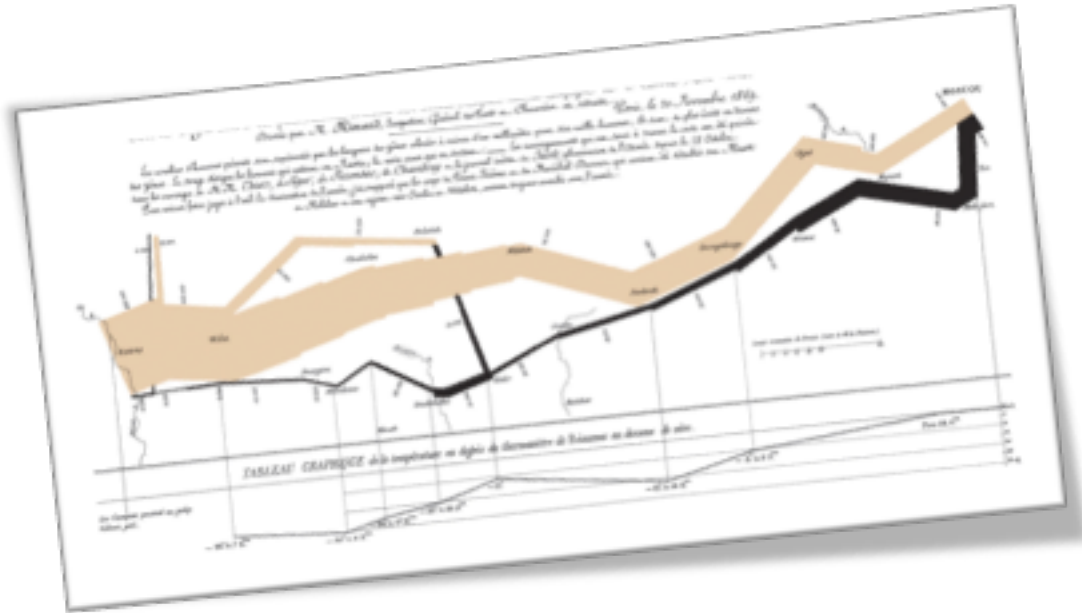


Visualisation d'Information

Introduction

Sylvain Malacria

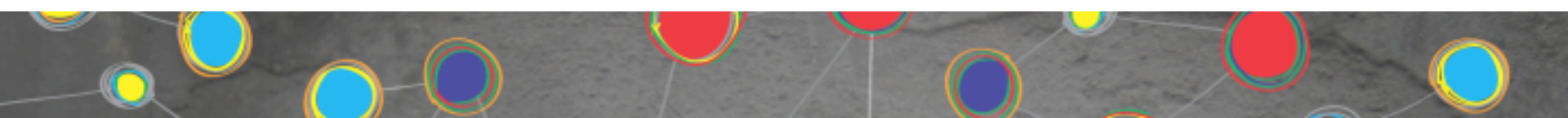


Master 2 IVI

Note: Transparents réalisés par Fanny Chevalier et très largement inspirés des cours de Petra Isenberg, Jean-Daniel Fekete, Pierre Dragicevic, Wesley Willet et Frédéric Vernier (www.aviz.fr) et Jeffrey Heer (<http://courses.cs.washington.edu/courses/cse512/14wi/>).

Pourquoi

La visualisation d'information





800 exabytes (**800×10^{19}**) d'**information digitale**
ont été générés en 2009

[source: The Diverse and Exploding Digital Universe, IDC, 2008]

[credit: Did You Know; Fisch, McLeod, Brenman]

La Révolution "Big Data"

Toujours plus de données collectées et **stockées**.



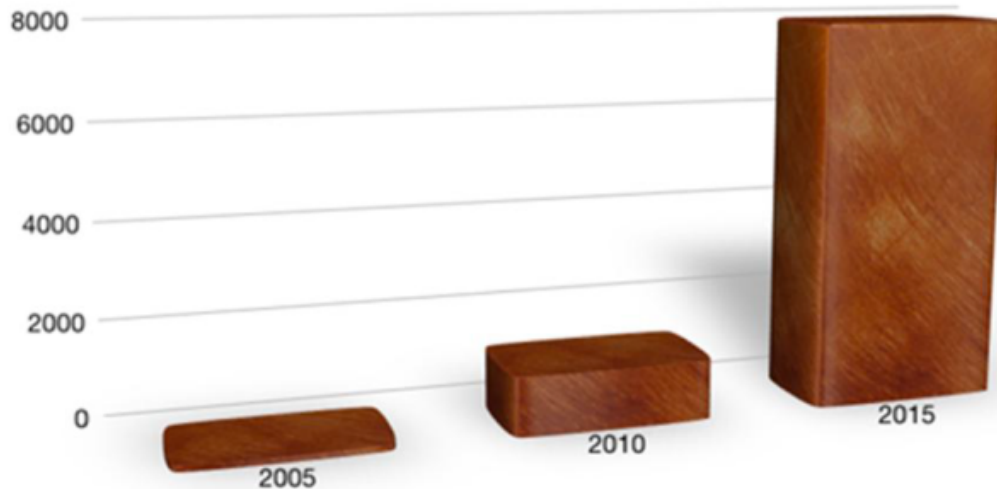
La Révolution "Big Data"

Toujours plus de données collectées et **stockées**.

L'univers digital explose:

- 2007: 281 Exabytes (281 billions de Gigabytes)
- 2010: Zetabytes atteint
- 2011: 1.8 Zetabytes
- 2015: 7 910 Zetabytes

A Decade of Digital Universe Growth: Storage in Exabytes



[Source: IDC's Digital Universe Study, sponsored by EMC, June 2011]



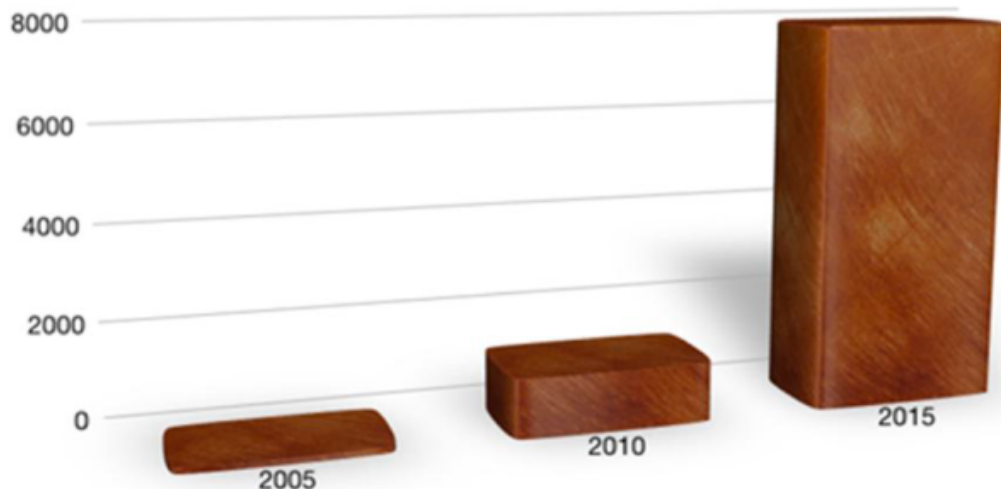
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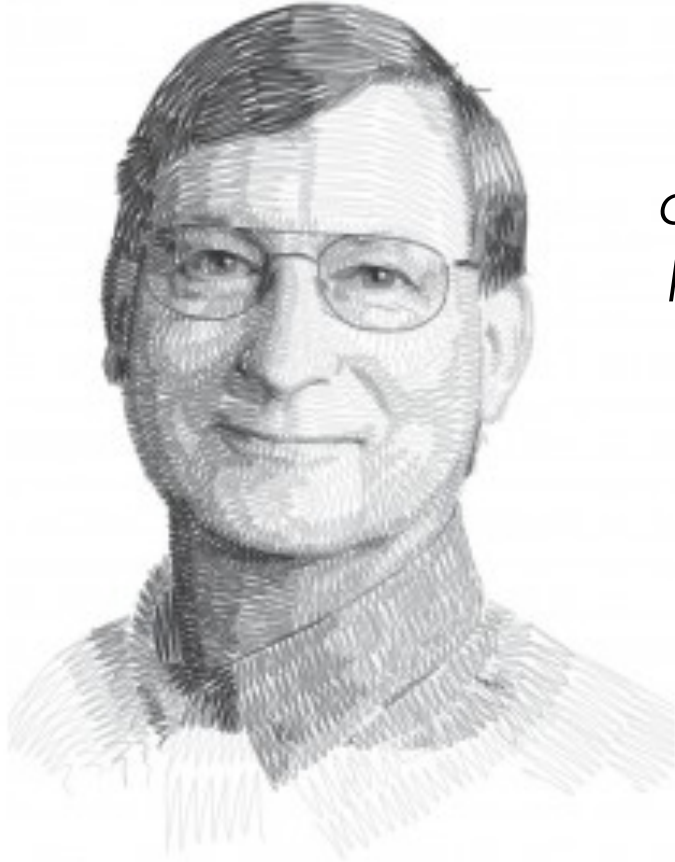
[Source: IDC's Digital Universe Study, sponsored by EMC, June 2011]



VOIR LE RAPPORT IDC 2011



Data Science



“La capacité à s'appropriier les données

– être capable de comprendre les données, de les traiter, d'en extraire de l'information, de les visualiser et de les communiquer –

va devenir une compétence incommensurable dans les prochaines décennies.”

Hal Varian

Chef économiste chez Google

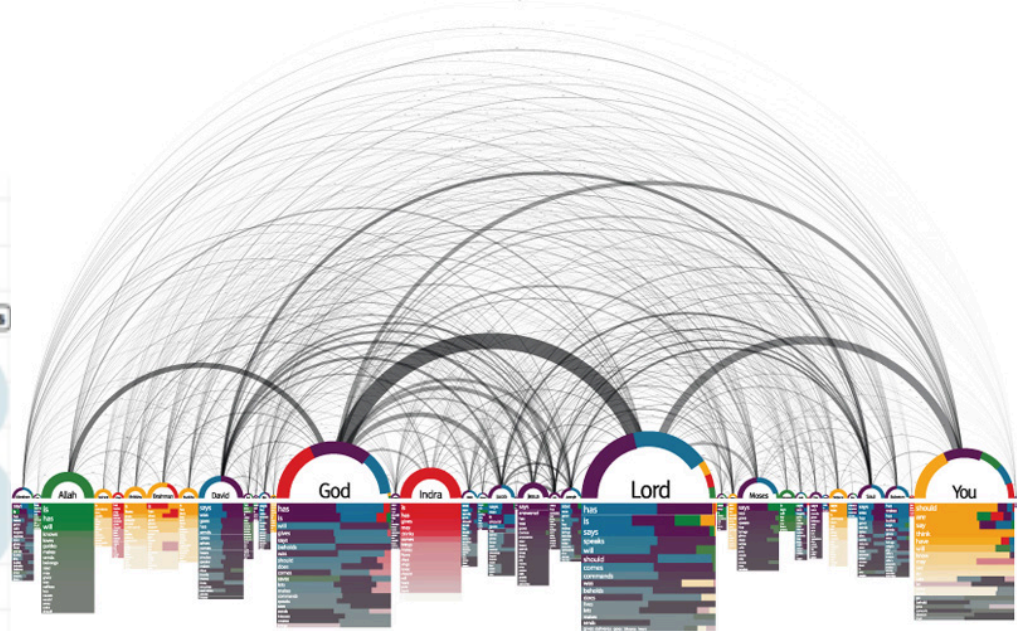
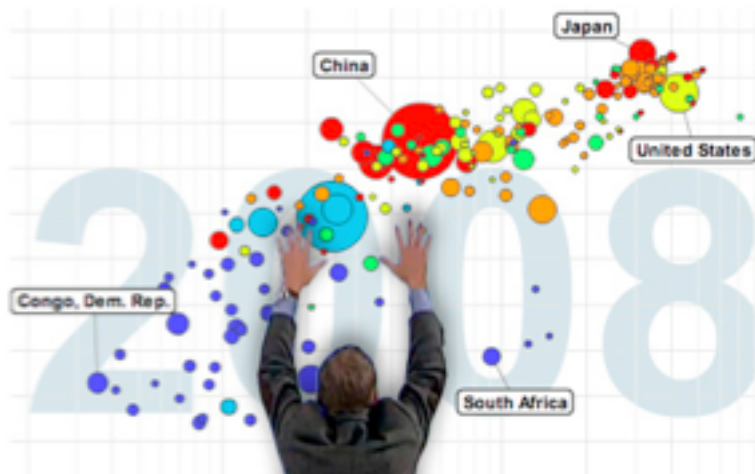
Google™

Questions

Comment peut-on accéder à l'information efficacement ?

- Comprendre la structure des données ?
- Faire des comparaisons ?
- Prendre des décisions ?
- Découvrir de nouvelles connaissances ?
- Communiquer aux autres ?
- Convaincre ?
- ...

Une solution...



La visualisation d'information



La valeur de la visualisation

I		II		III		IV	
x	y	x	y	x	y	x	y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

Les données brutes du Quartet d'Anascombe

La valeur de la visualisation

L'analyse statistique suggère que les données sont équivalentes

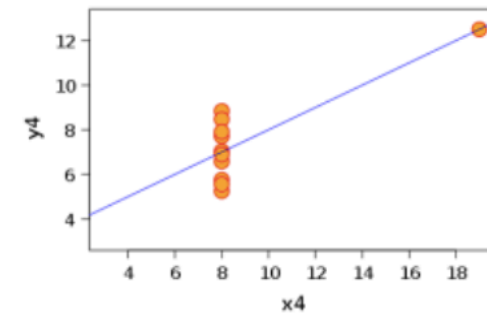
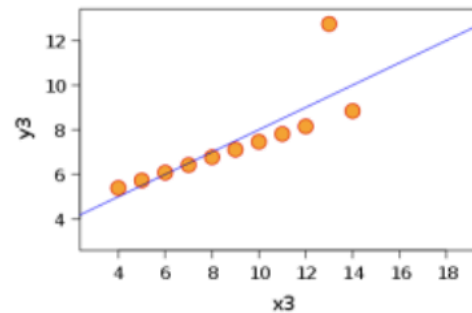
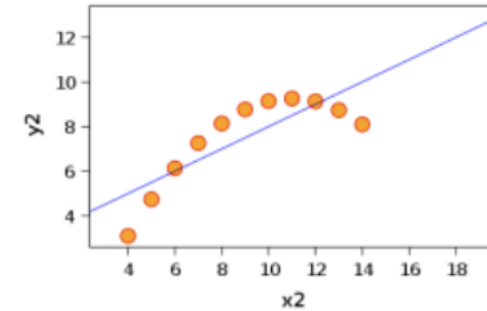
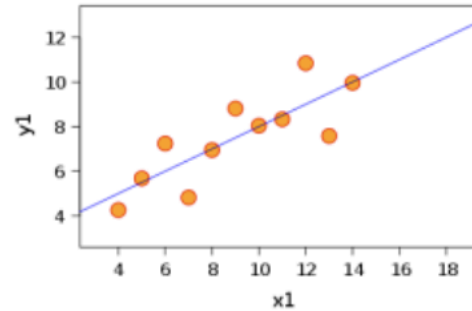
I		II		III		IV	
x	y	x	y	x	y	x	y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

Moyenne en x 9
Variance en x 11
Moyenne en y 7,5
Variance en y 4,12
Correlation entre x et y 0.816
Régression linéaire $y = 3 + 0.5 x$

