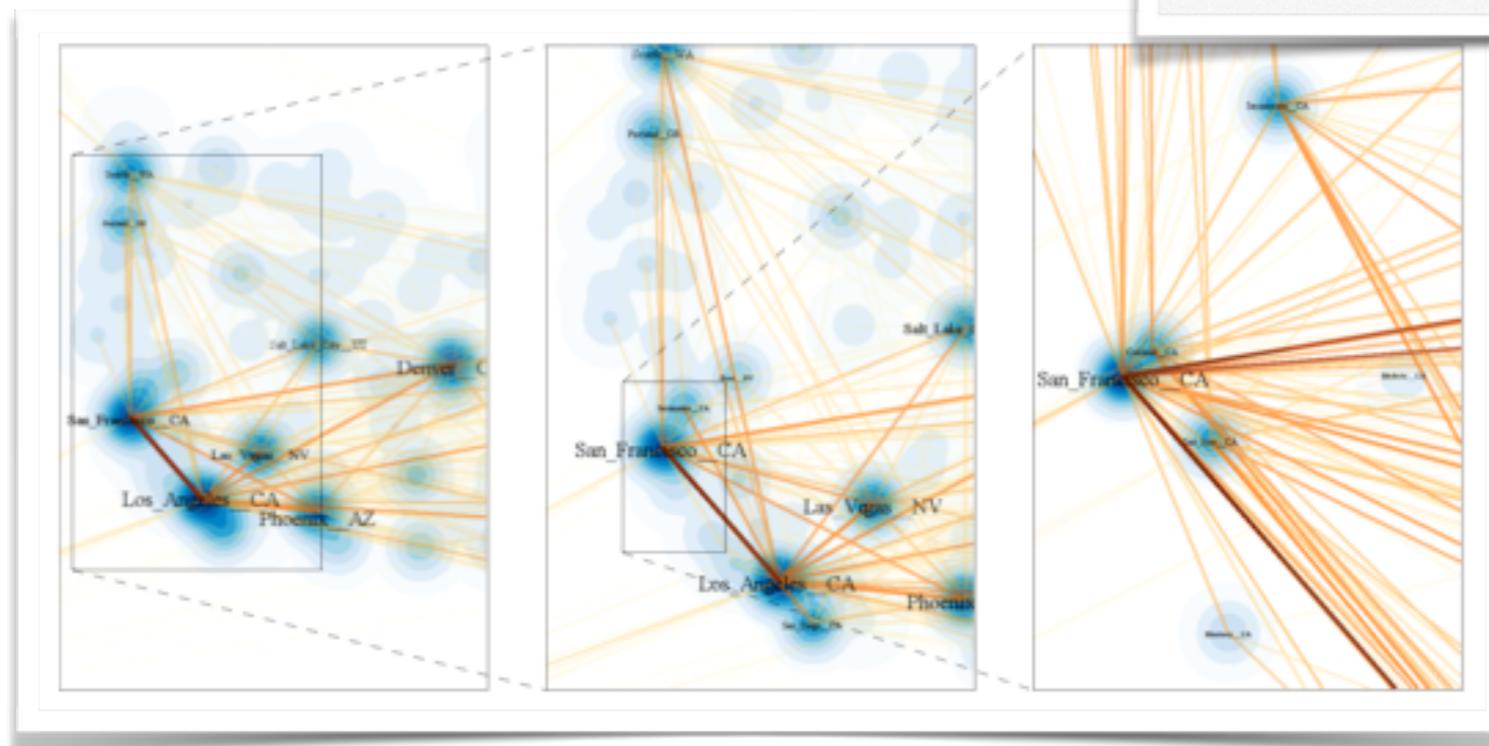
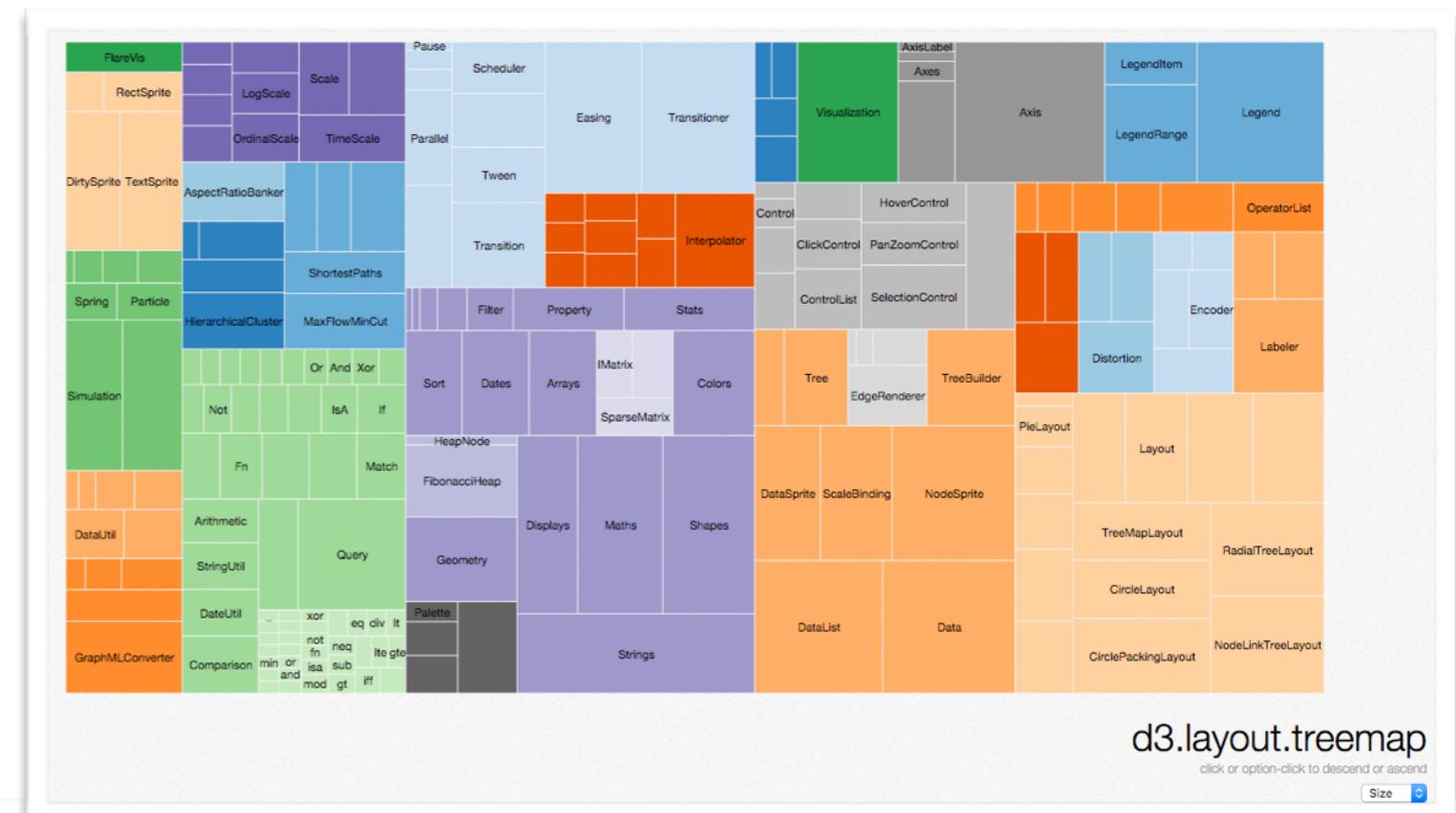
<http://bl.ocks.org/mbostock/4063530>

Hierarchical Design



Hierarchical Interactive Design

Interactive Treemap



<http://mbostock.github.io/d3/talk/20111018/treemap.html>

Level of Detail

Gestalt Principles

CS

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based on . . .

Untersuchungen zur Lehre von der Gestalt.

II.

Von

Max Wertheimer.

Mit 56 Abbildungen im Text.

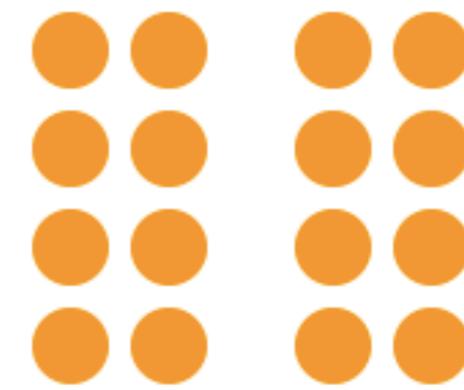
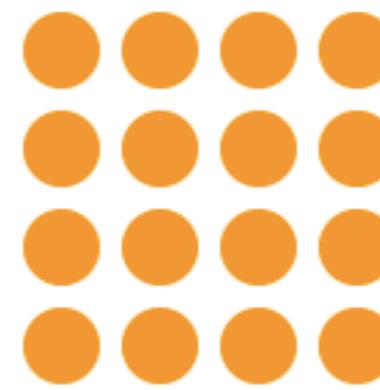
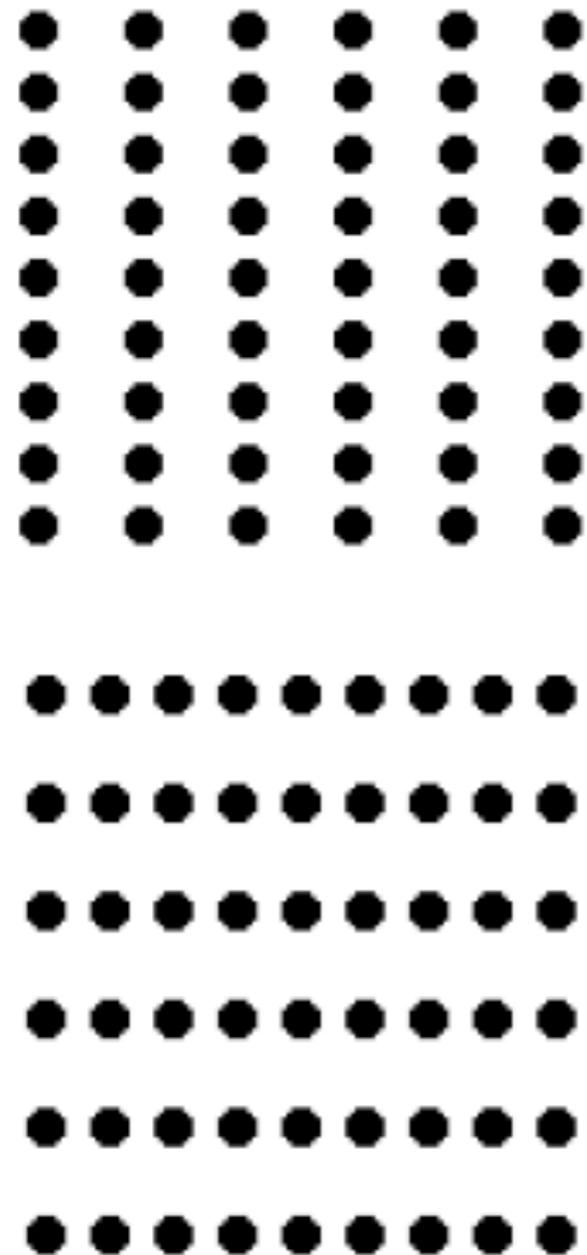
Ich stehe am Fenster und sehe ein Haus, Bäume, Himmel.

Und könnte nun, aus theoretischen Gründen, abzuzählen versuchen
und sagen: da sind . . . 327 Helligkeiten (und Farbtöne).

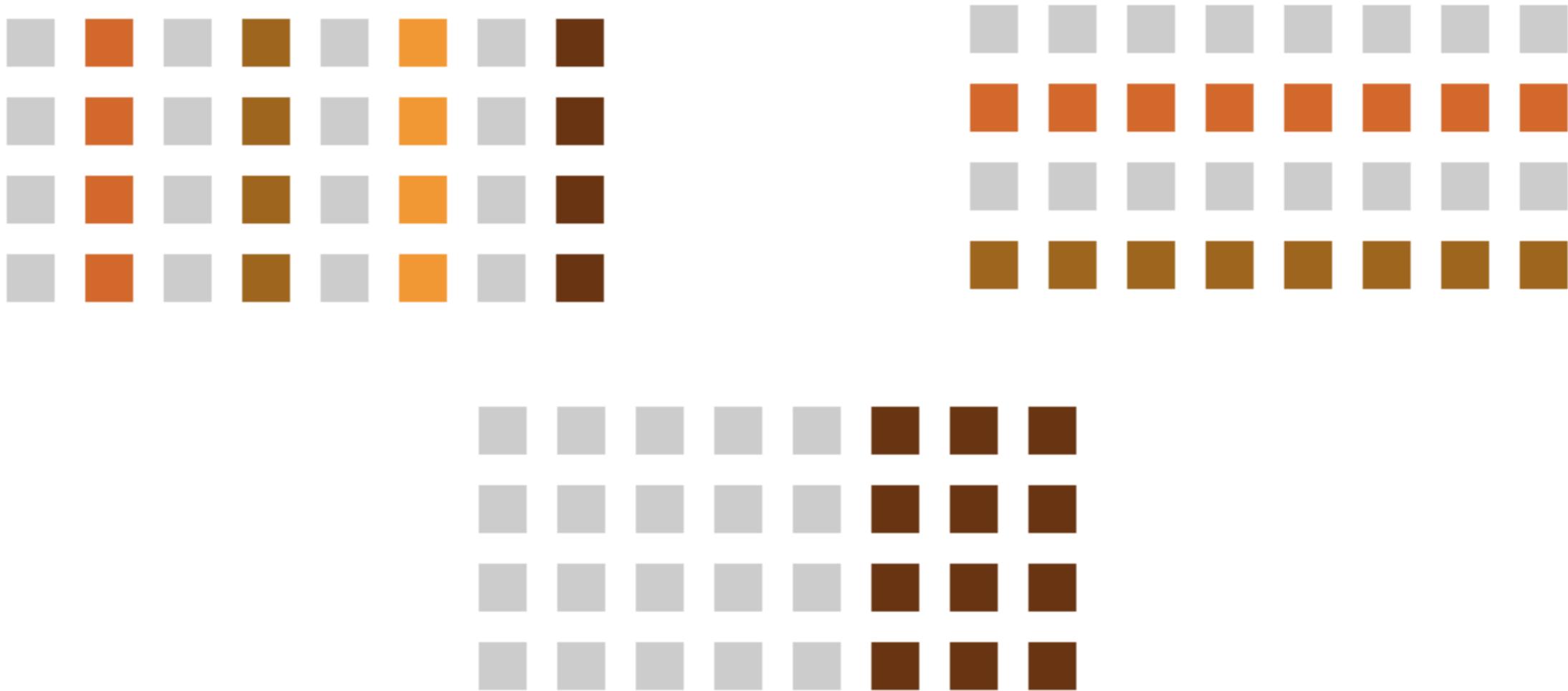
(Habe ich „327“? Nein; Himmel, Haus, Bäume; und das Haben der
„327“ als solcher kann keiner realisieren.)