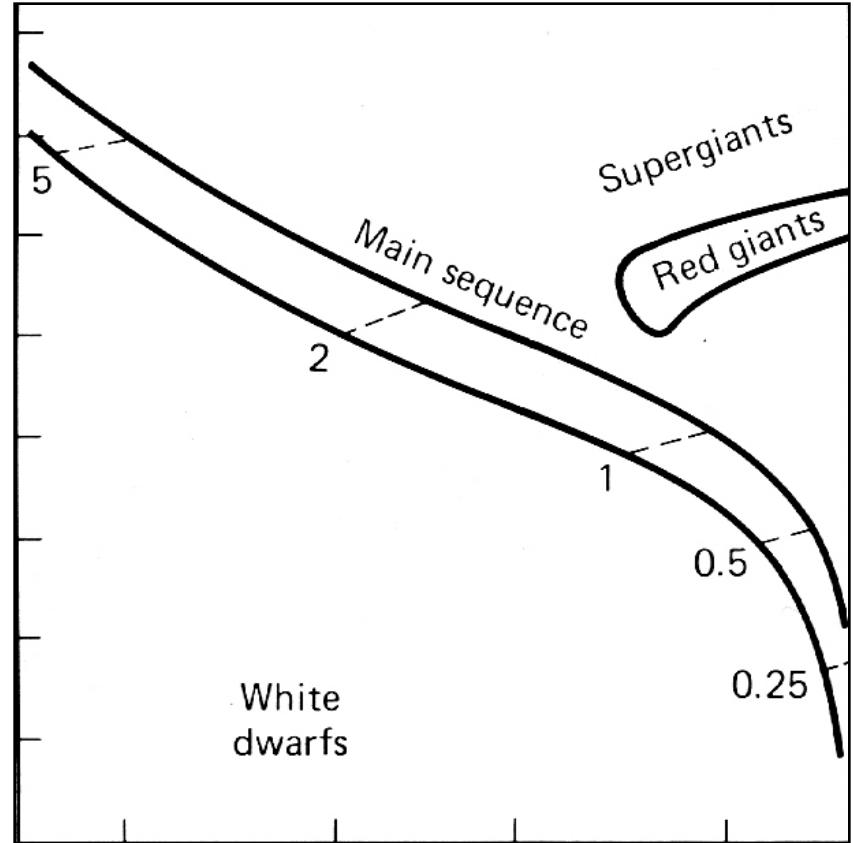
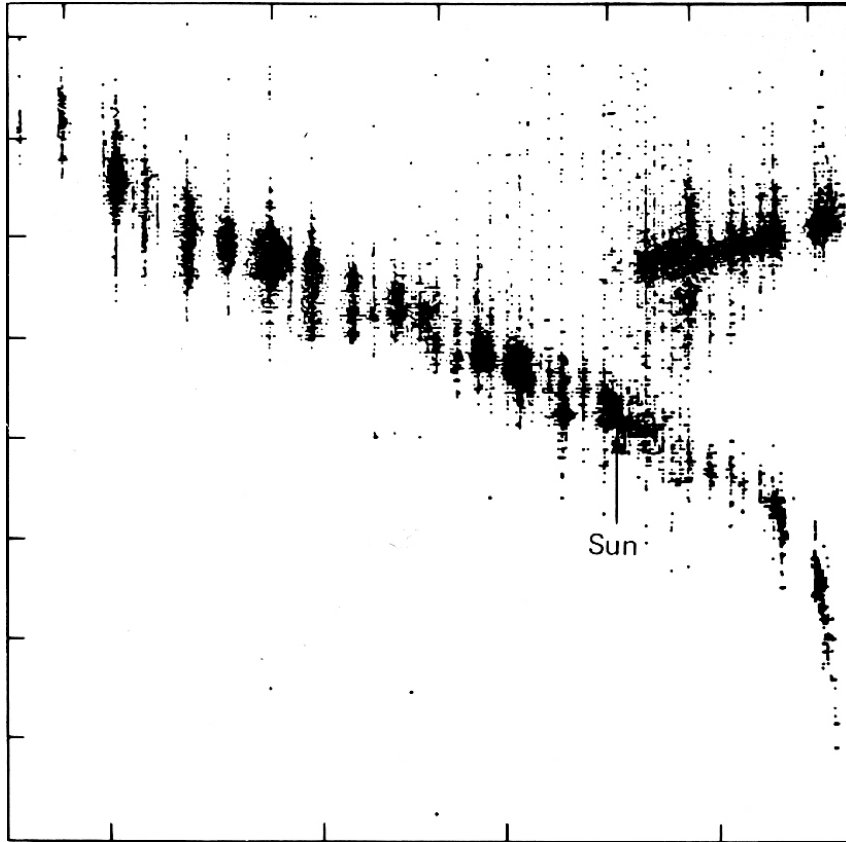
La valeur de la visualisation

La représentation visuelle raconte une toute autre histoire...

I		II		III		IV	
x	y	x	y	x	y	x	y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
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5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89



Capacité d'abstraction

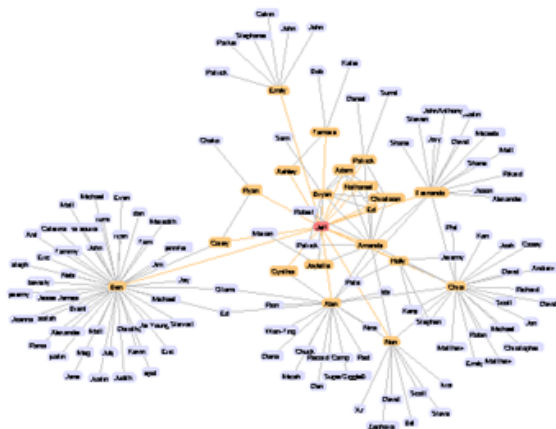


Le diagramme de Hertzsprung Russell Diagram et son interpretation

Pourquoi des représentations visuelles?

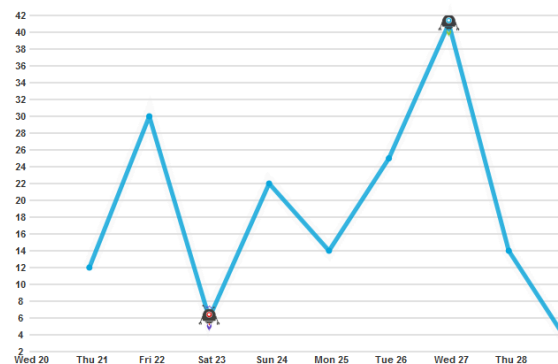
- La vision est notre sens dominant
- Nous sommes très bons à identifier des motifs
- Nous avons besoin de voir et comprendre, afin d'expliquer, raisonner, et prendre des décisions

Hiérarchies et réseaux



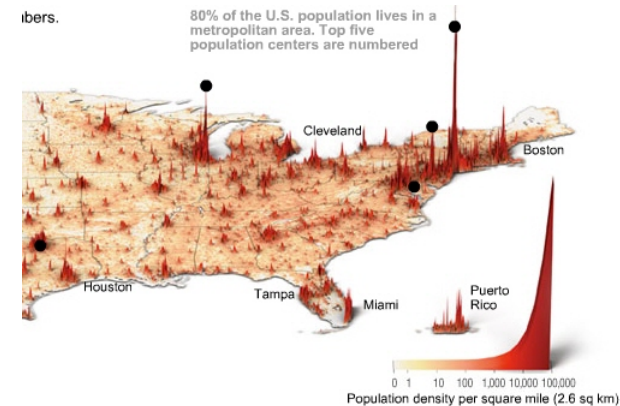
Source: prefuse.org

Graphiques



Source: wijmo.com/

Cartes



Source: New York Times

Pourquoi des représentations visuelles?

- La vision est notre sens dominant
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- Nous avons besoin de voir et comprendre, afin d'expliquer, raisonner, et prendre des décisions

Hiérarchies et réseaux



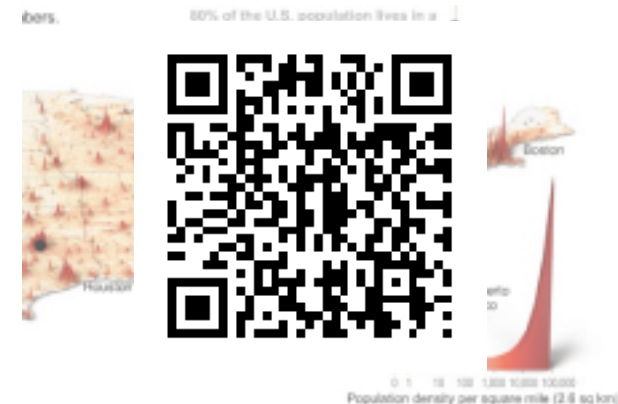
Source: prefuse.org

Graphiques



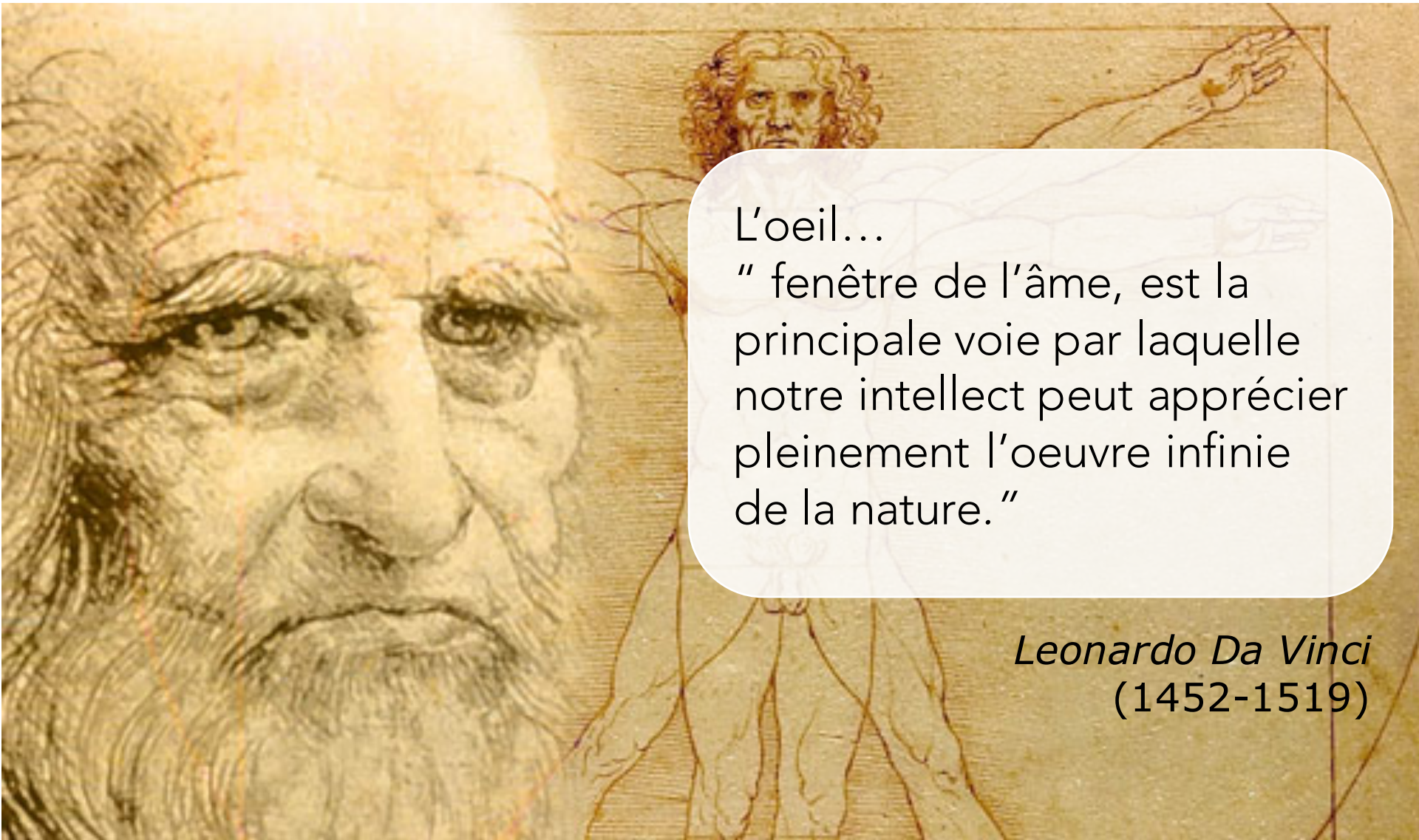
Source: wijmo.com/

Cartes



Source: New York Times

Vision



L'oeil...

" fenêtre de l'âme, est la principale voie par laquelle notre intellect peut apprécier pleinement l'oeuvre infinie de la nature."

Leonardo Da Vinci
(1452-1519)

"A picture is worth a 1,000 words"



Confucius



Napoléon Bonaparte

百聞不如一見

"One hundred rumors are not comparable to one look."

An Old Chinese Inscription

Qu'est-ce que la visualisation ?



1. Action de rendre visible d'une façon matérielle l'action et les effets d'un phénomène
2. Présentation visuelle sur un écran, sous forme d'image alphanumérique ou graphique, d'un ensemble d'informations traitées par des moyens informatiques.

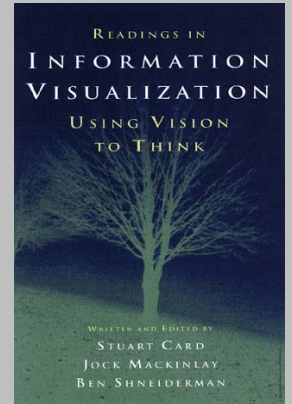
Visualisation d'information

- Concevoir des représentations visuelles
- Concerne les **données abstraites**
- Inclut l'interaction

Définition officielle

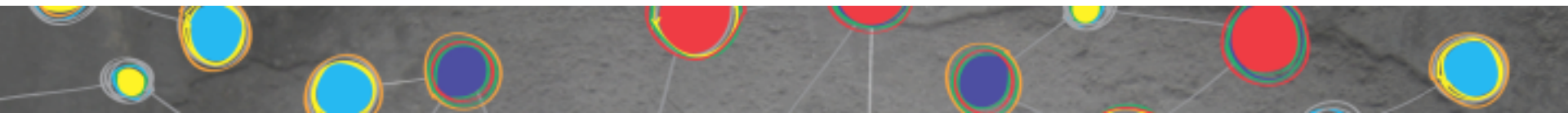
The use of computer-supported, interactive, visual representations of abstract data to amplify cognition.

[Card et al. 1999]



La visualisation d'information ne date pas d'hier...

Exemples Historiques



La marche de Moscou de Napoléon

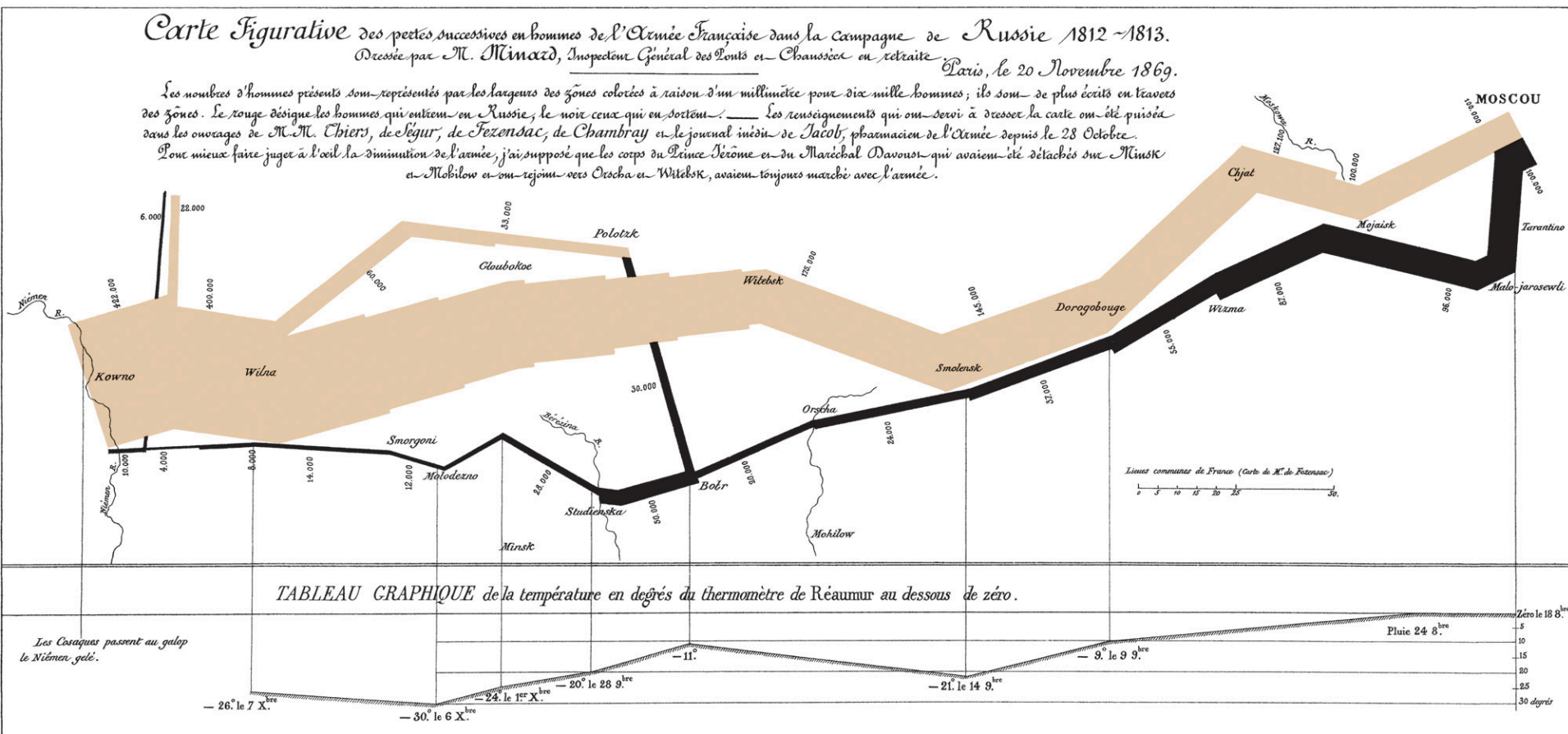
Charles Minard, 1869



Qualifiée par Edward Tufte comme la meilleure représentation statistique de tous les temps

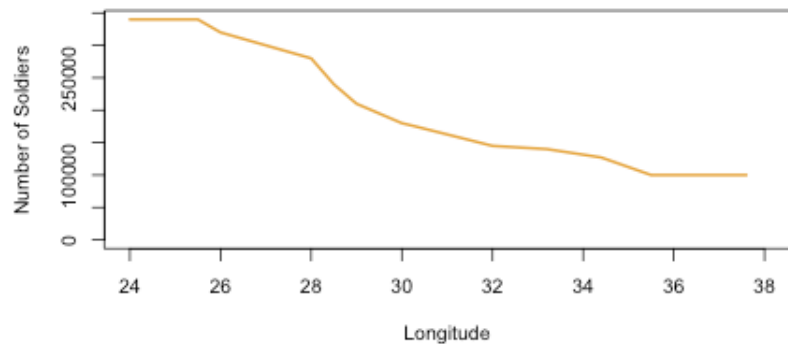
Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.
Dressée par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite Paris, le 20 Novembre 1869.

Les nombres d'hommes présents sont représentés par les largeurs des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en travers des zones. Le rouge désigne les hommes qui entrent en Russie, le noir ceux qui en sortent. Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M. M. Chiers, de Légar, de Fezensac, de Chambray et le journal inédit de Jacob, pharmacien de l'Armée depuis le 28 Octobre. Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps du Prince Jérôme et du Maréchal Davoust qui avaient été détachés sur Minsk et Mohilow et ont rejoint vers Orscha et Witebsk, avaient toujours marché avec l'armée.

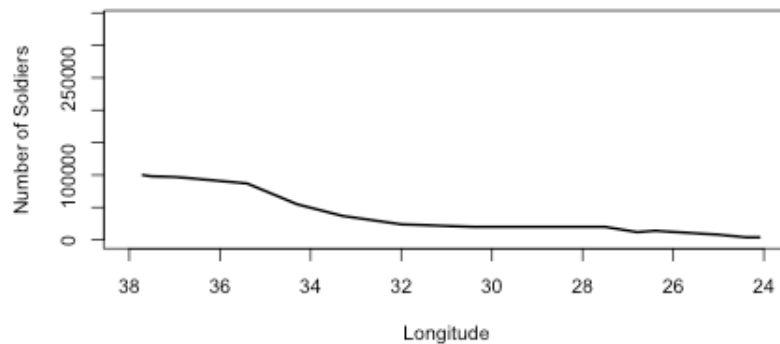


Les Cosaques passent au galop le Niémen gelé.

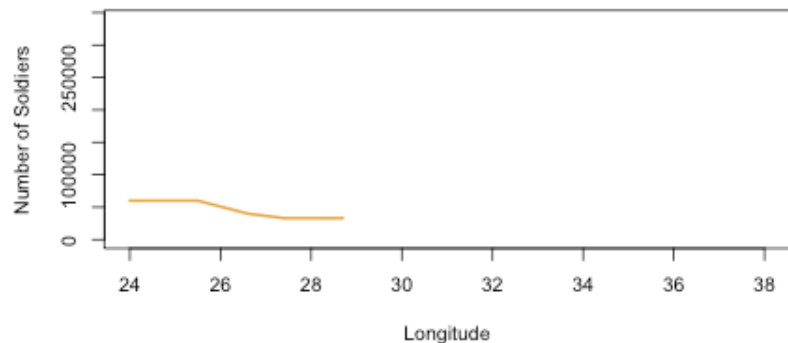
Advance, Group 1



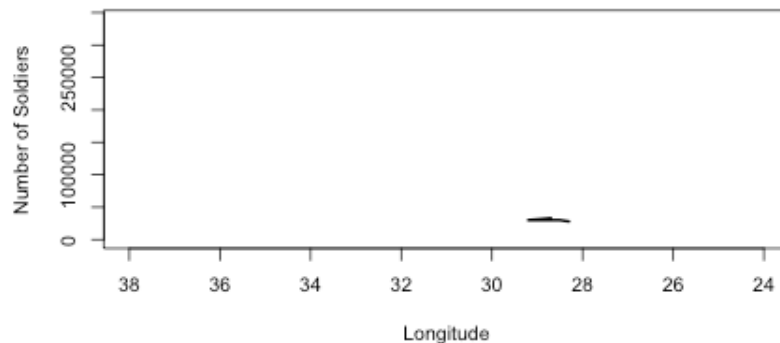
Retreat, Group 1



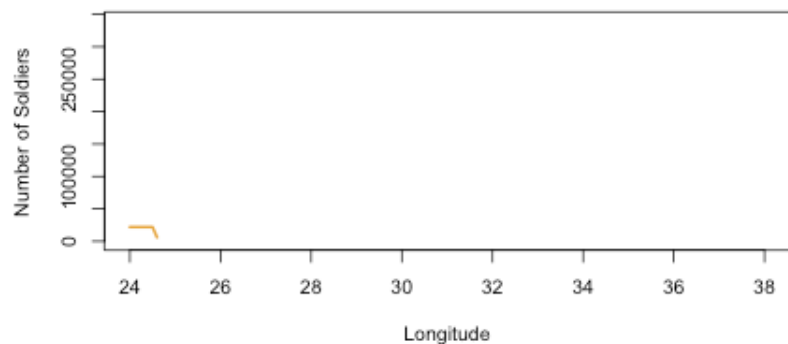
Advance, Group 2



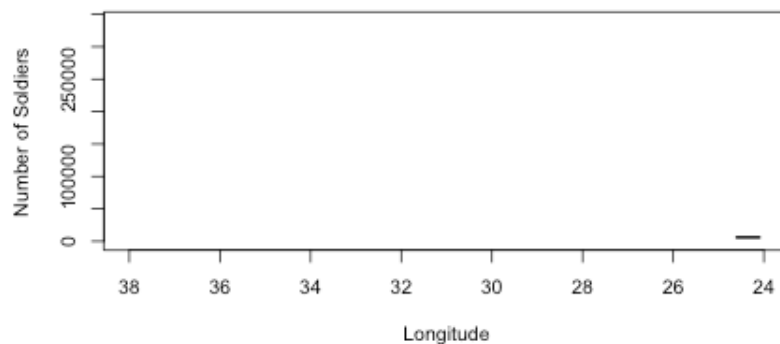
Retreat, Group 2



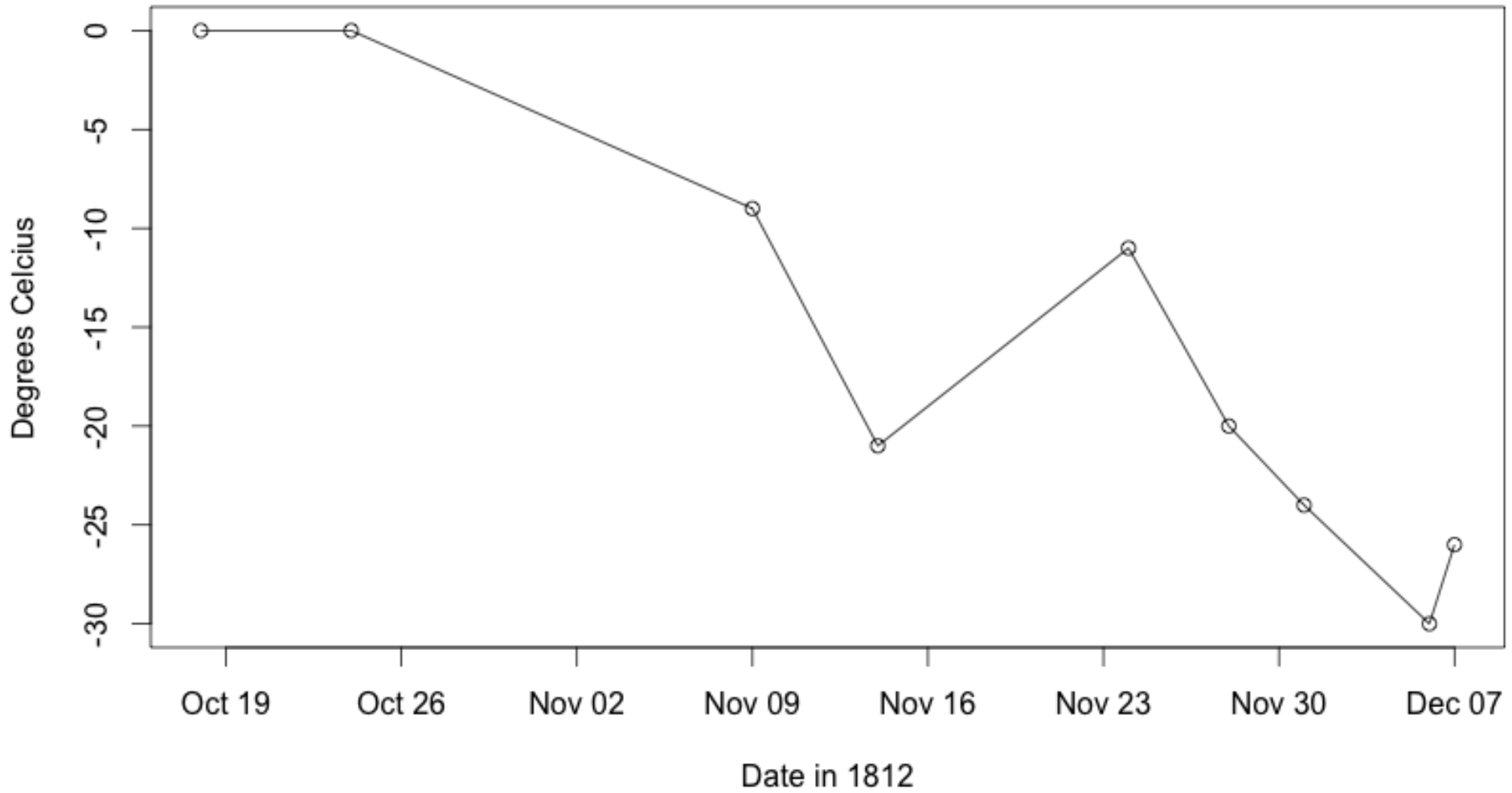
Advance, Group 3



Retreat, Group 3



Temperature During The Retreat





La marche de Moscou de Napoléon

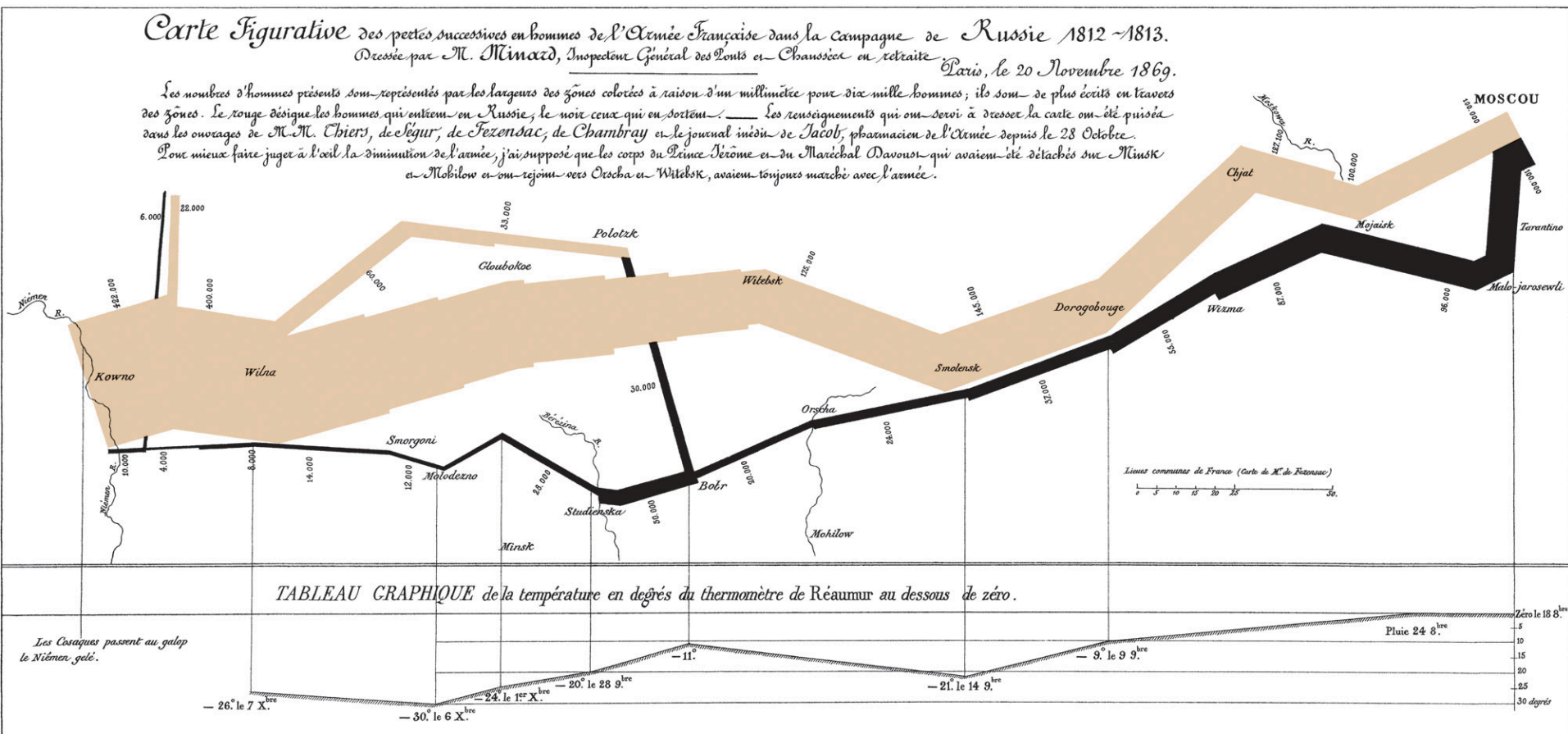
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Épidémie de choléra de *Broad Street* (1854)

“La pire épidémie de choléra qui soit jamais arrivée dans ce royaume”
– John Snow

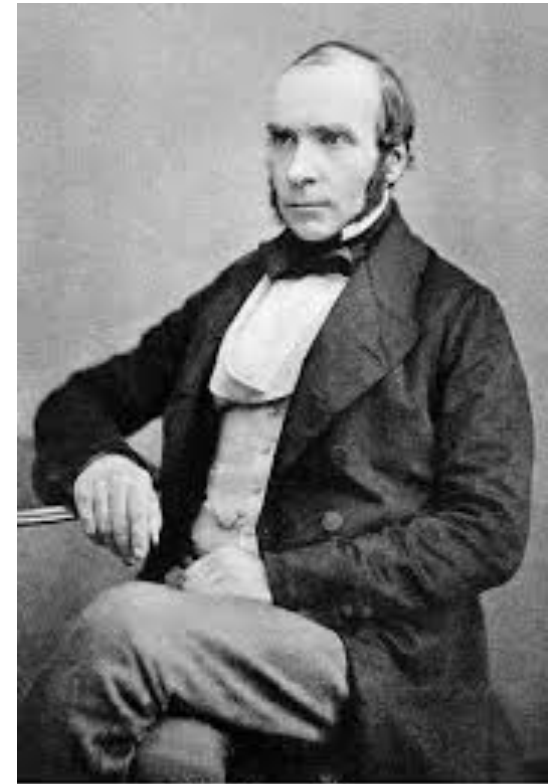
En 1854, Londres a été victime d'une épidémie de choléra

- 127 personnes près de Broad Street ont trouvé la mort dans l'espace de 3 jours
- 616 personnes sont mortes en 30 jours

Le Dr. John Snow a été le premier à faire le lien entre l'eau contaminée des pompes et la propagation de la maladie

Comment a-t'il fait?