1923

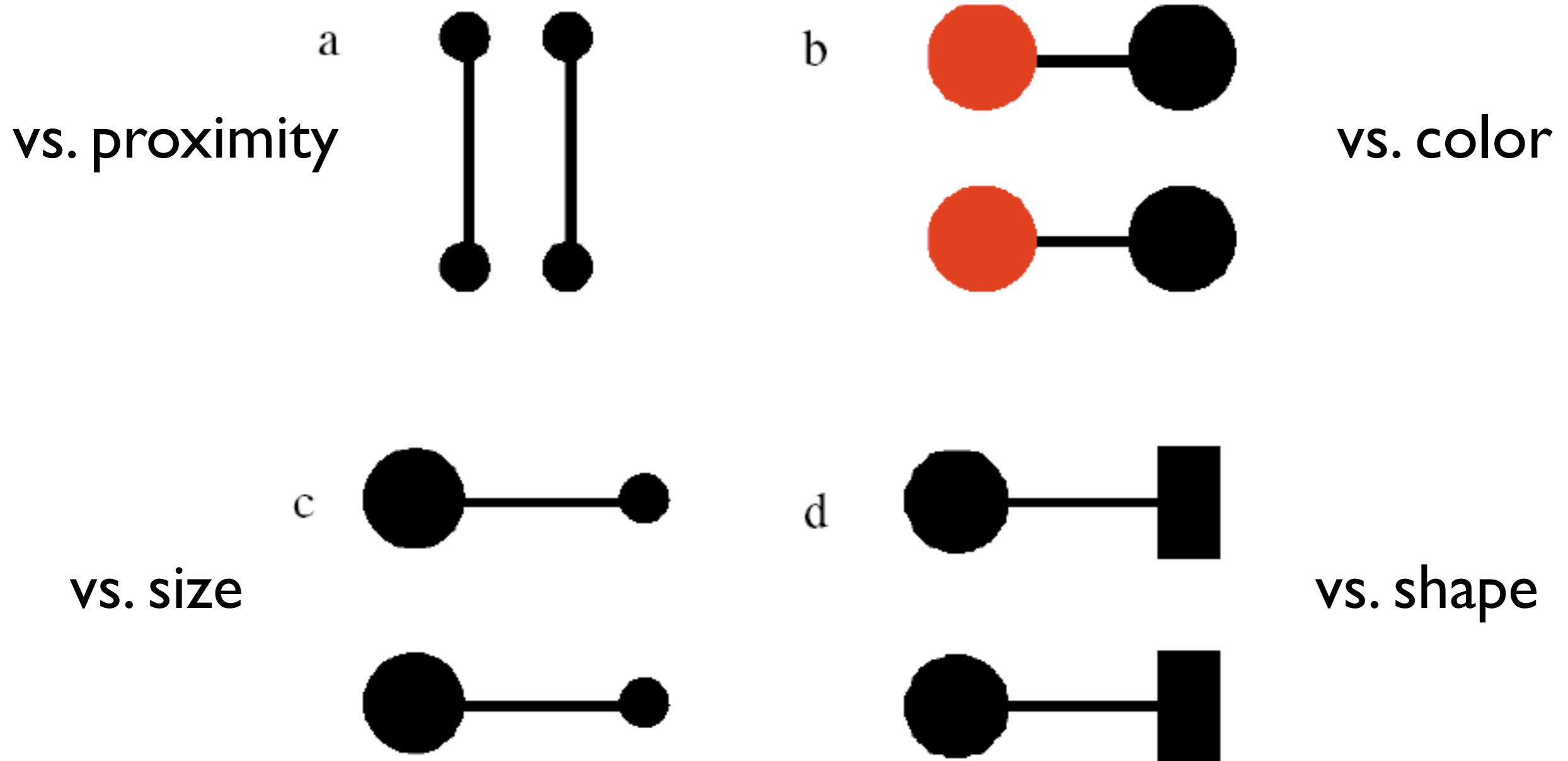
Proximity



Similarity



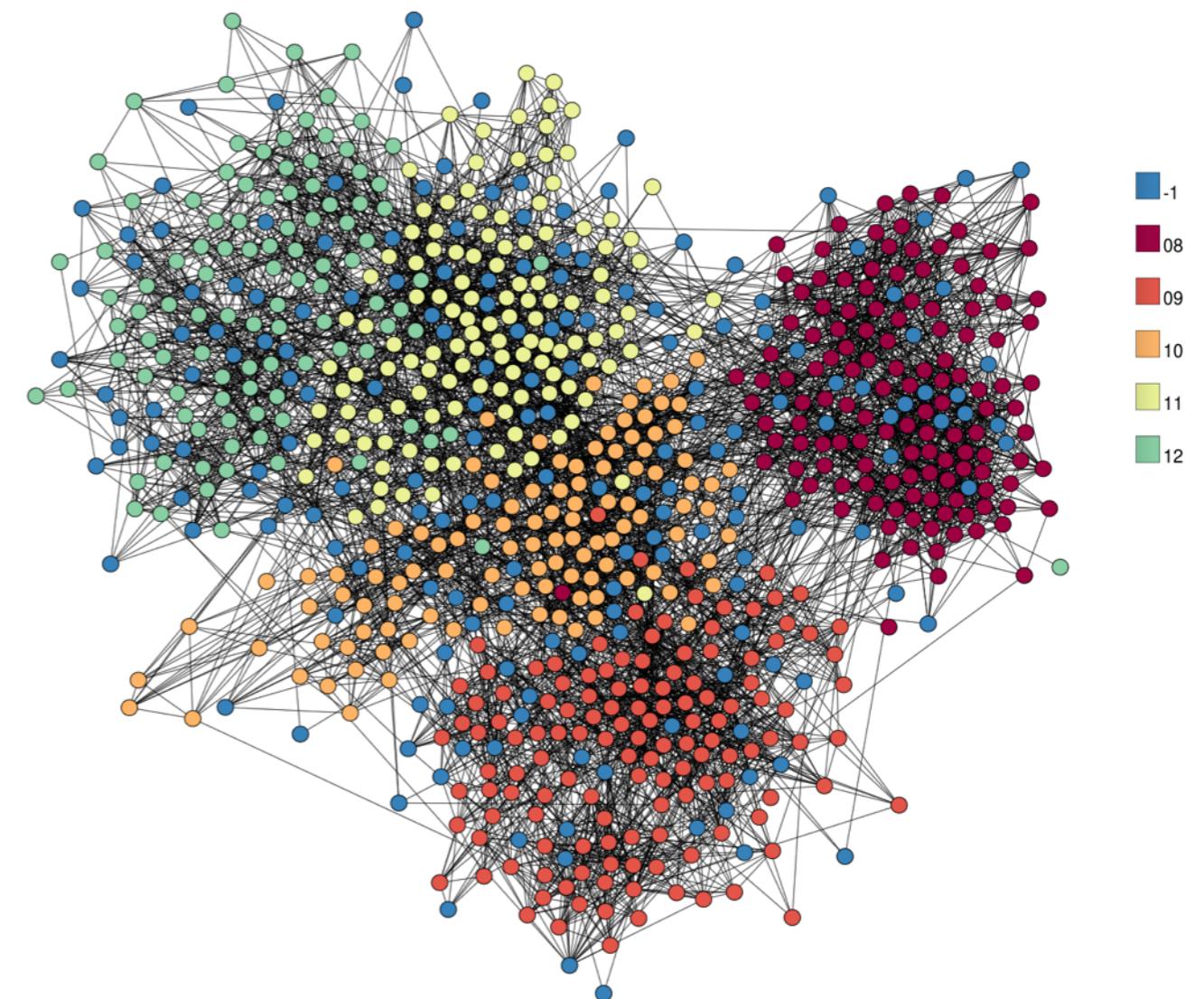
Connection



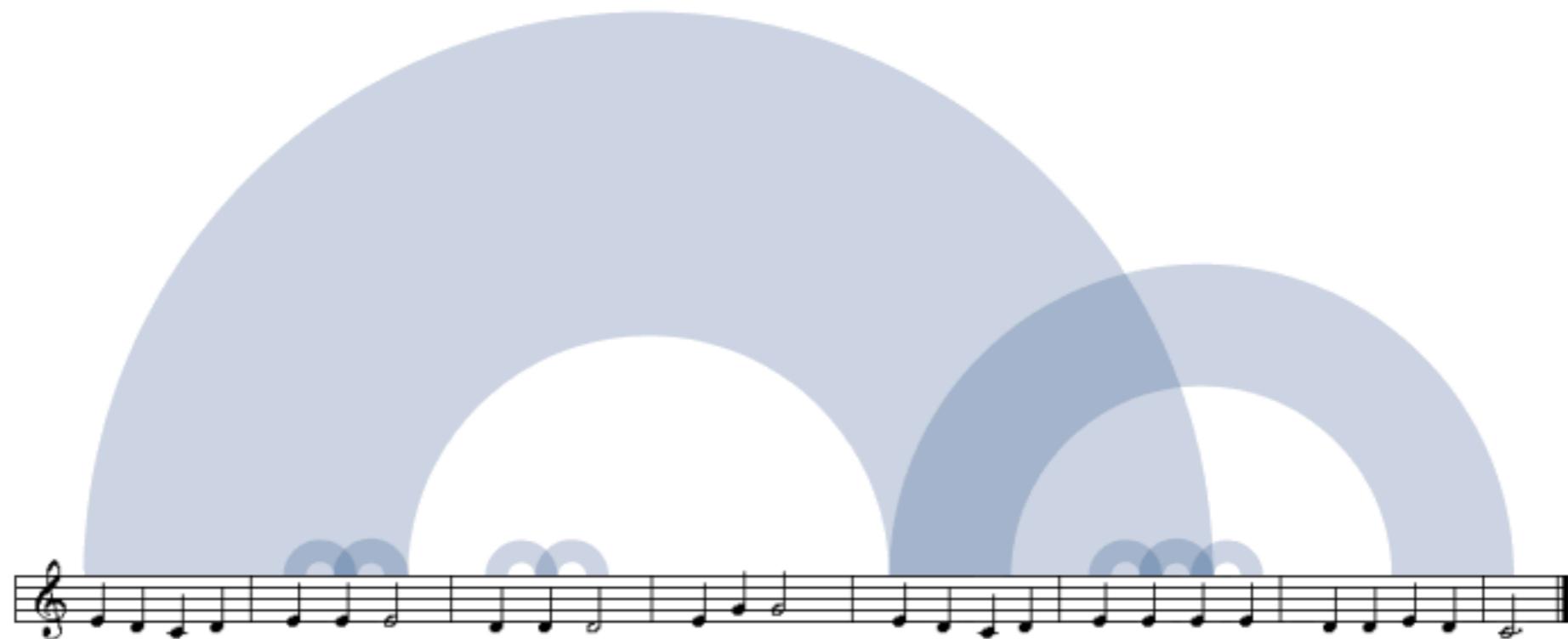
Connection in Vis



Connection in Vis

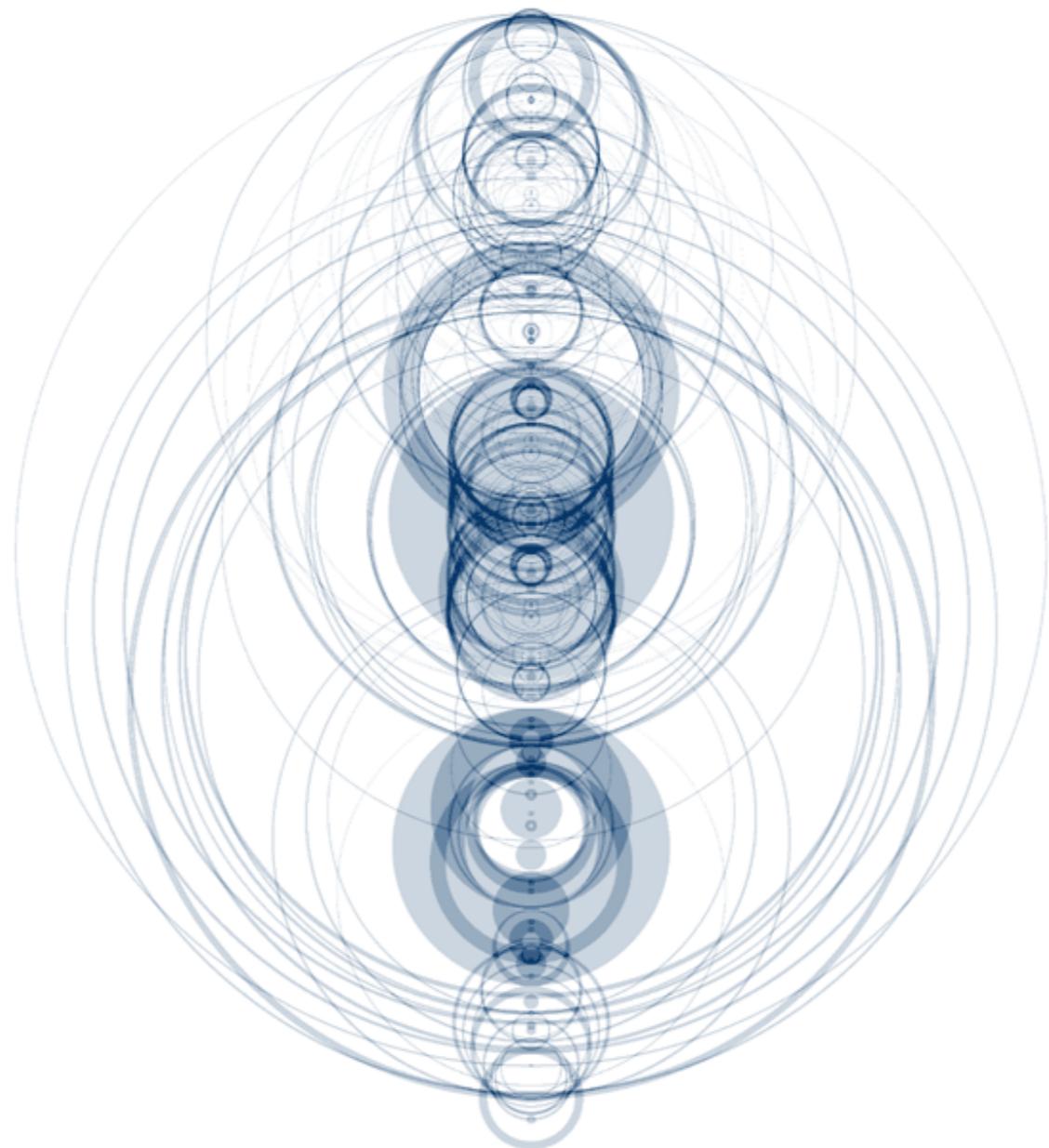


Shape of Music

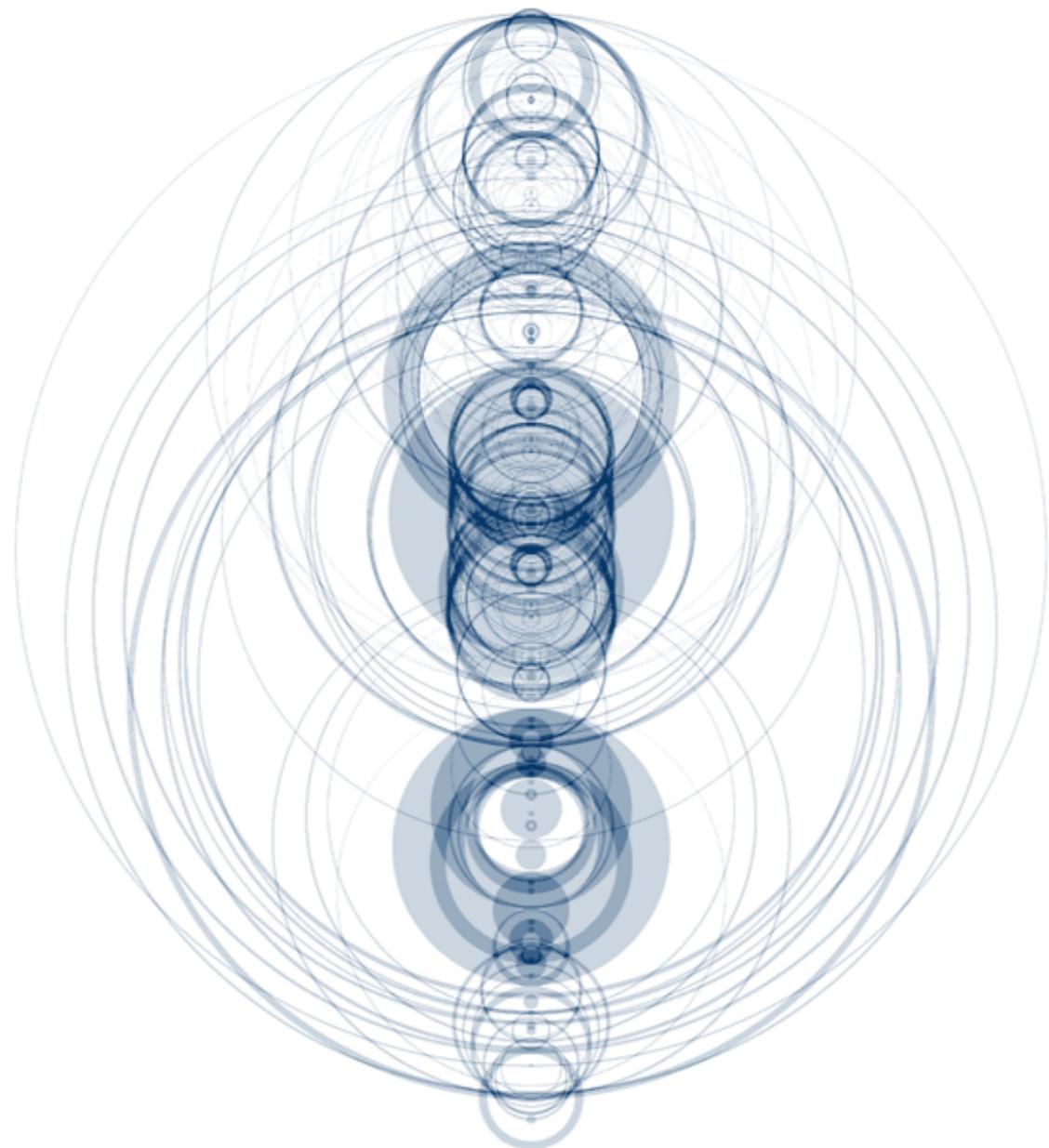


Mary Had a Little Lamb.