- Il a parlé aux résidents locaux
- Il a identifié la pompe à eau comme source potentielle
- Il a utilisé des cartes pour illustrer sa théorie
- Il a convaincu les autorités de condamner les pompes



John Snow

Épidémie de choléra de *Broad Street* (1854)



En savoir plus: *The Visual Display of Quantitative Information* (Tufte)

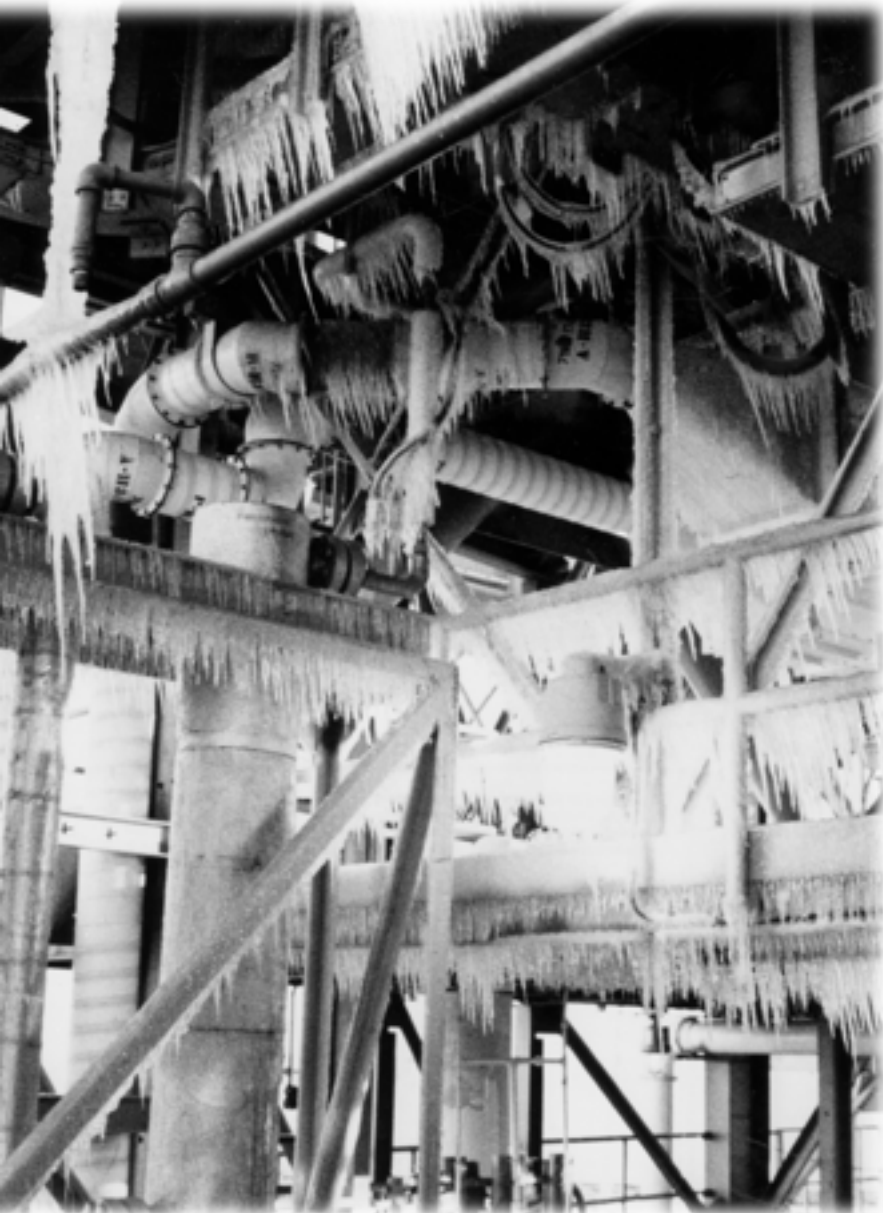
La navette spatiale *Challenger* (1986)



La navette spatiale *Challenger* (1986)



Accident de la navette spatiale *Challenger* (1986)



- 7 personnes de l'équipage sont mortes dans l'explosion

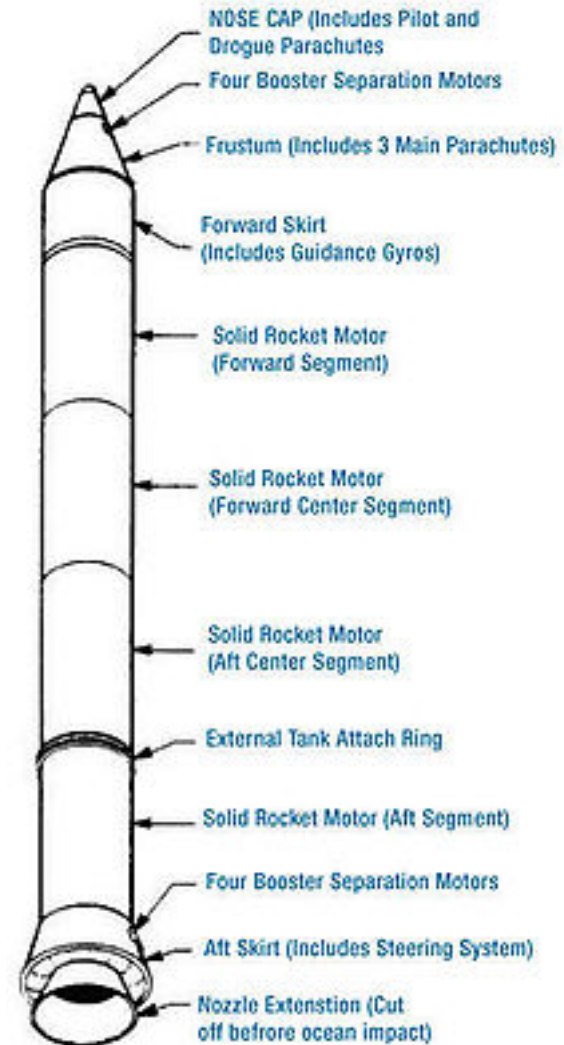
La catastrophe aurait pu être évitée

- Les prévisions pour le 28 janvier avaient annoncé une matinée exceptionnellement froide, avec des températures proches de $-0,5\text{ °C}$
- Les basses températures ont suscité l'inquiétude des ingénieurs de Morton Thiokol, chargé de la maintenance du propulseur d'appoint à poudre (SRB)
- Les ingénieurs redoutaient l'effet de la température sur la résistance des joints toriques en caoutchouc qui permettaient de sceller les joints du SRB

Accident de la navette spatiale *Challenger* (1986)

Propulseur d'appoint à poudre de la navette spatiale américaine

Ils permettent d'apporter la poussée supplémentaire nécessaire à la navette dans la première phase de son ascension



Accident de la navette spatiale Challenger (1986)

HISTORY OF O-RING DAMAGE ON SRM FIELD JOINTS							
	SRM No.	Cross Sectional View			Top View		Clocking Location (deg)
		Erosion Depth (in.)	Perimeter Affected (deg)	Nominal Dia. (in.)	Length Of Max Erosion (in.)	Total Height Affected Length (in.)	
Oct 30, 1985 AFT	61A LH Center Field**	22A	None	None	0.280	None	36° - 66°
	61A LH Center Field**	22A	NONE	NONE	0.280	NONE	338° - 18°
	51C LH Forward Field**	15A	0.010	154.0	0.280	4.25	163
	51C RH Center Field (prim)***	15B	0.038	130.0	0.280	12.50	354
	51C RH Center Field (sec)***	15B	None	45.0	0.280	None	354
	41D RH Forward Field	13B	0.028	110.0	0.280	3.60	275
	41C LH Aft Field*	11A	None	None	0.280	None	--
	41B LH Forward Field	10A	0.040	217.0	0.280	3.60	351
	STS-2 RH Aft Field	2B	0.053	116.0	0.280	--	90

*Hot gas path detected in putty. Indication of heat on O-ring, but no damage.
 **Soot behind primary O-ring.
 ***Soot behind primary O-ring, heat affected secondary O-ring.

Clocking location of leak check port - 0 deg.

OTHER SRM-15 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY AND NO SOOT NEAR OR BEYOND THE PRIMARY O-RING.

SRM-22 FORWARD FIELD JOINT HAD PUTTY PATH TO PRIMARY O-RING, BUT NO O-RING EROSION AND NO SOOT BLOWBY; OTHER SRM-22 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY.

BLOW BY HISTORY

SRM-15 WORST BLOW-BY

- o 2 CASE JOINTS (30°), (110°) ARC
- o MUCH WORSE VISUALLY THAN SRM-22

SRM 12 BLOW-BY

- o 2 CASE JOINTS (30-40°)

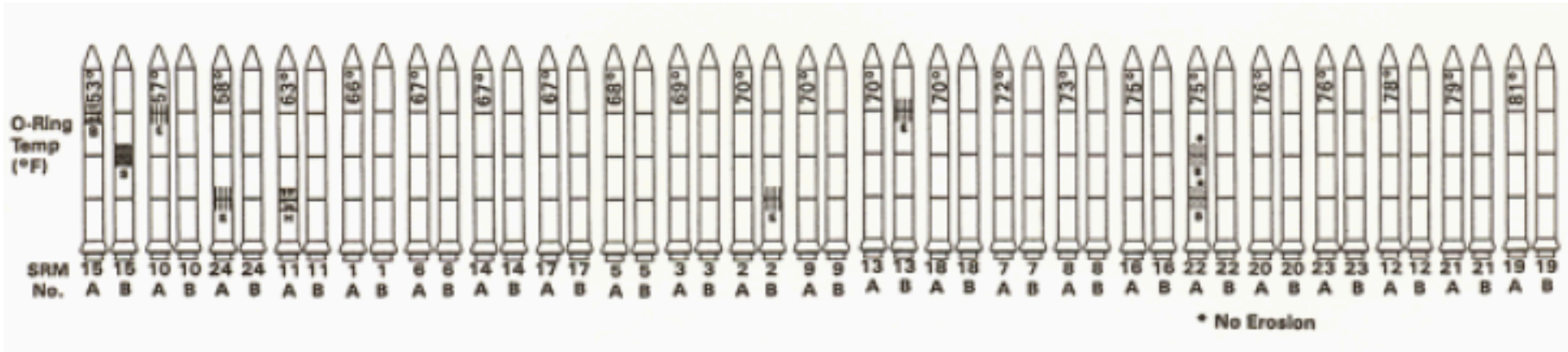
SRM-13A, 15, 16A, 18, 23A 24A

- o NOZZLE BLOW-BY

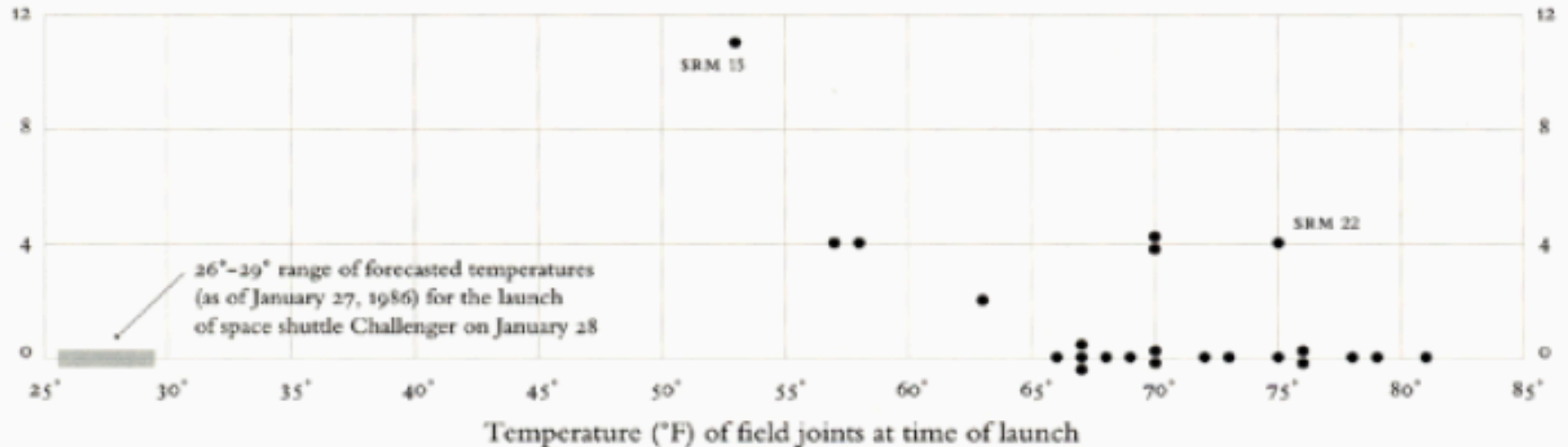
HISTORY OF O-RING TEMPERATURES (DEGREES - F)					
MOTOR	MBT	AMB	O-RING	WIND	
DM-1	68	36	47	10 MPH	
DM-2	76	45	52	10 MPH	
QM-3	72.5	40	48	10 MPH	
QM-4	76	48	51	10 MPH	
SRM-15	52	64	53	10 MPH	
SRM-22	77	78	75	10 MPH	
SRM-25	55	26	29	10 MPH	25 MPH

2 of 13 pages of material faxed to NASA by Morton Thiokol [from Tufte 1997]

Accident de la navette spatiale *Challenger* (1986)



O-ring damage index, each launch



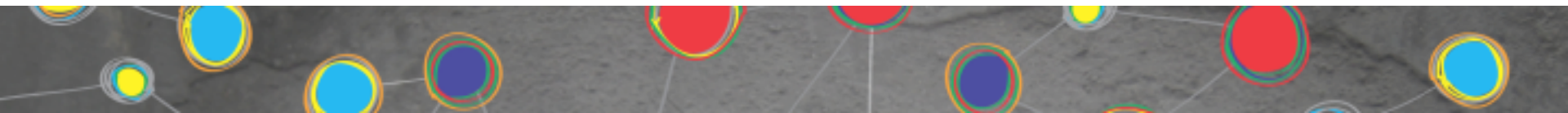
Les données dans leur contexte

Les nombres deviennent des preuves lorsqu'ils sont mis en relation les uns avec les autres et dans leur contexte.

Edward Tufte (1997)



Et bien plus récemment...

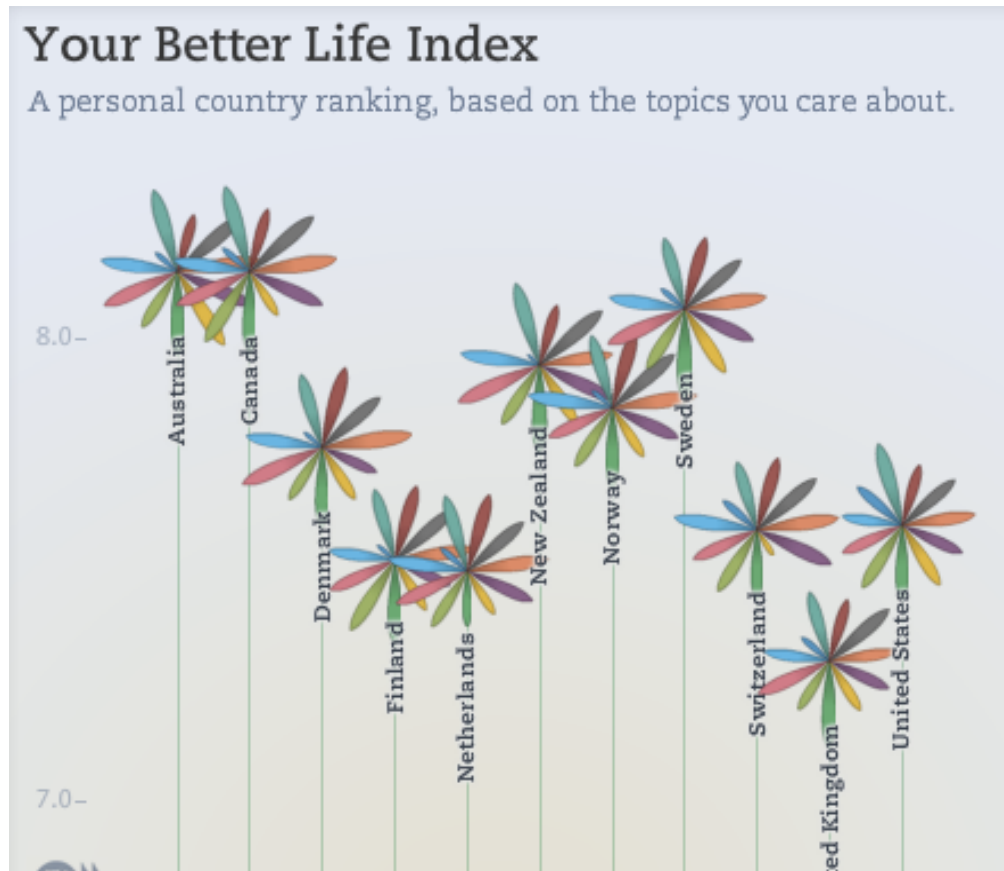


Trash Track (MIT, 2009)



Open Data

- Mouvement pour rendre les données gouvernementales publiques et gratuites
- Encourage la participation de tout le monde



Many Eyes (IBM, 2009)

explore
visualizations
data sets
comments
topic hubs

participate
register
create visualization
upload data set
create topic hub

learn more
quick start
visualization types
about Many Eyes

sign in search

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Perchlorate in Food, 2005-2006
From FDA survey data
by Wischnen

Gospel of John
Jesus answered ... path... etc.
by O'Neill

Hindu Universe
India is at the center.
by Anonymous

US Government Receipts
As percentage of GDP, 1934-2008. Remarkably constant, post-war.
by lancunous

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(dive into a topic of interest, or create a hub of your own)

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Planes, trains, and automobiles!

OECD Factbook 2007
Official statistics.

Embed
live visualizations on your site

many eyes beta
for shared visualization and discovery

brought to you by **IBM**

Resources pour plus d'exemples

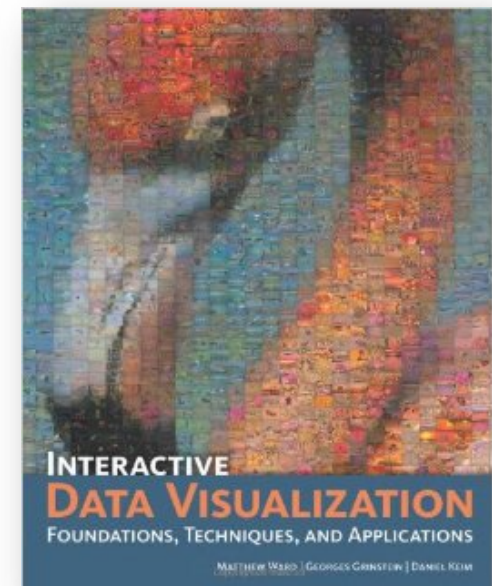
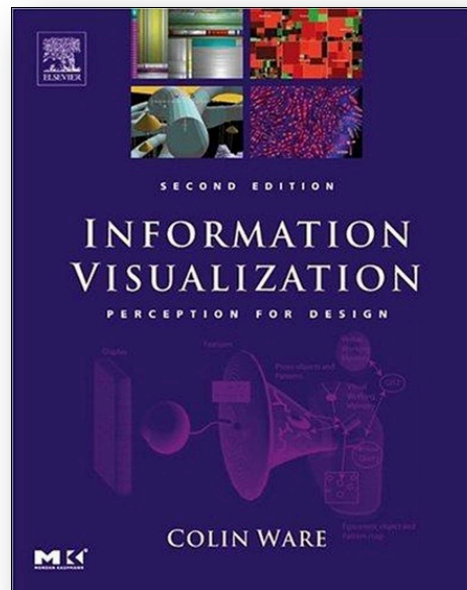
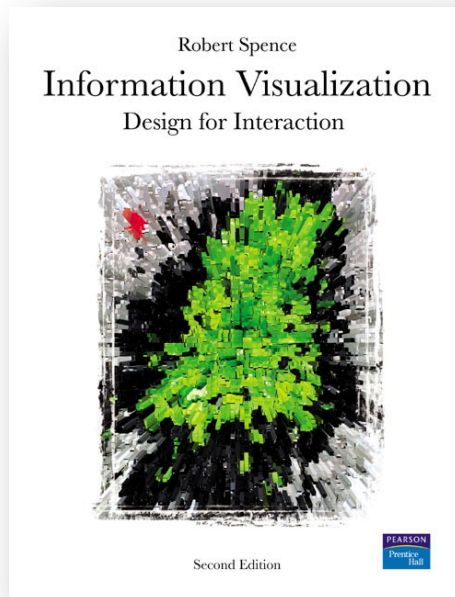
Blogs

- <http://infosthetics.com/>
- <http://flowingdata.com/>
- <http://felinlovewithdata.com/>
- <http://eagereyes.org/>

Tufte

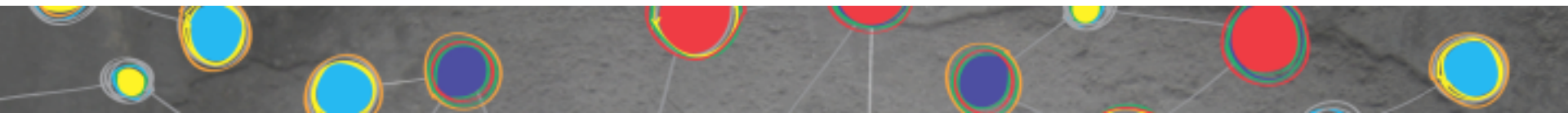


Livres



Pourquoi ça marche ?

Représentations et perception



Il n'est pas facile de créer de *bonnes* visualisations

Parmi toutes les représentations possibles, seules un petit nombre d'entre elles sont efficaces



Qu'est-ce qu'une représentation ?

1. Un système formel via lequel l'information peut être décrite (D. Marr)
2. Un système de signes et symboles tel qu'il représente autre chose que lui-même

Exemple: le nombre trente-quatre

34

décimal

100010

binaire

XXXIV

chiffres romains

Présentation

Différentes représentations révèlent différents aspects de l'information

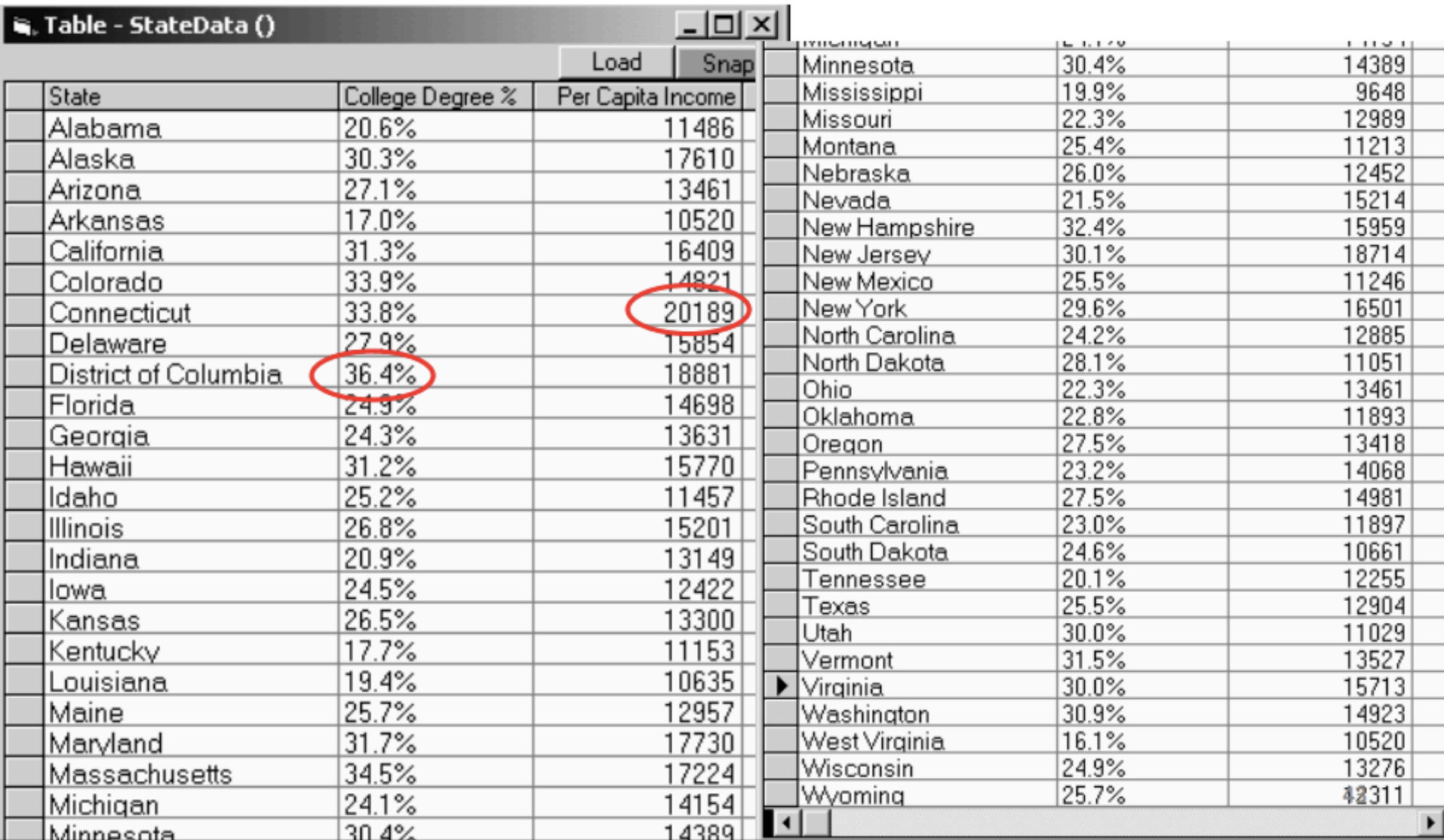
décimal: compte et information dans la base 10,
binaire: compte et information dans la base 2,
chiffres romains: pour impressionner vos amis

Présentation

comment la représentation est placée ou organisée sur le dispositif d'affichage

34, 34, 34

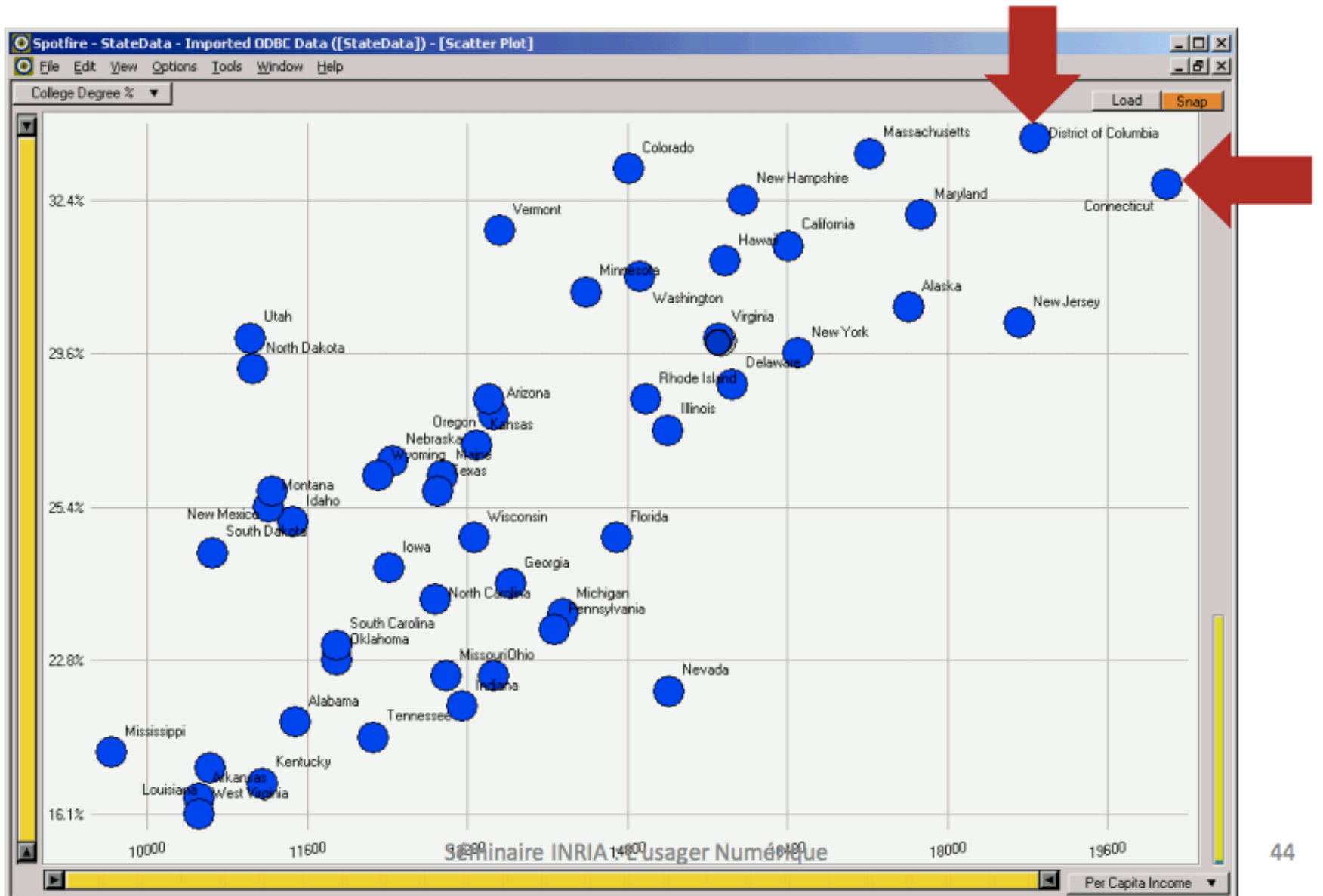
Bonne représentation ?



The image shows a screenshot of a data table titled "Table - StateData ()". The table has two columns: "College Degree %" and "Per Capita Income". The "College Degree %" column is sorted in descending order, with values ranging from 17.0% to 36.4%. The "Per Capita Income" column is sorted in ascending order, with values ranging from 10520 to 20189. Two cells are circled in red: "36.4%" in the "College Degree %" column for the District of Columbia, and "20189" in the "Per Capita Income" column for Connecticut. The table is displayed in a window with standard OS controls (minimize, maximize, close) and a scrollbar at the bottom.

State	College Degree %	Per Capita Income
Alabama	20.6%	11486
Alaska	30.3%	17610
Arizona	27.1%	13461
Arkansas	17.0%	10520
California	31.3%	16409
Colorado	33.9%	14821
Connecticut	33.8%	20189
Delaware	27.9%	15854
District of Columbia	36.4%	18881
Florida	24.9%	14698
Georgia	24.3%	13631
Hawaii	31.2%	15770
Idaho	25.2%	11457
Illinois	26.8%	15201
Indiana	20.9%	13149
Iowa	24.5%	12422
Kansas	26.5%	13300
Kentucky	17.7%	11153
Louisiana	19.4%	10635
Maine	25.7%	12957
Maryland	31.7%	17730
Massachusetts	34.5%	17224
Michigan	24.1%	14154
Minnesota	30.4%	14389
Mississippi	19.9%	9648
Missouri	22.3%	12989
Montana	25.4%	11213
Nebraska	26.0%	12452
Nevada	21.5%	15214
New Hampshire	32.4%	15959
New Jersey	30.1%	18714
New Mexico	25.5%	11246
New York	29.6%	16501
North Carolina	24.2%	12885
North Dakota	28.1%	11051
Ohio	22.3%	13461
Oklahoma	22.8%	11893
Oregon	27.5%	13418
Pennsylvania	23.2%	14068
Rhode Island	27.5%	14981
South Carolina	23.0%	11897
South Dakota	24.6%	10661
Tennessee	20.1%	12255
Texas	25.5%	12904
Utah	30.0%	11029
Vermont	31.5%	13527
Virginia	30.0%	15713
Washington	30.9%	14923
West Virginia	16.1%	10520
Wisconsin	24.9%	13276
Wyoming	25.7%	42311

Bonne représentation !