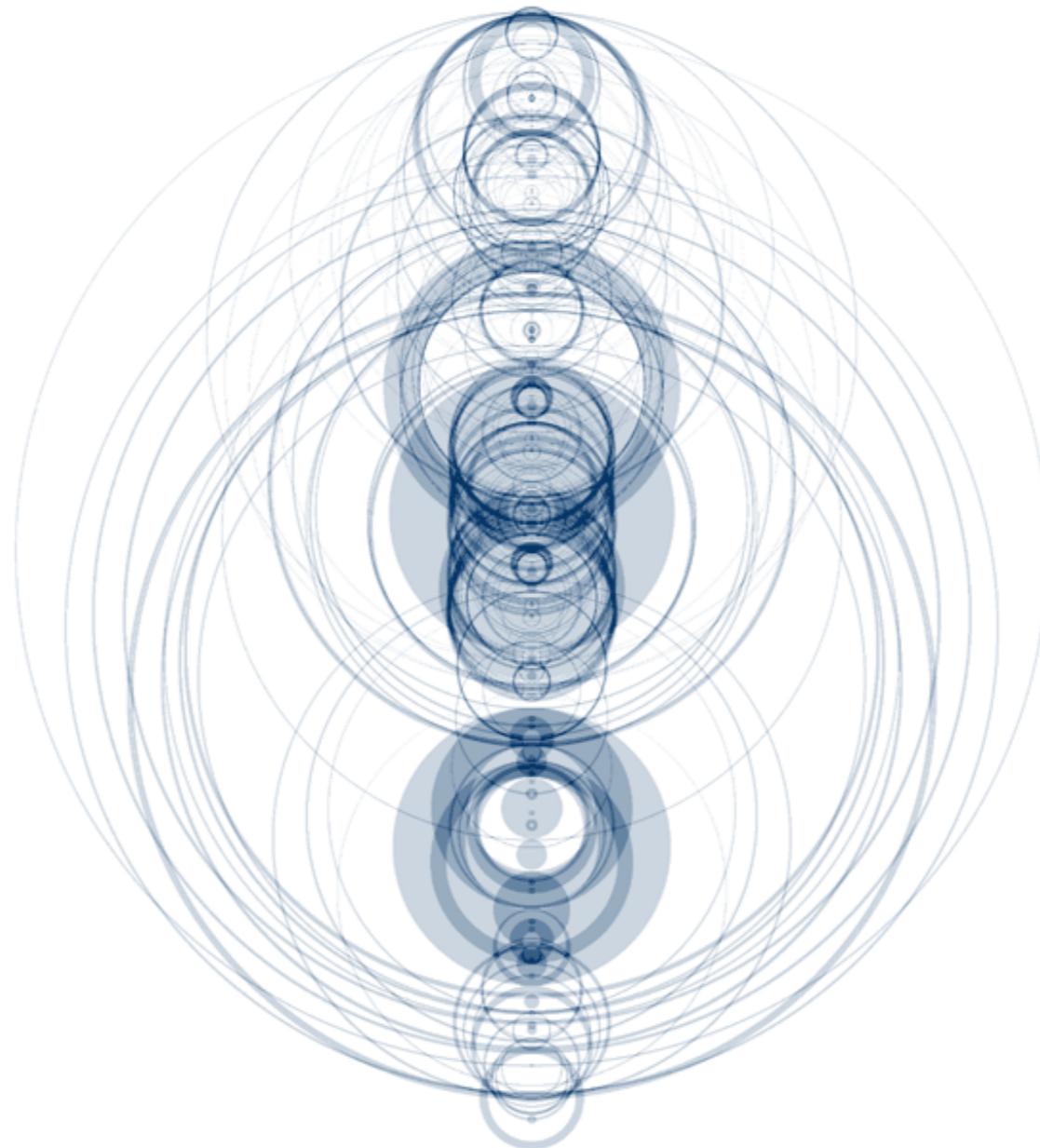
Shape of Music



Shape of Music



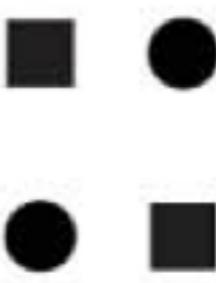
Shape of Music



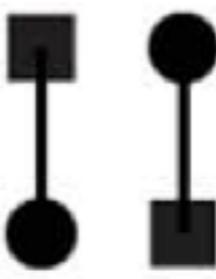
Moonlight Sonata / Beethoven

Enclosure

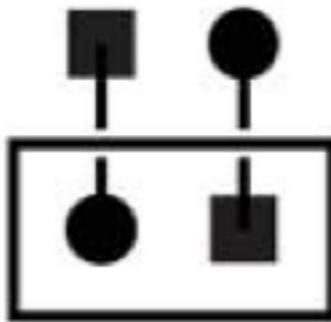
Similarity



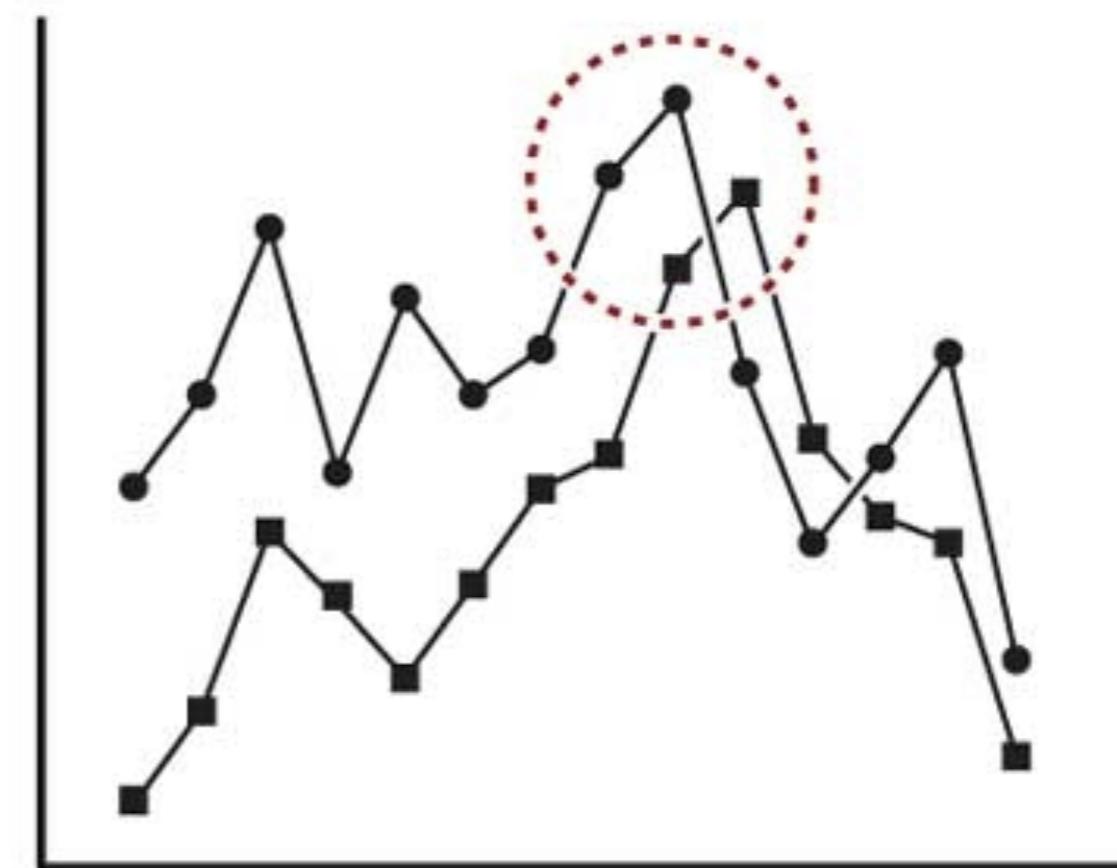
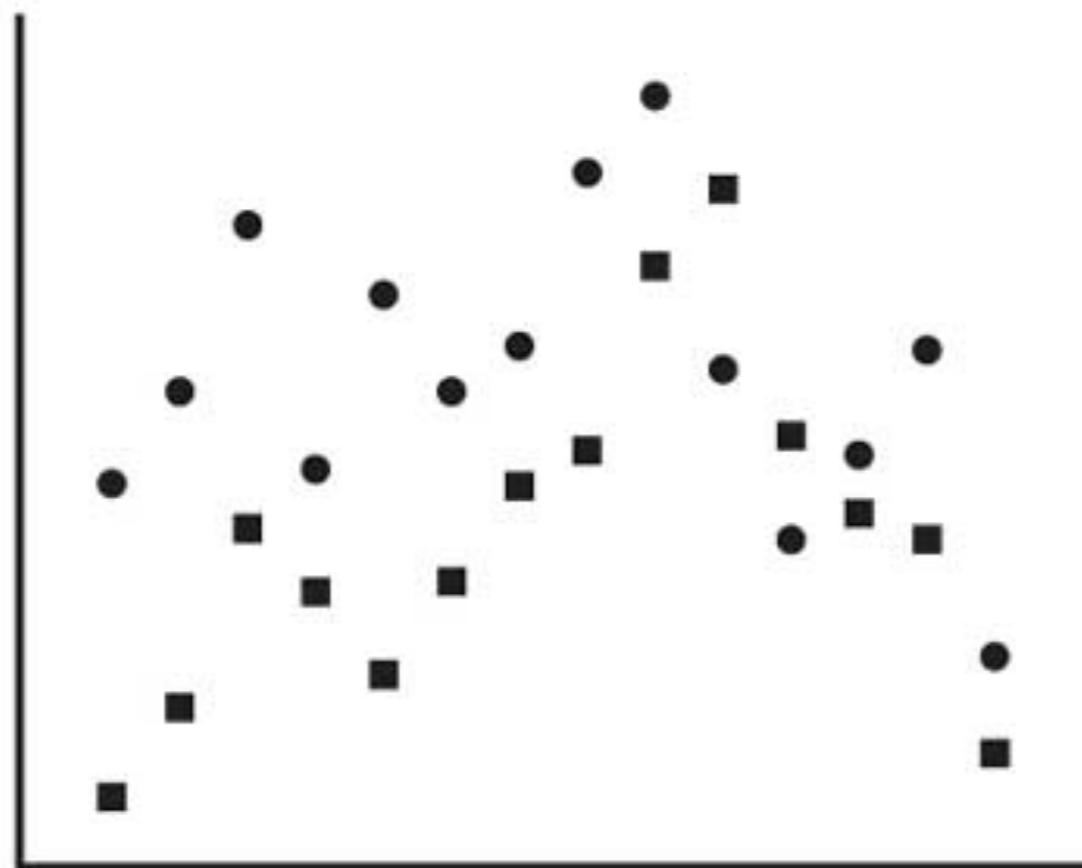
Connection



Enclosure



Enclosure

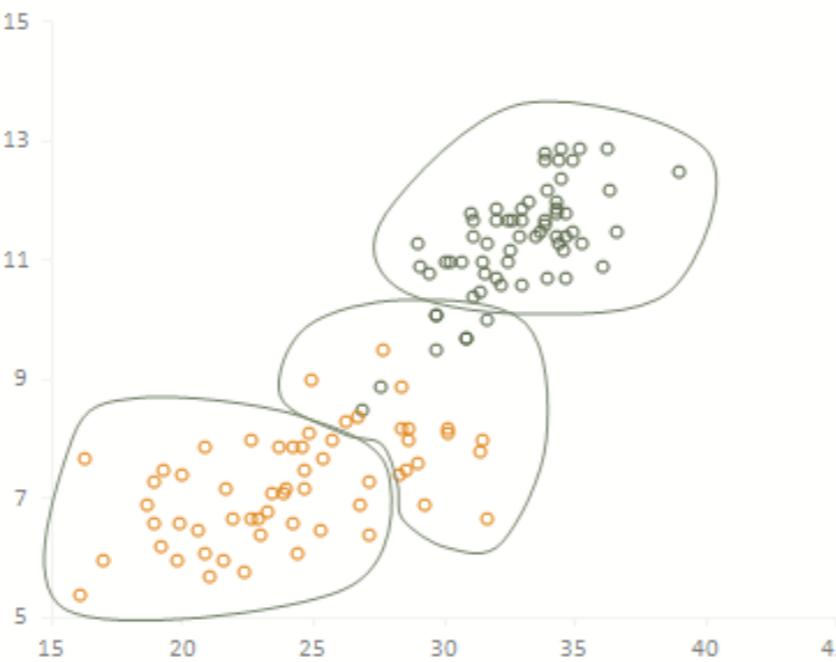
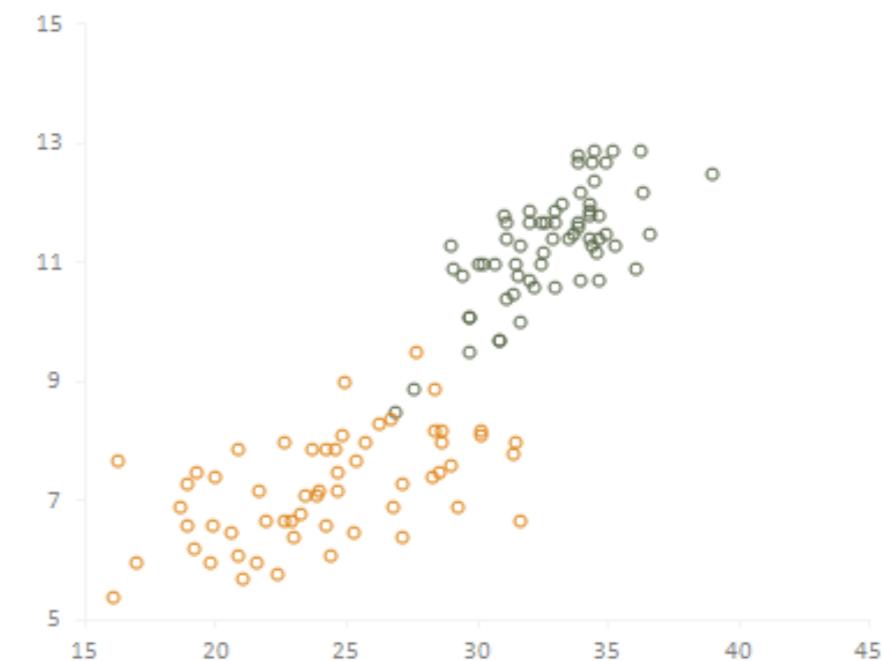
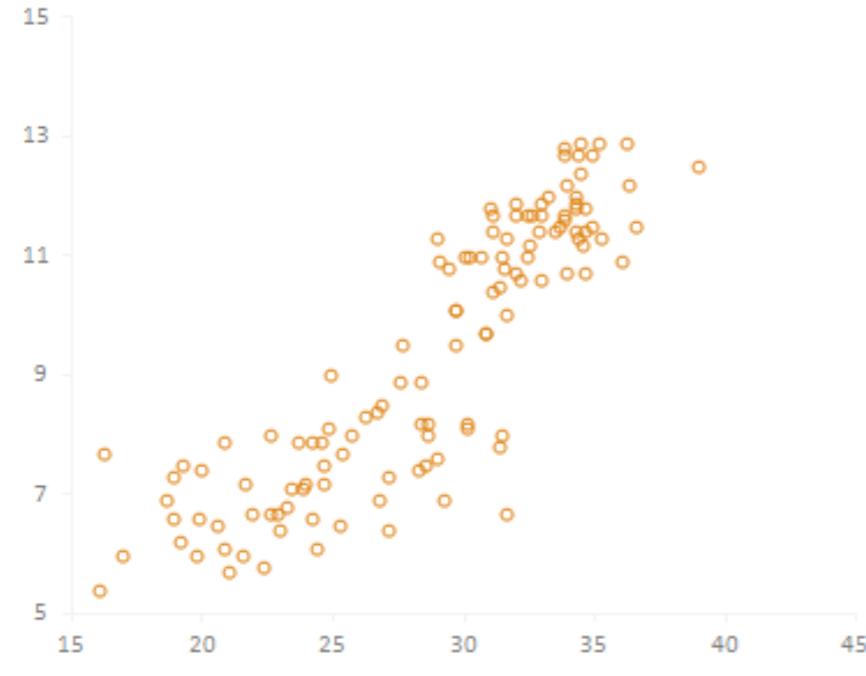


Activity

Which one is at work ?...

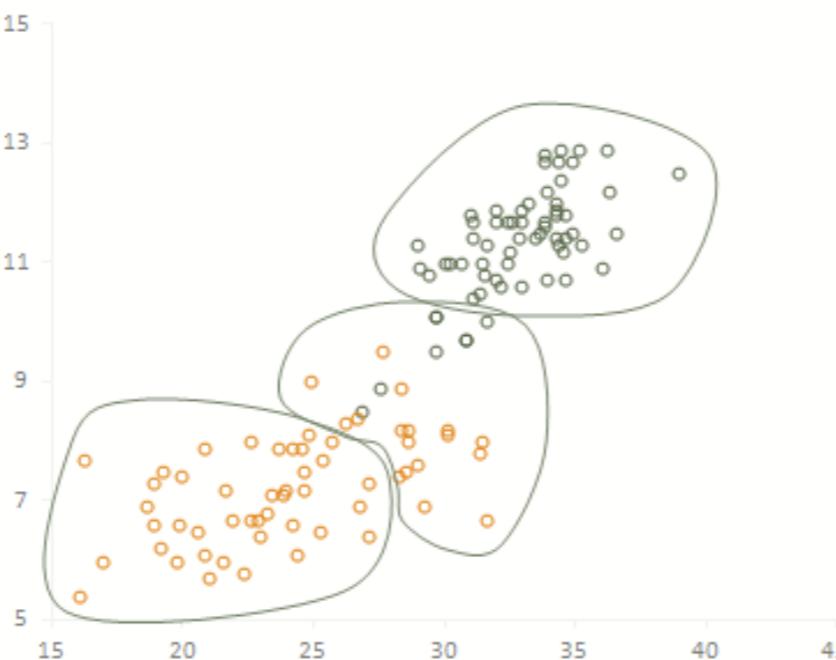
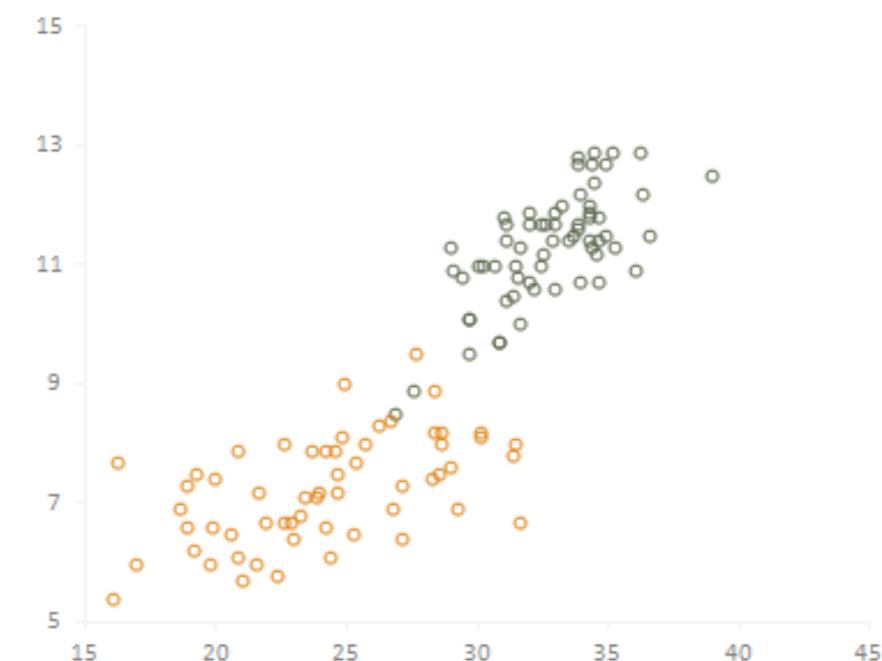
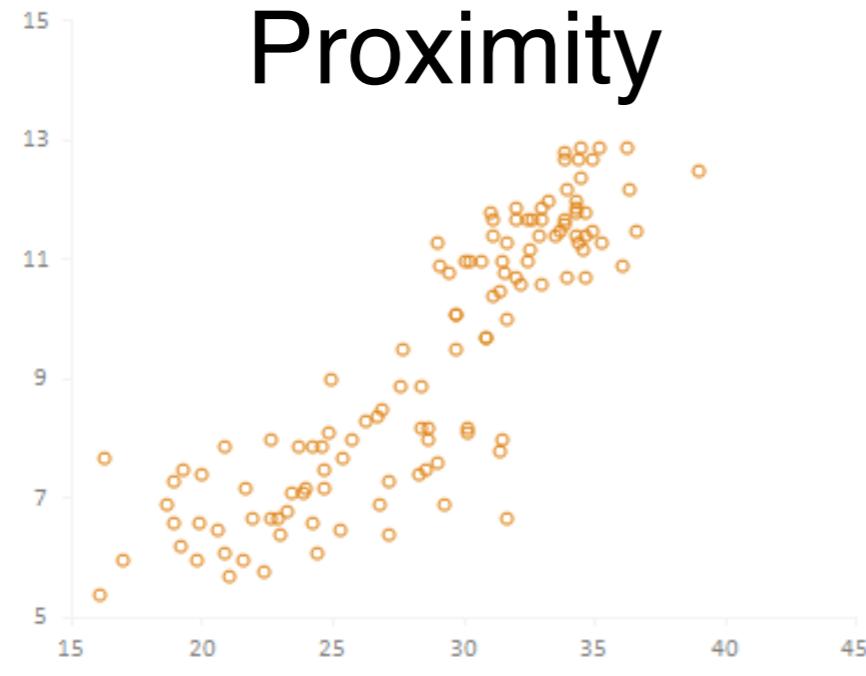


Grouping



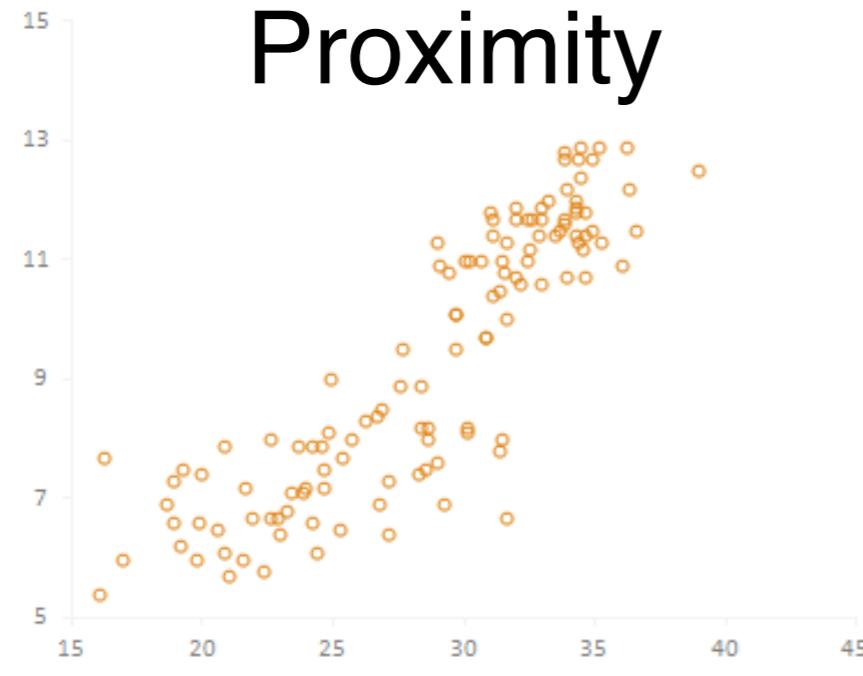
Grouping

Proximity

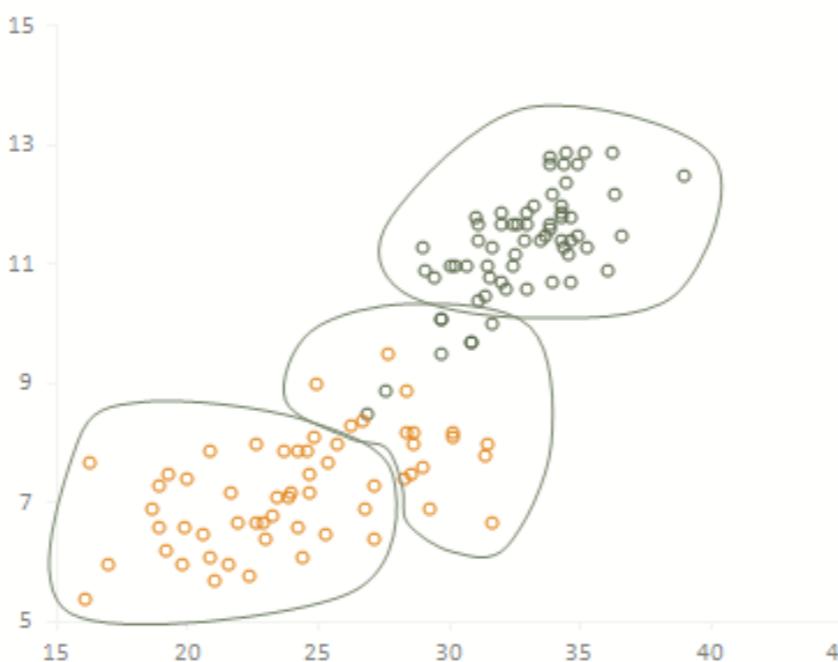
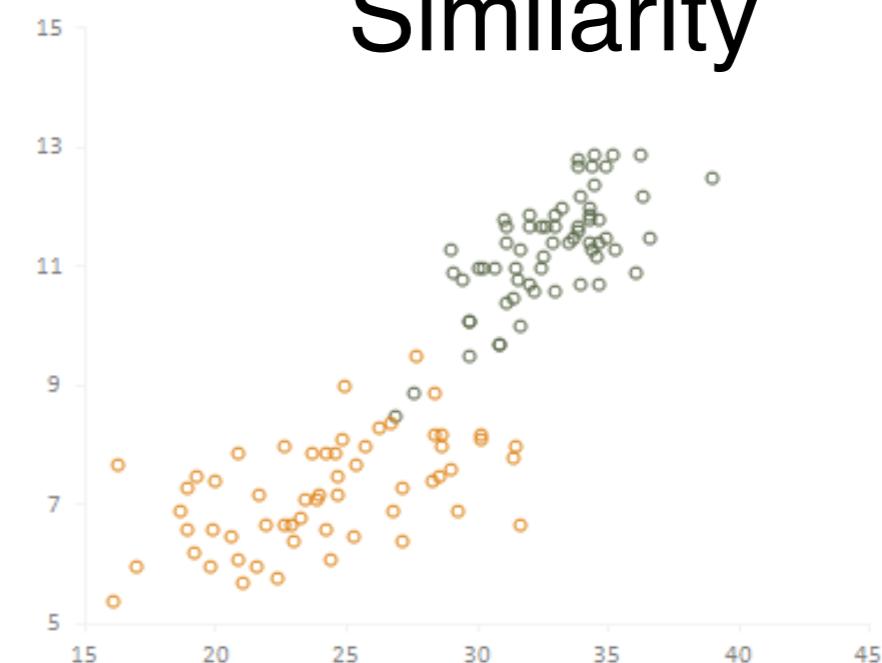