Perception préattentive

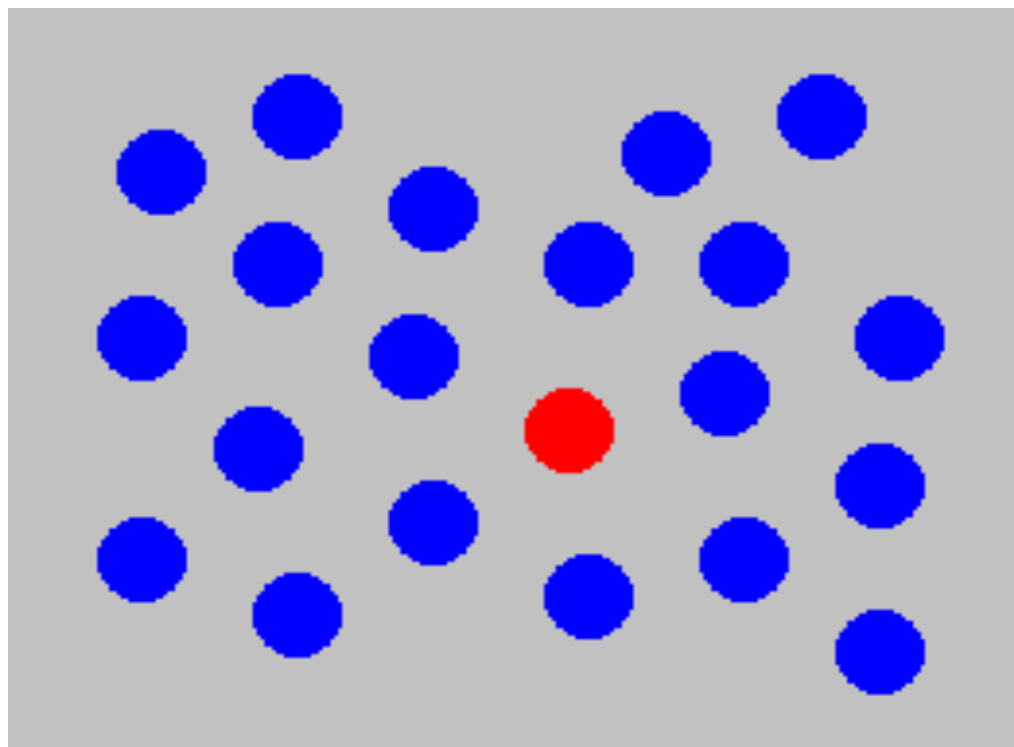
On a appris des psychologues que certaines variables visuelles sont perçue

- sans aucun effort
- d'un simple coup d'oeil
- en un temps constant

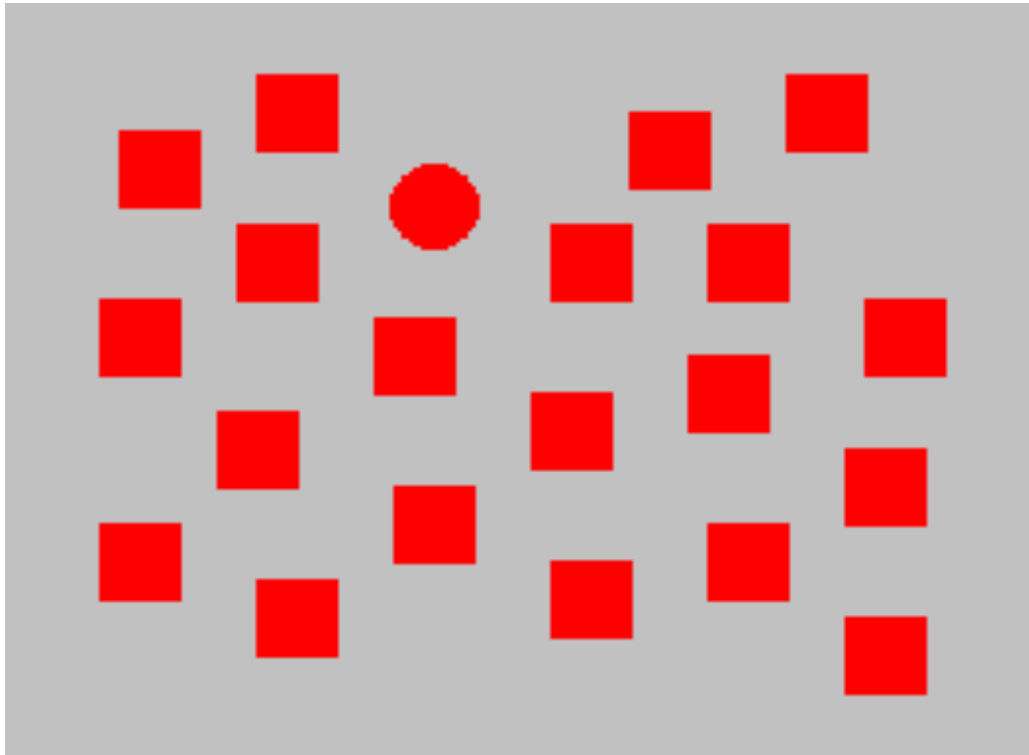
1281768756138976546984506985604982826762
9809858458224509856458945098450980943585
9091030209905959595772564675050678904567
8845789809821677654876364908560912949686

12817687561**3**8976546984506985604982826762
980985845822450985645894509845098094**3**585
90910**3**0209905959595772564675050678904567
8845789809821677654876**3**64908560912949686

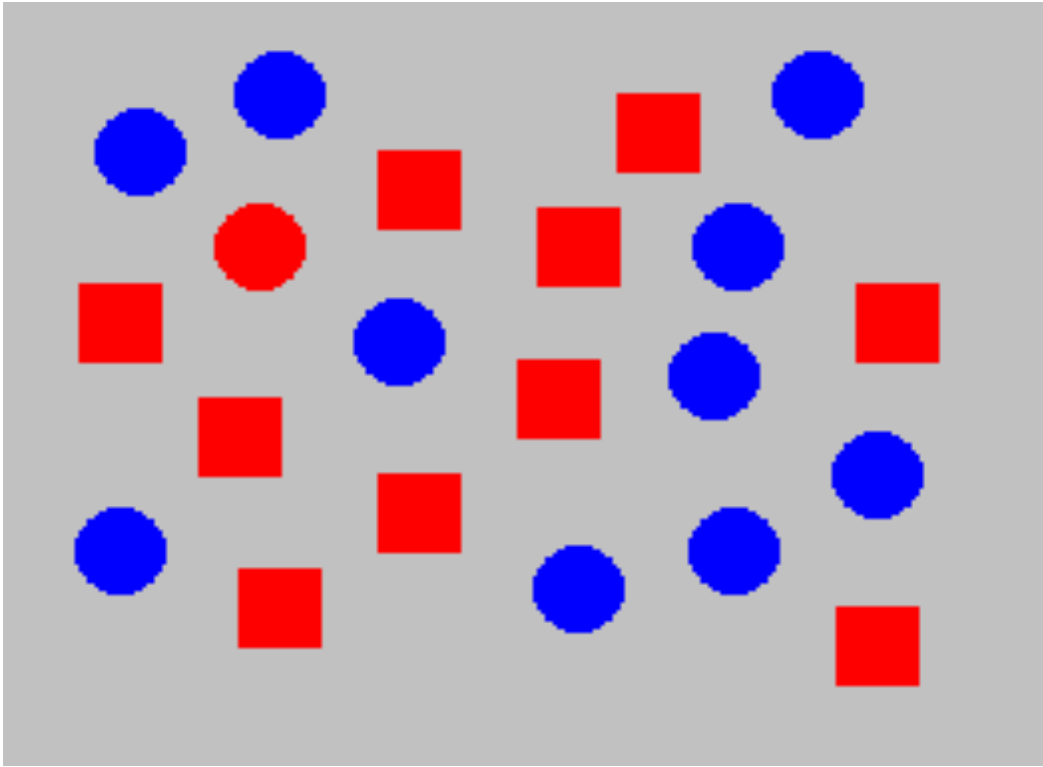
Localiser l'objet rouge



Localiser le cercle



Localiser le cercle rouge

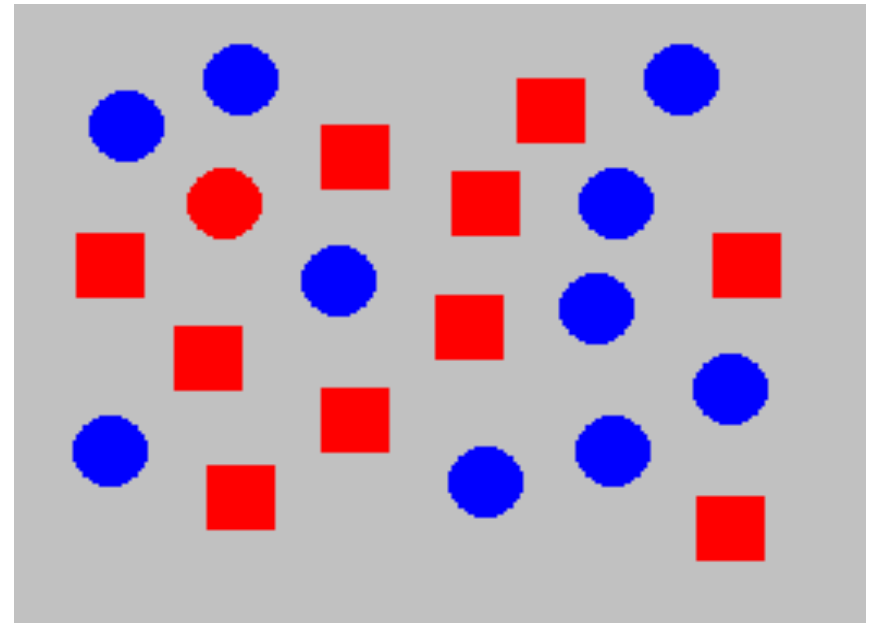


Perception préattentive: problèmes

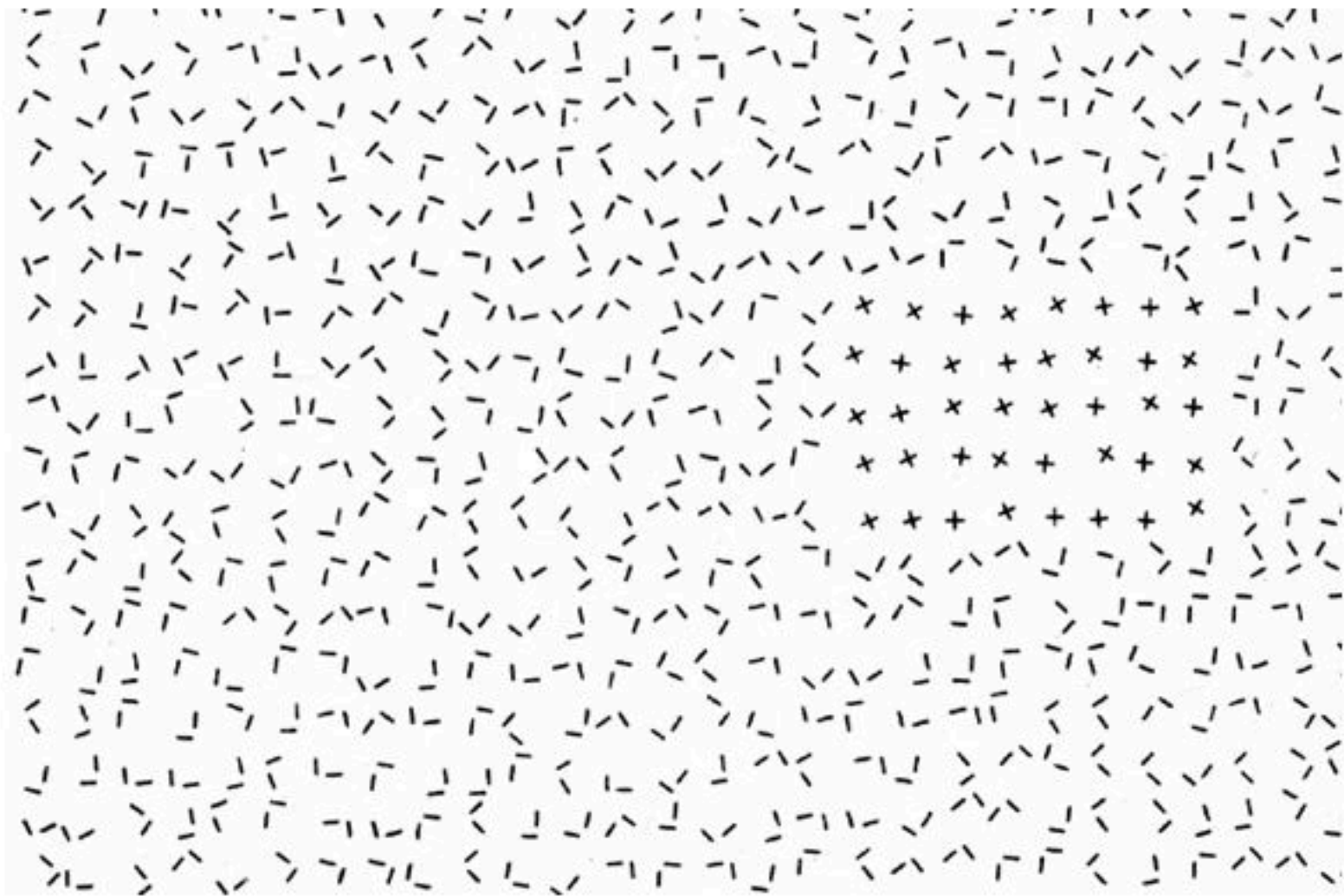
Les variables visuelles préattentives interfèrent les unes avec les autres.

Les variables visuelles préattentives restent préattentives dans certaines limites

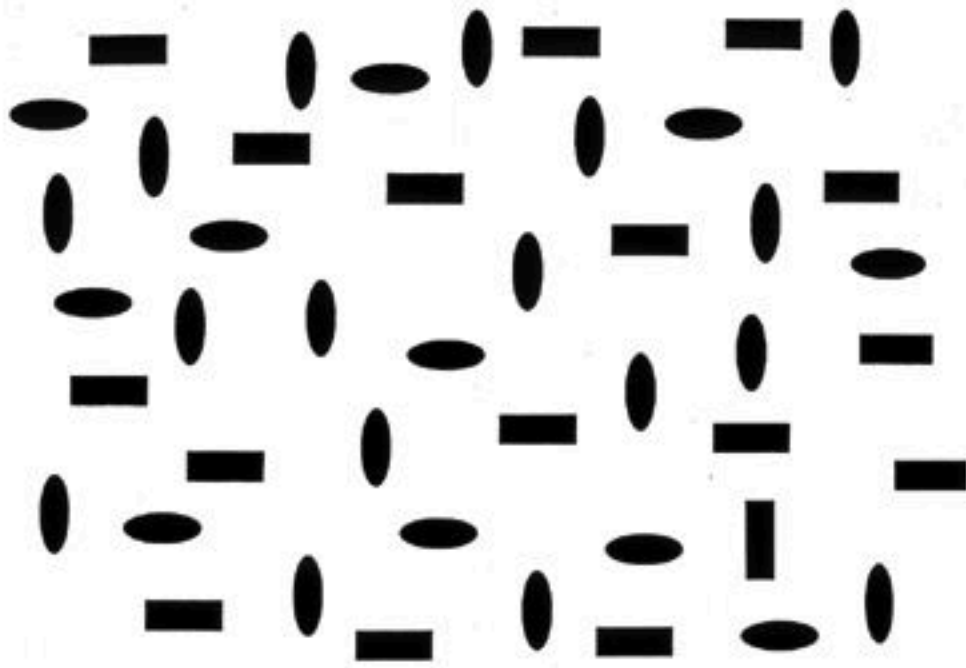
- 7 couleurs maximum
- 2 ou 3 formes
- ...