Grouping

Proximity

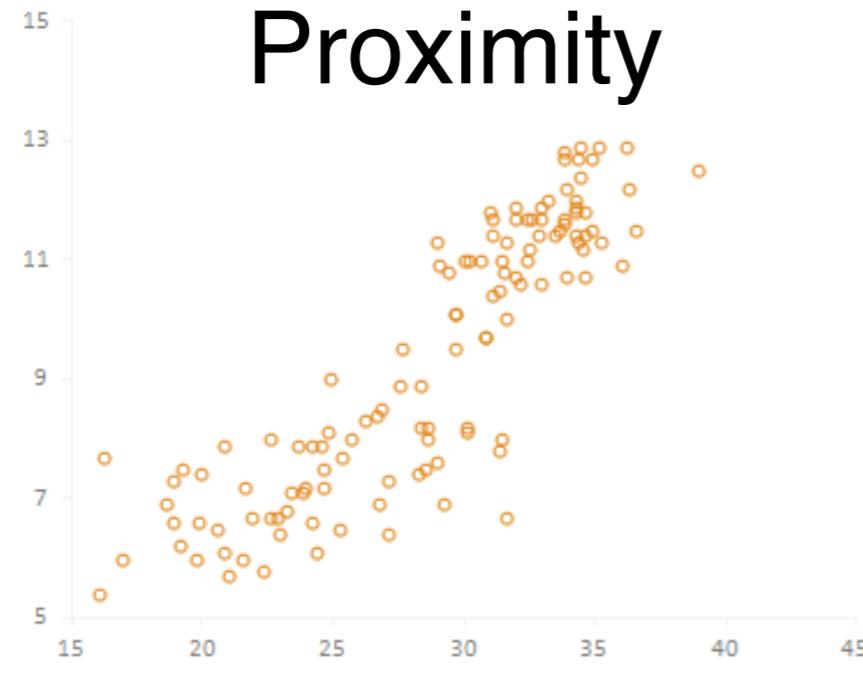


Similarity

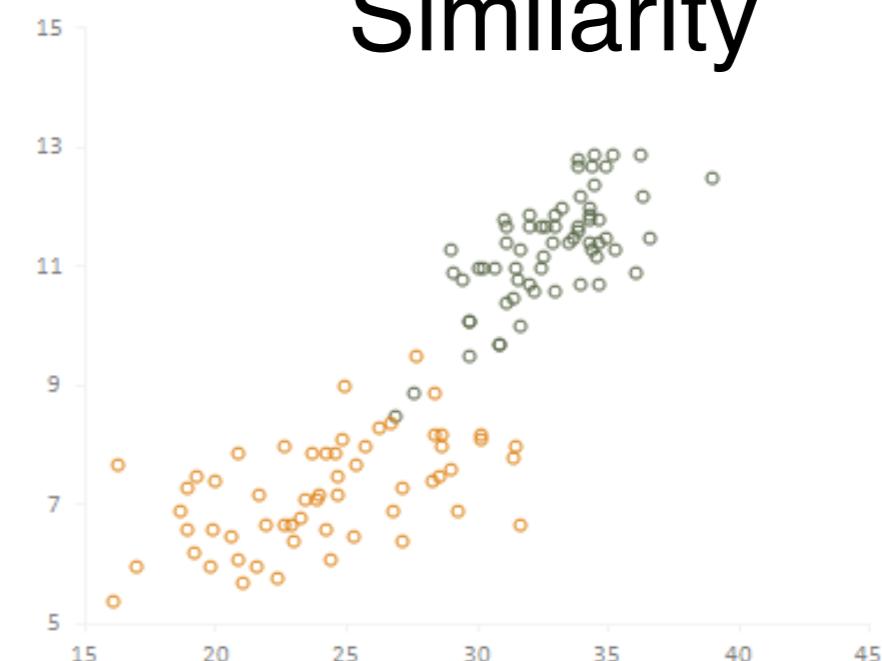


Grouping

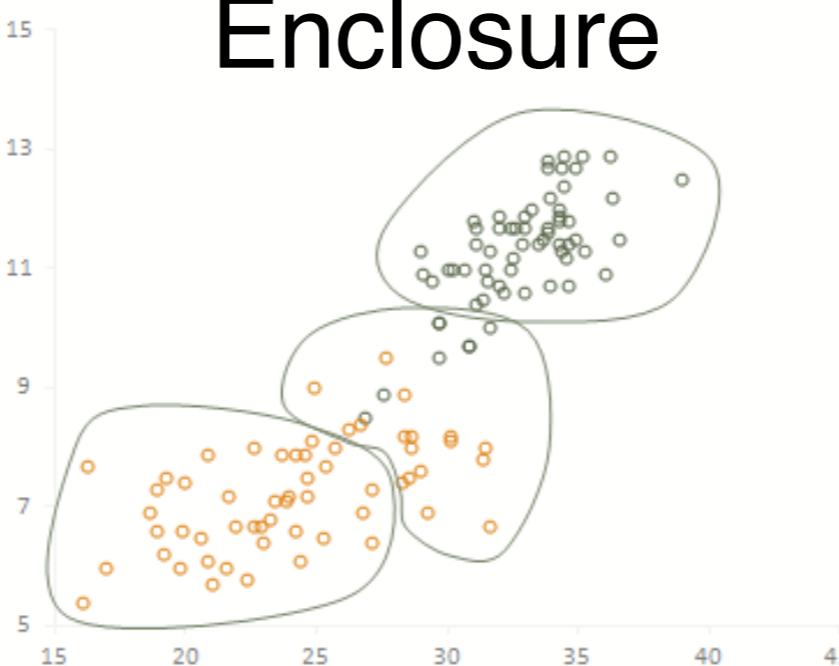
Proximity



Similarity



Enclosure



Attention & Change Blindness

CS
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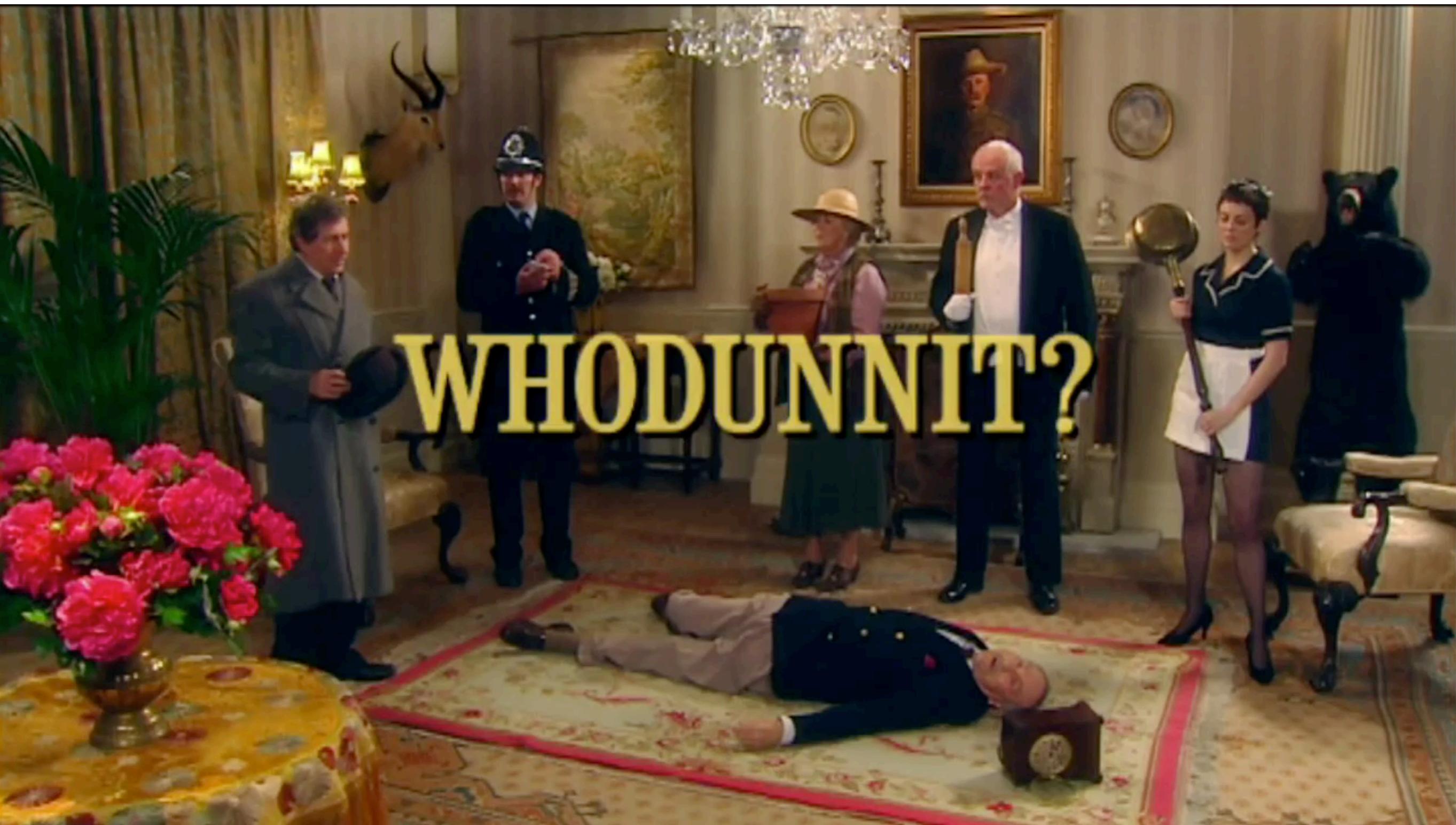


Activity

- This example requires sustained attention and concentration
- 3 players in white and 3 players in black passing a different basketball to each other
- Count the total number of times people wearing white are passing the ball
- Do not count passes by the players in black







WHODUNNIT?



WHODUNNIT?

Activity

Notice Anything Changing?



Activity

Notice Anything Changing?



Get Ready!









Activity

Let's make that easier.

Raise your hand when you see the change





Ron Rensink 2002



Ron Rensink 2002



Rensink 2002,
<http://www.psych.ubc.ca/%7erensink/flickr/download/index.html>



Rensink 2002,
<http://www.psych.ubc.ca/%7erensink/flickr/download/index.html>

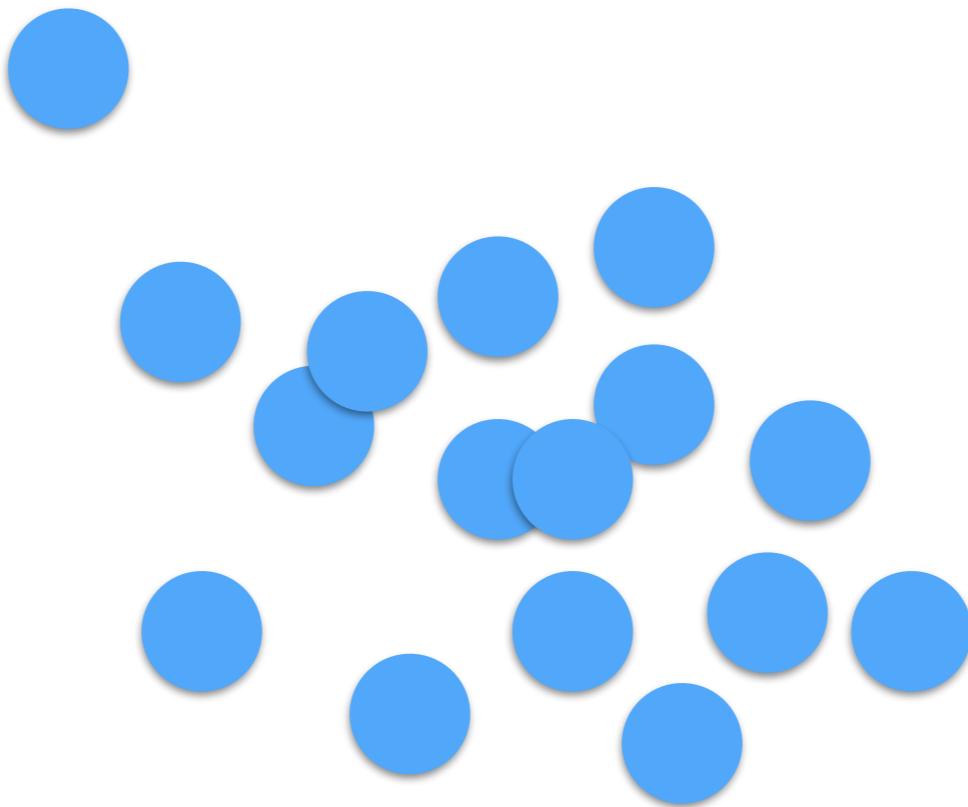


Rensink 2002,
<http://www.psych.ubc.ca/%7erensink/flickr/download/index.html>

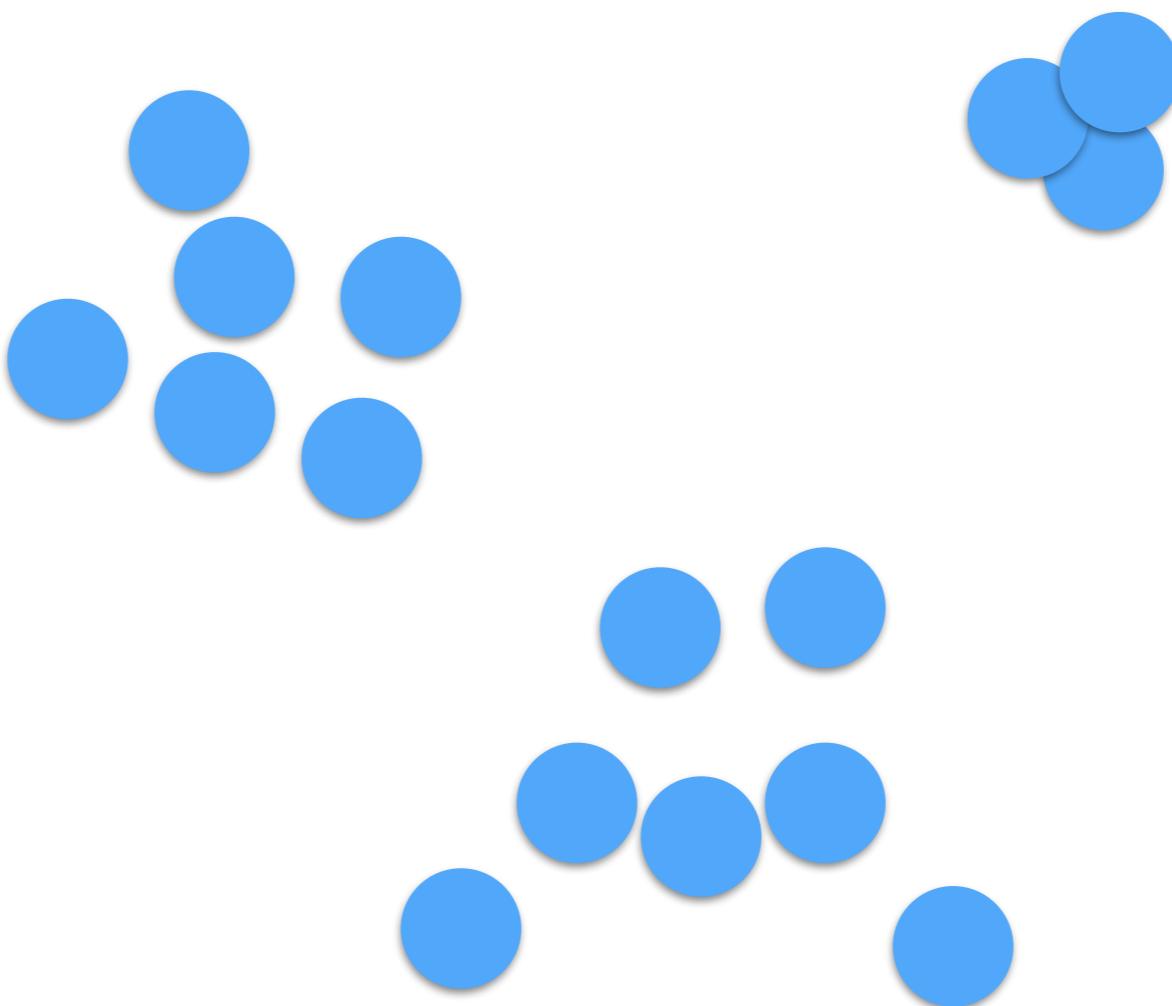


Rensink 2002,
<http://www.psych.ubc.ca/%7erensink/flickr/download/index.html>

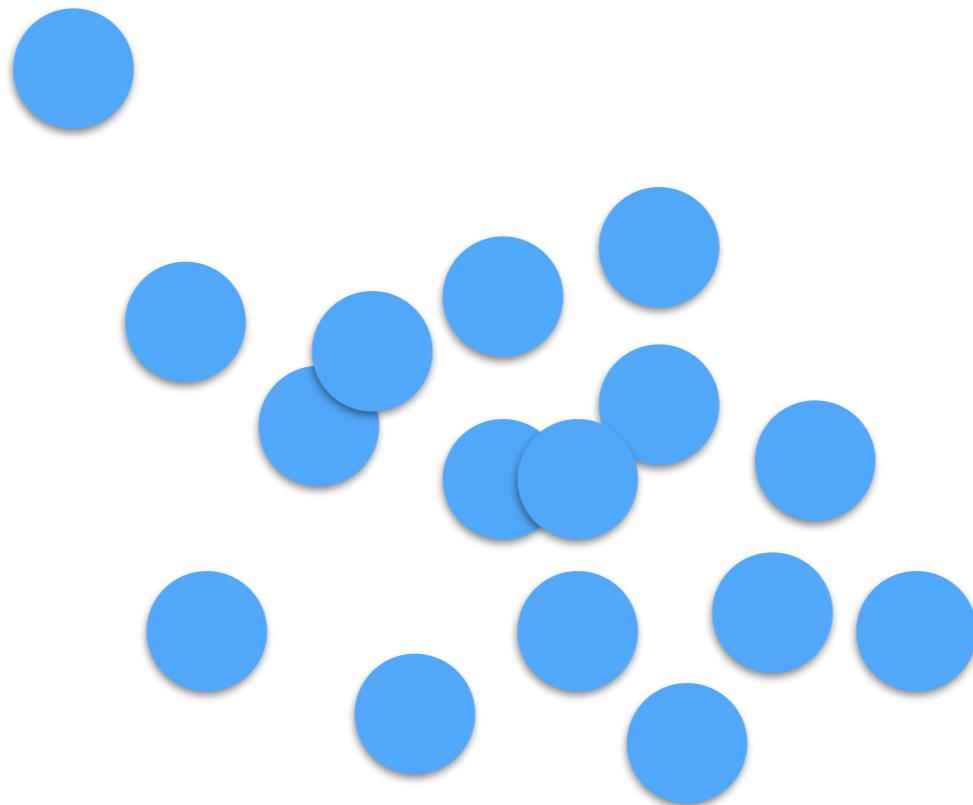
Change Blindness



Change Blindness

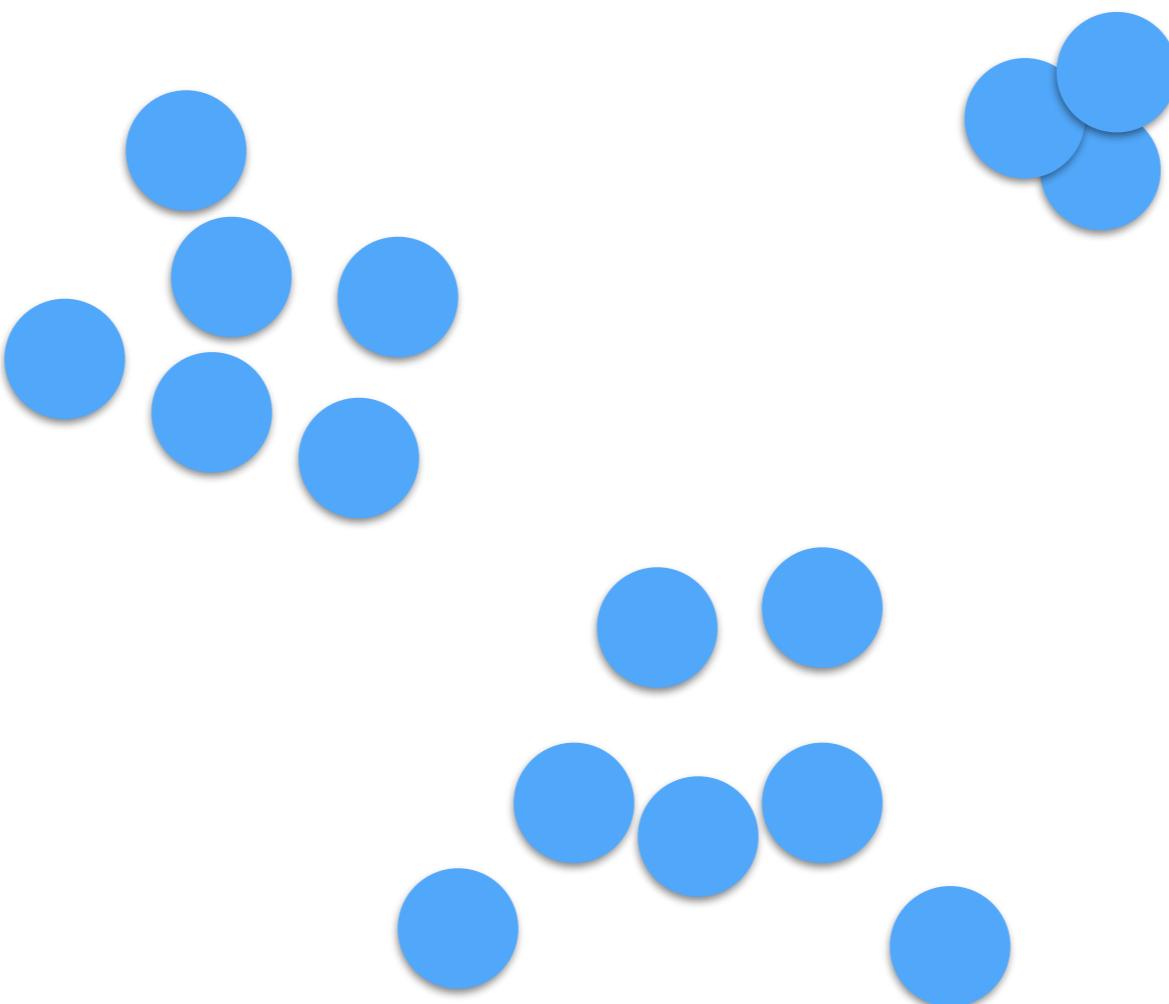


Change Blindness



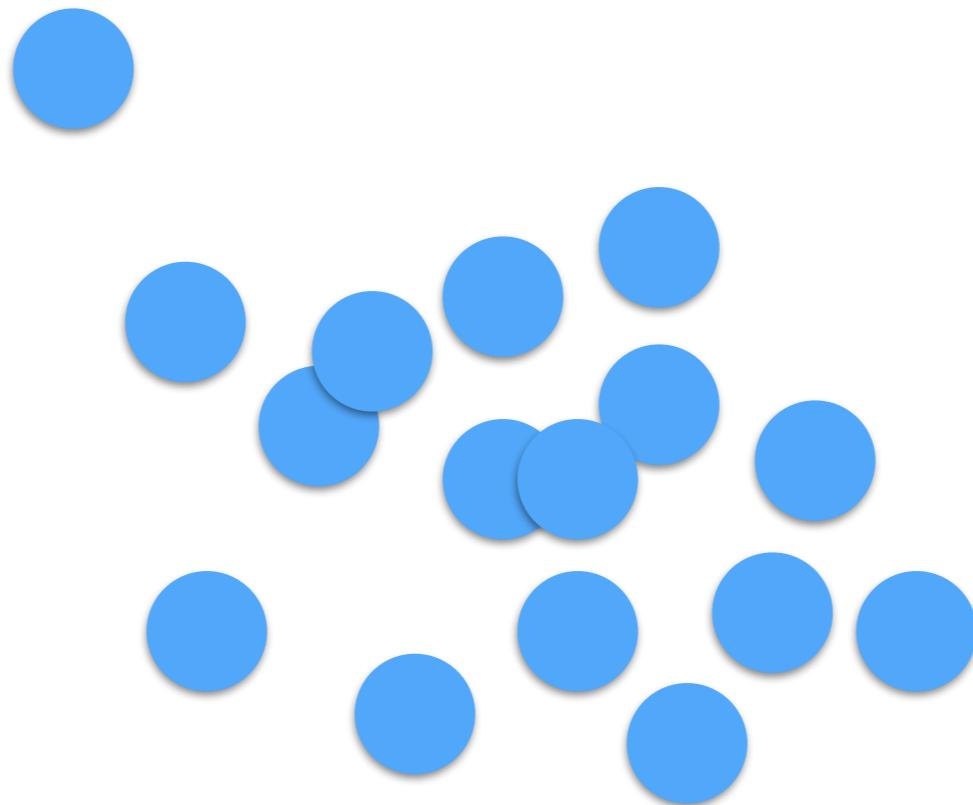
transitions can help

Change Blindness



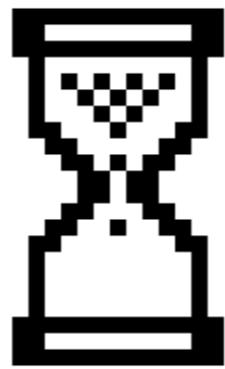
transitions can help

Change Blindness



“the large data phenomenon”

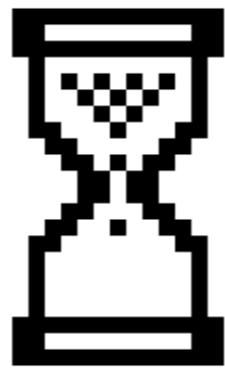
Change Blindness



Loading

“the large data phenomenon”

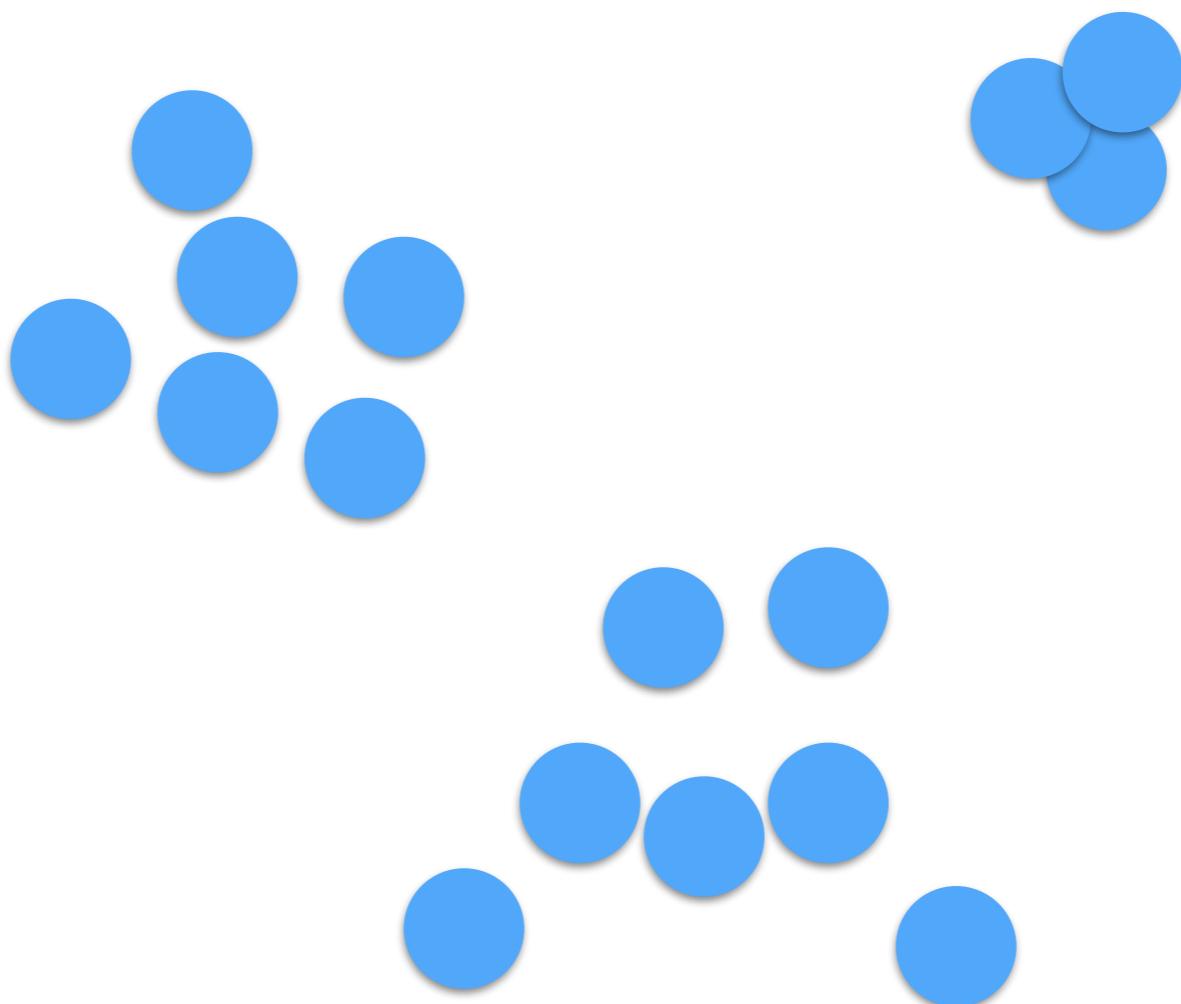
Change Blindness



Loading

“the large data phenomenon”

Change Blindness



“the large data phenomenon”