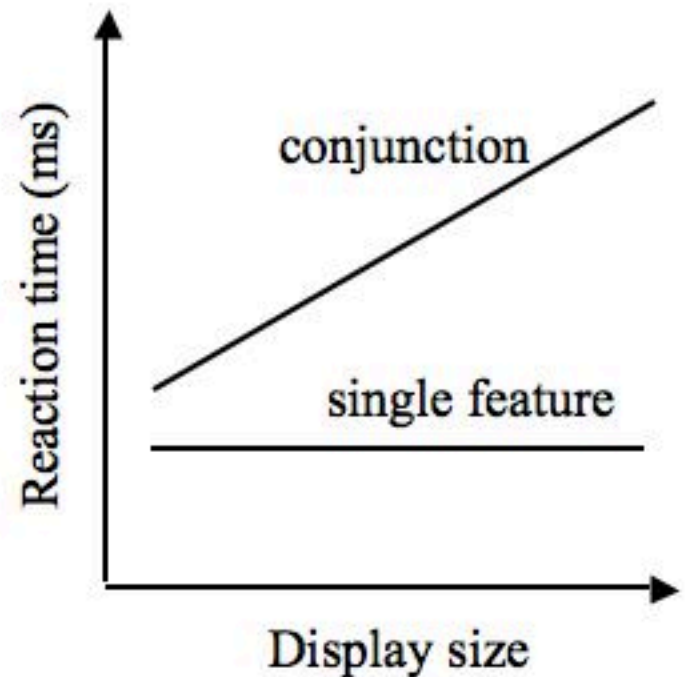
Visual search



Feature integration theory

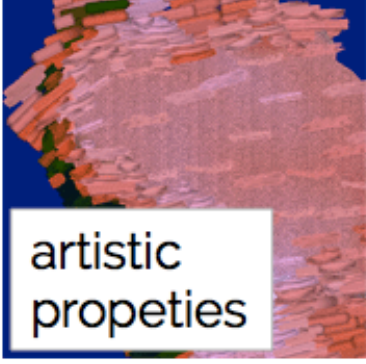
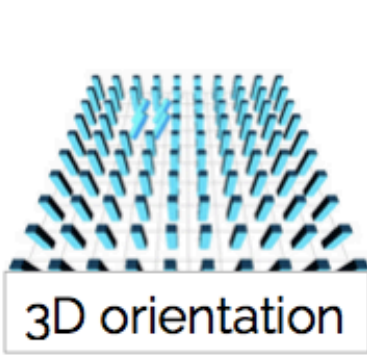
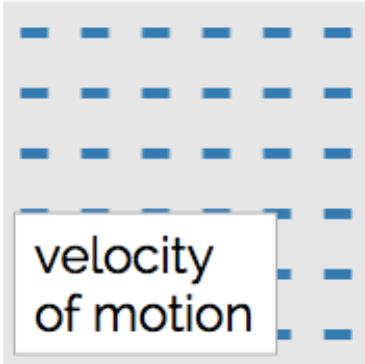
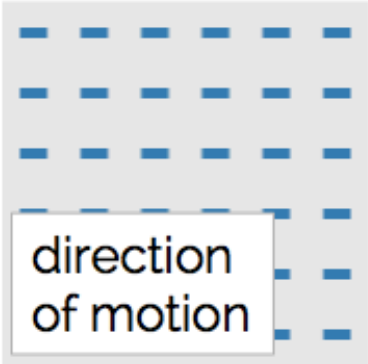
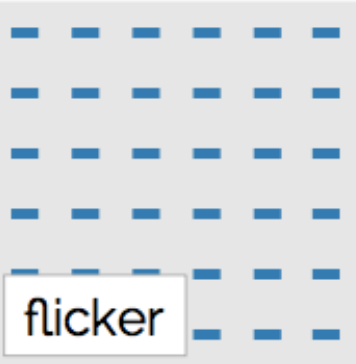
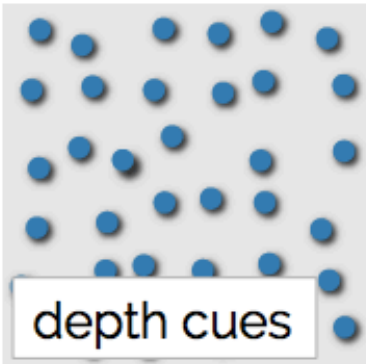
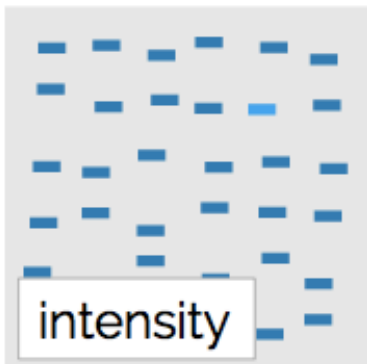
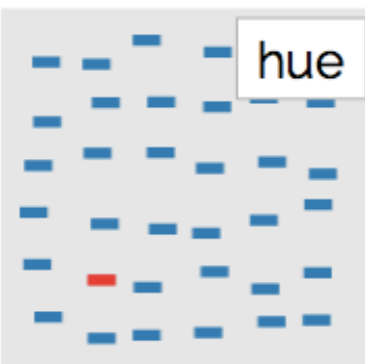
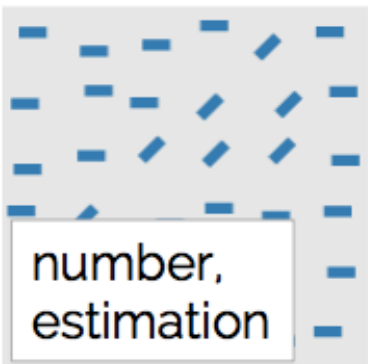
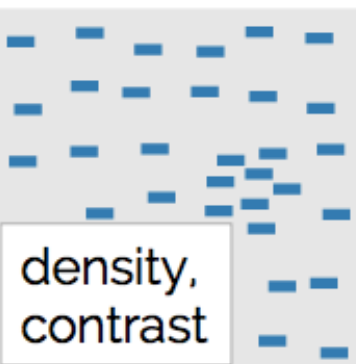
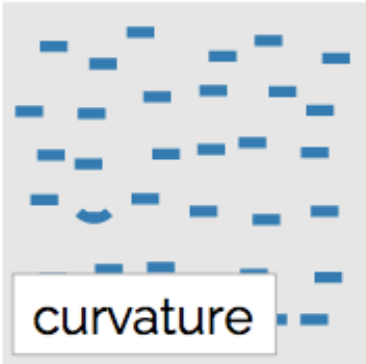
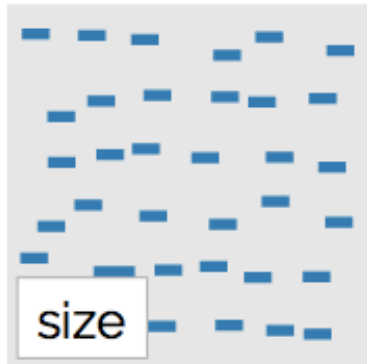
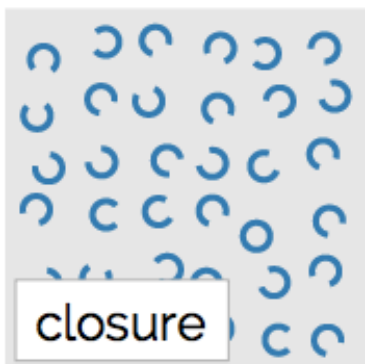
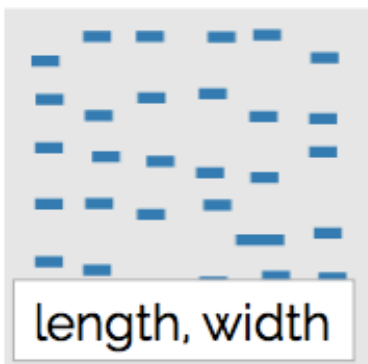
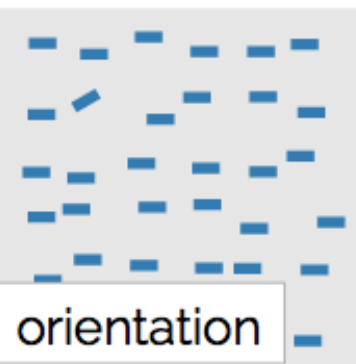


Conjunction search: find vertical rectangle



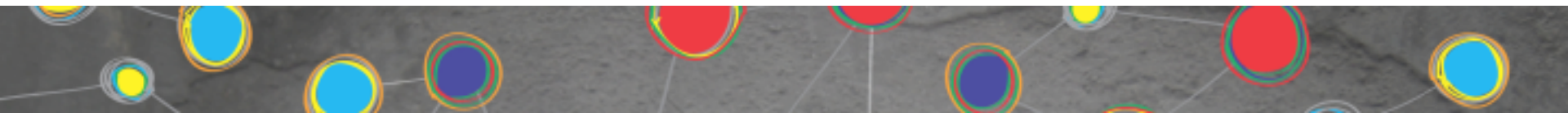
Set size effect

Les variables visuelles préattentives

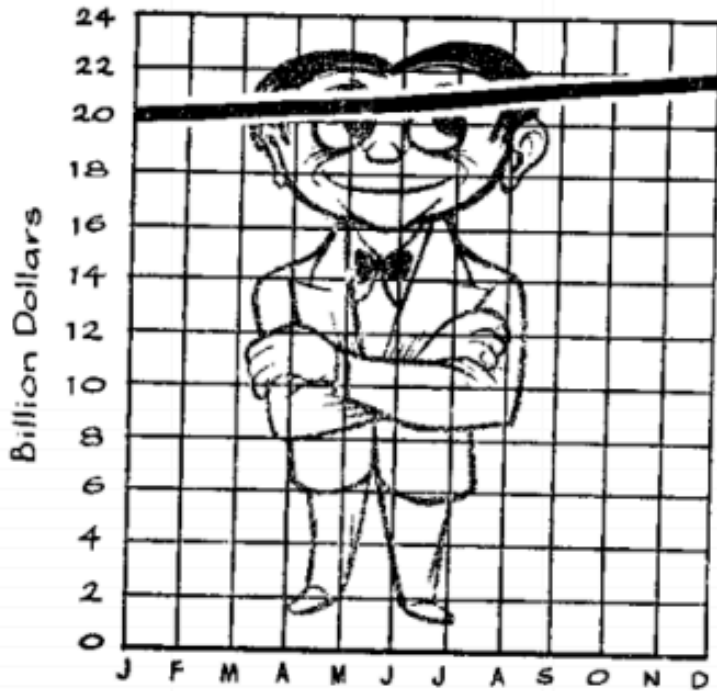


Je ne crois que ce que je vois !

Biais des représentations visuelles

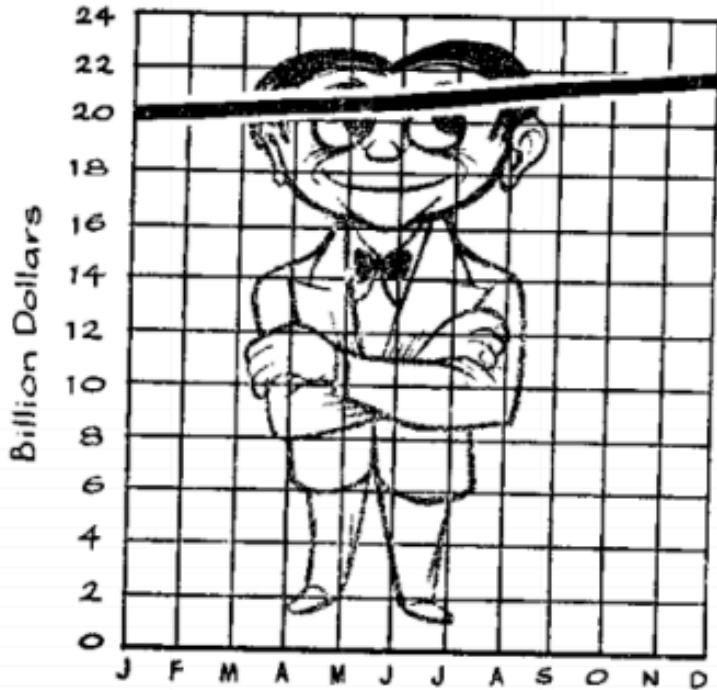


- Provide a proper baseline



A 10% increase. Good!

- Provide a proper baseline

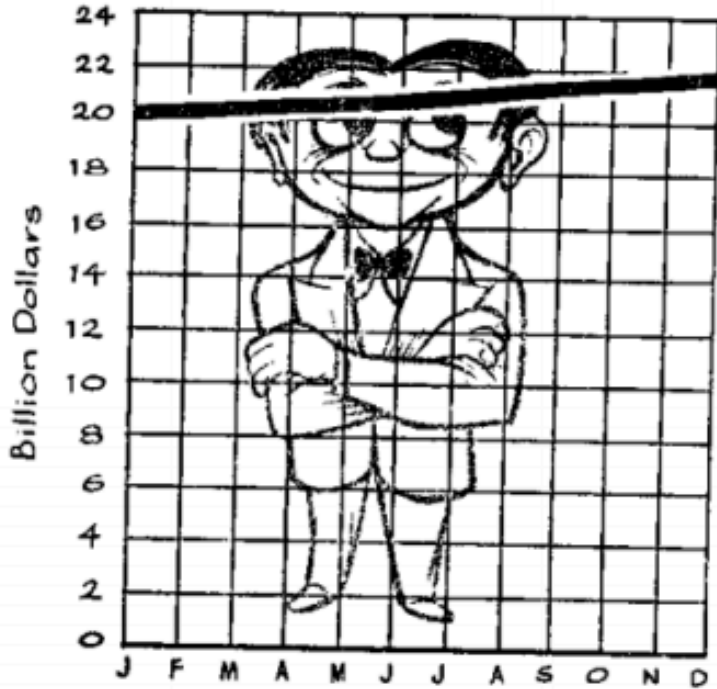


A 10% increase. Good!



Already looks more impressive

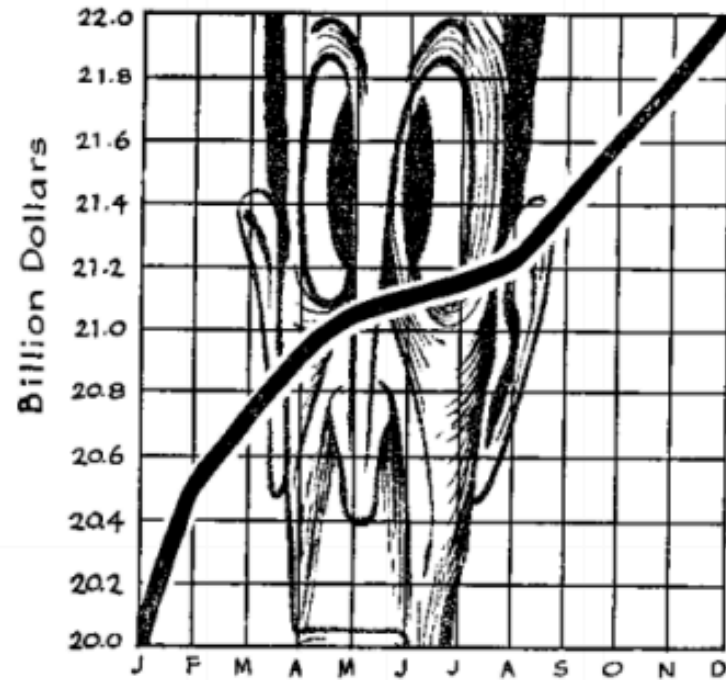
- Provide a proper baseline



A 10% increase. Good!