Unpacking “top-down” guidance



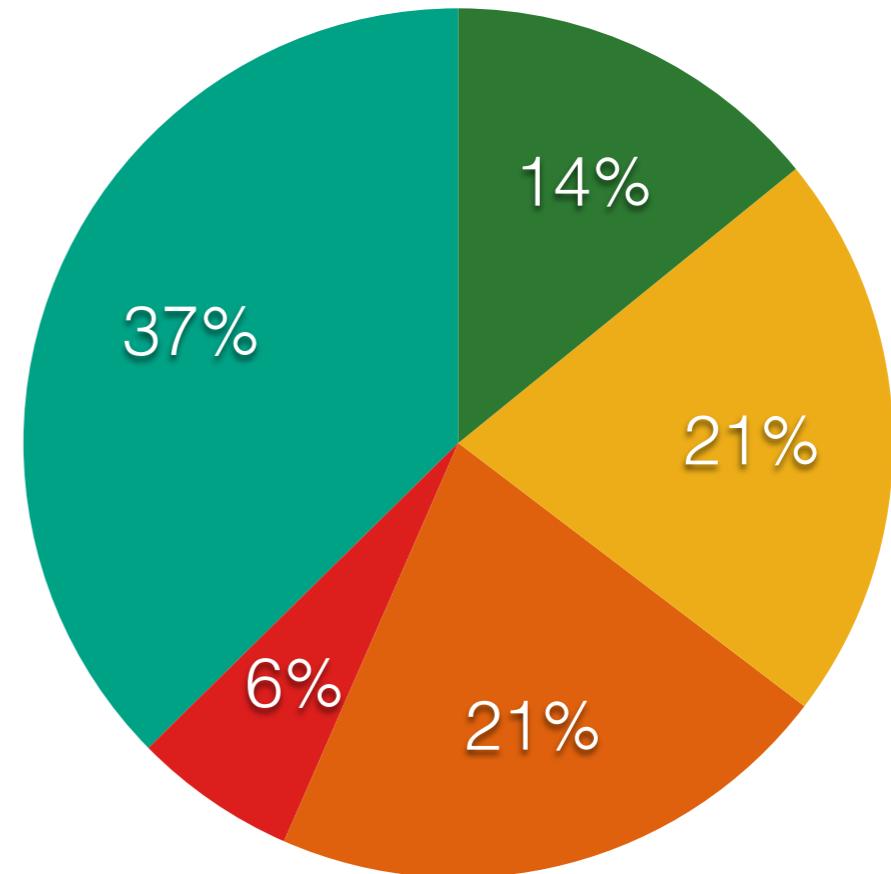
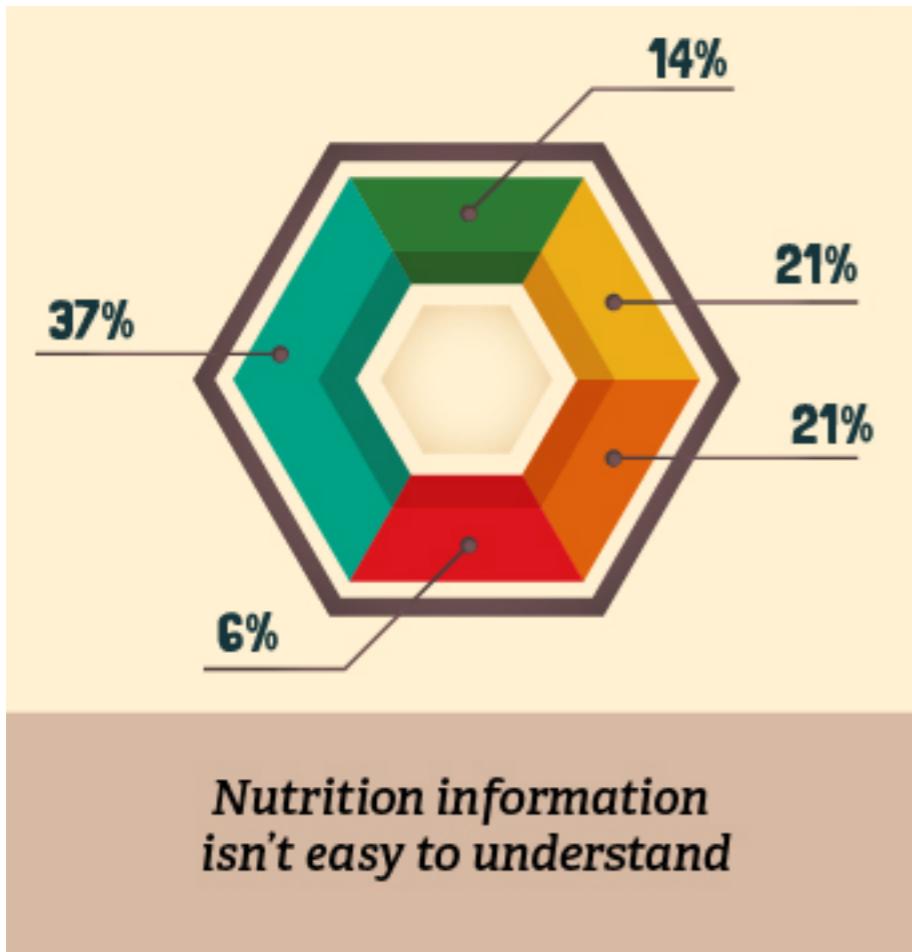
Find the mug

Unpacking “top-down” guidance



Find the painting

Refer back to knowledge of target group. Standard is good.



Today

Ranking of Visual Channels

visual channels can be ranked by their performance,
channels and data type should map

Memory, Attention, and their Limits

the gist, chunking, hierarchical design, change blindness

Gestalt Principles

there are so many of them :)

1 min paper !!

How & What ?

How can we make best use of creating visualizations for electronic devices?

What does this allow us to do?

This Thursday...

- Scales & Axes in D3, SVG grouping
- Reading: D3 book: Chapter 7 and 8 (until page 130)

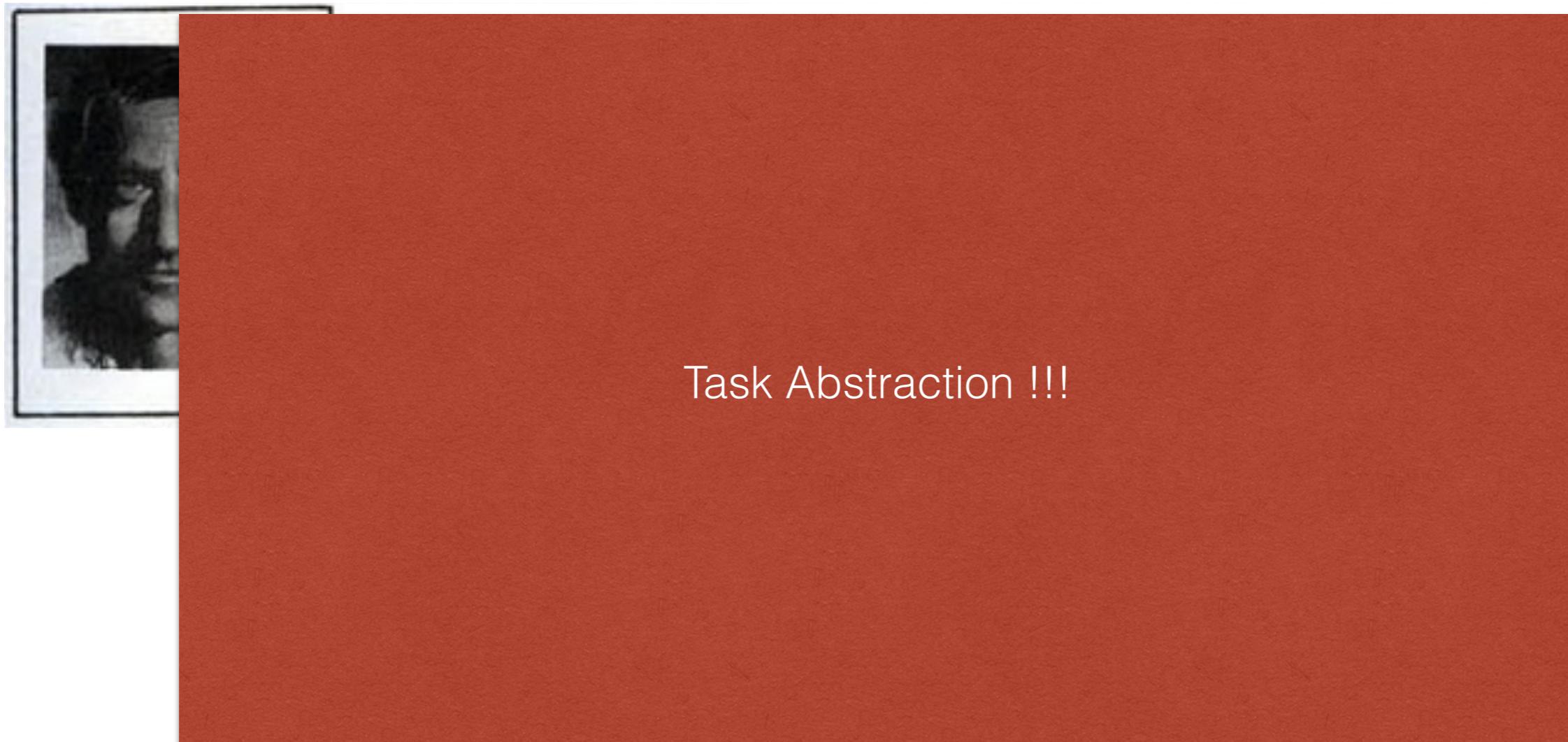
Next Tuesday...

- Interaction
- Reading: "Interactive Dynamics for Visual Analysis"
<http://bit.ly/cs171-heer-2012>

Homework (due Monday)...

- D3 Scales and Axes (HW4)

Abstraction



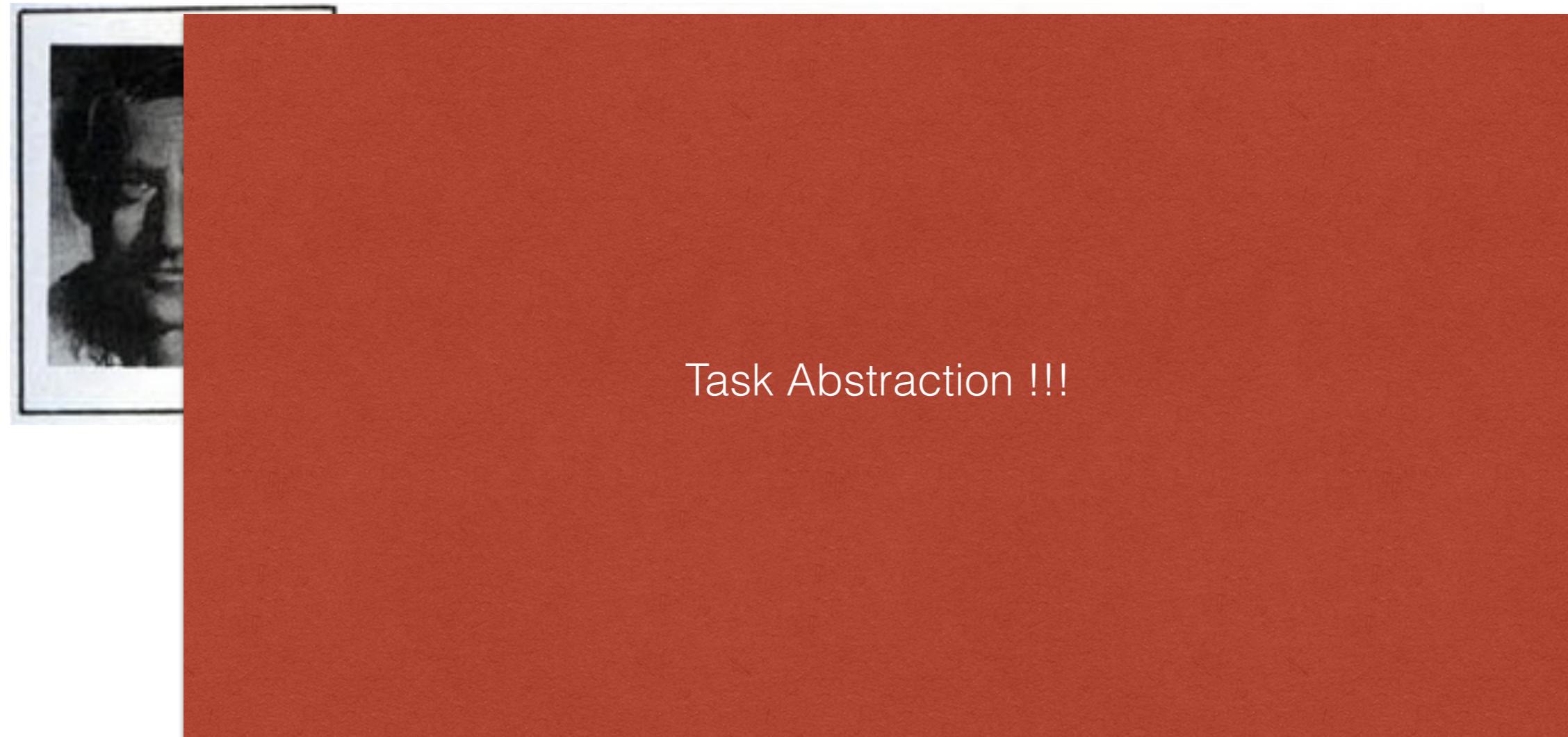
Scott McCloud: “Understanding Comics”

Abstraction



Scott McCloud: “Understanding Comics”

Abstraction



Face

Scott McCloud: “Understanding Comics”