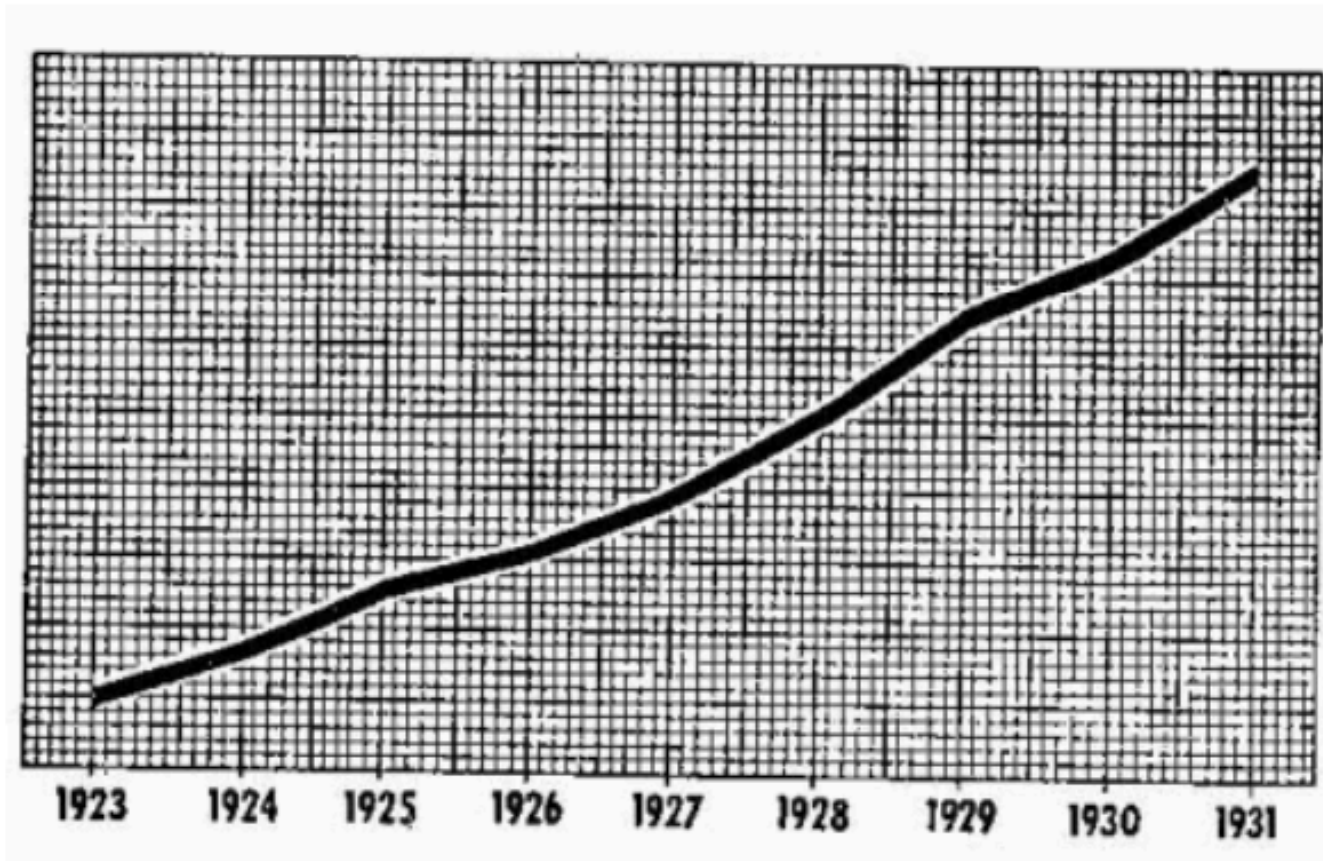


Already looks more impressive

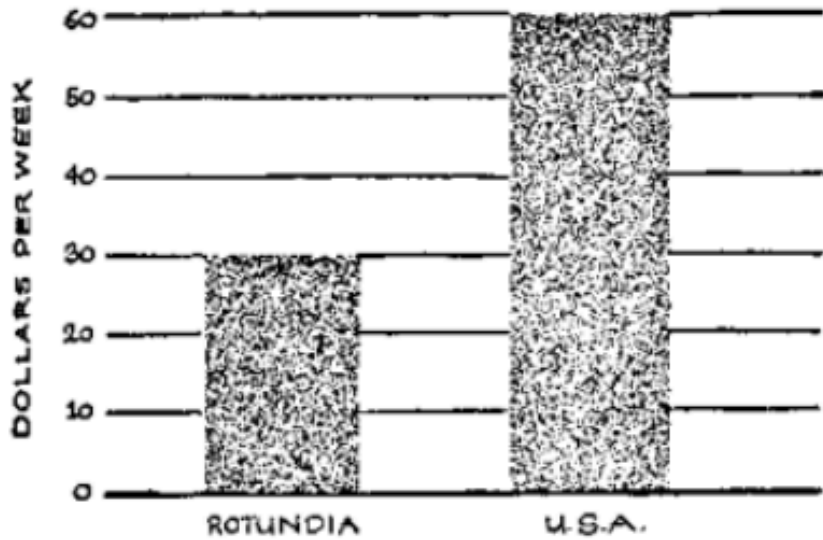


Wow!

- Provide a **proper baseline** & **label your axes**



- Provide a **proper baseline & label your axes**
- Avoid **eye-candy**



Actual data

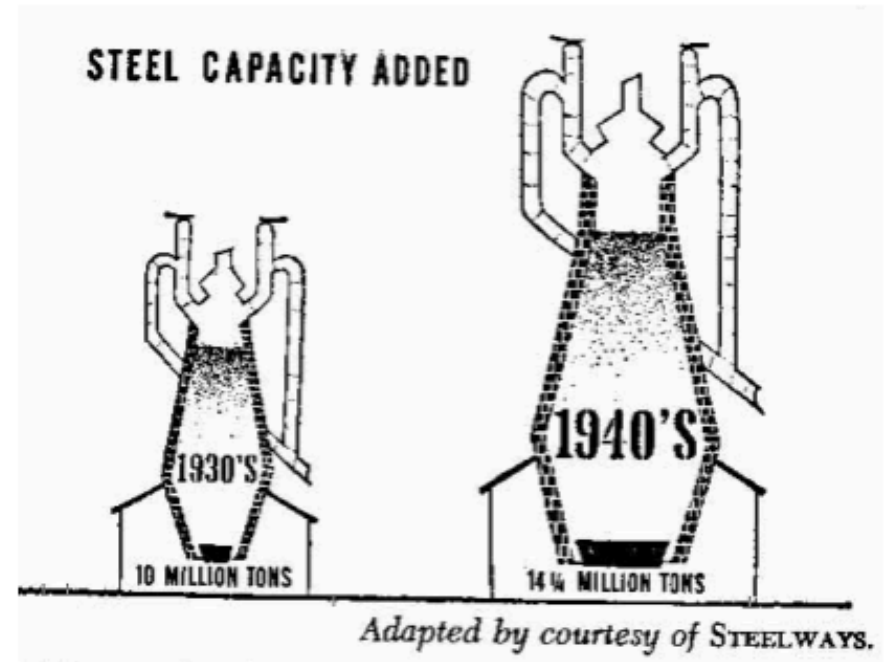


The same data with eye-candy & no numbers ... but at least it tells the same general story.



Impressive, but a lie!

- Provide a **proper baseline & label your axes**
- Avoid **eye-candy**
- Avoid **area comparisons** whenever possible



2012 PRESIDENTIAL RUN

GOP CANDIDATES



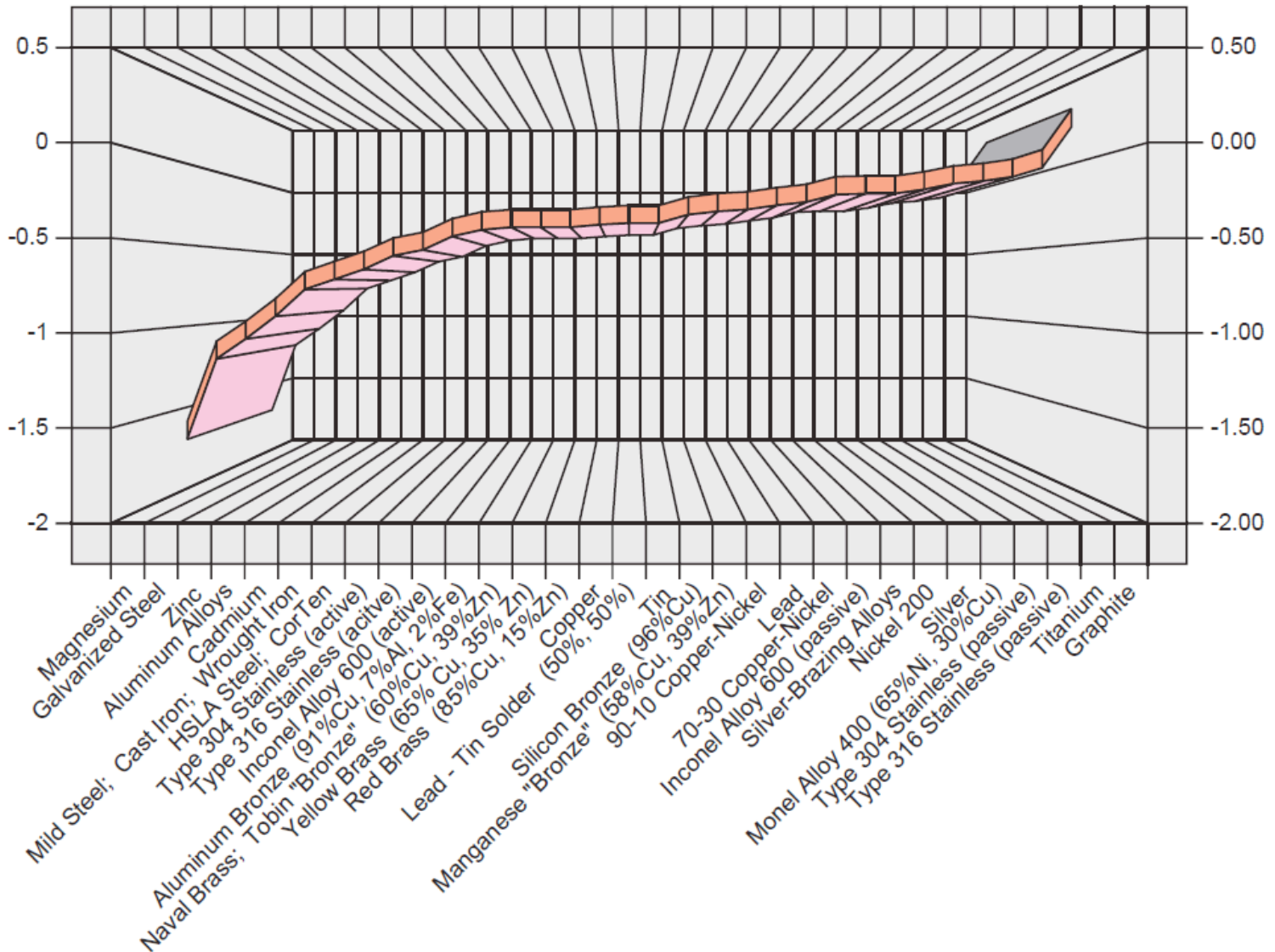
FOX

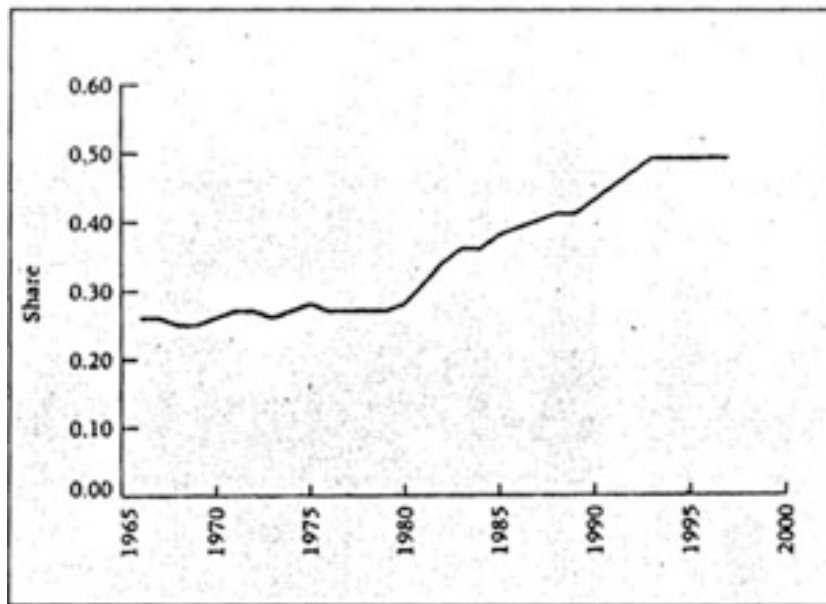
47'

SOURCE: OPINIONS

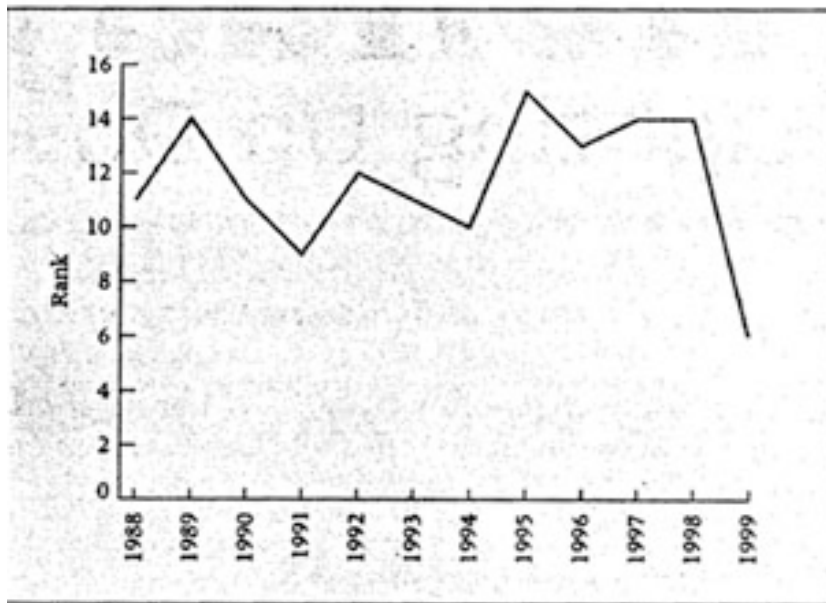
DYNAMIC

Average Voltage in Seawater



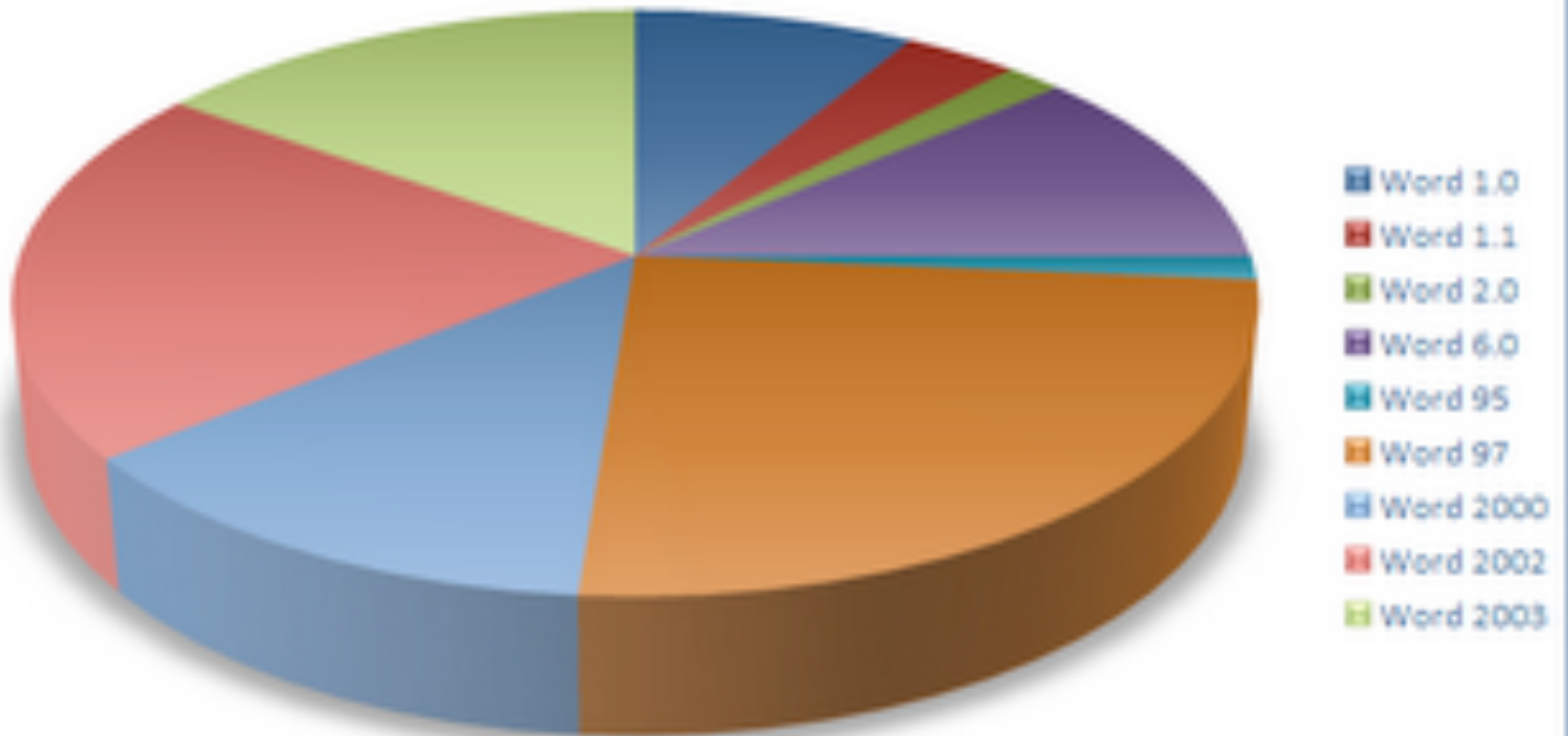


BY THE NUMBERS: OVER 35 YEARS, CORNELL'S TUITION HAS TAKEN AN INCREASINGLY LARGER SHARE OF ITS MEDIAN STUDENT FAMILY INCOME.



PECKING ORDER: OVER 12 YEARS, CORNELL'S RANKING IN *US NEWS & WORLD REPORT* HAS RISEN AND FALLEN ERRATICALLY.

Microsoft Word Features By Version Added



Sotheby's / Christie's

Worldwide Sales

Market Share Analysis

1985



1986



1987



1988



1989



1990

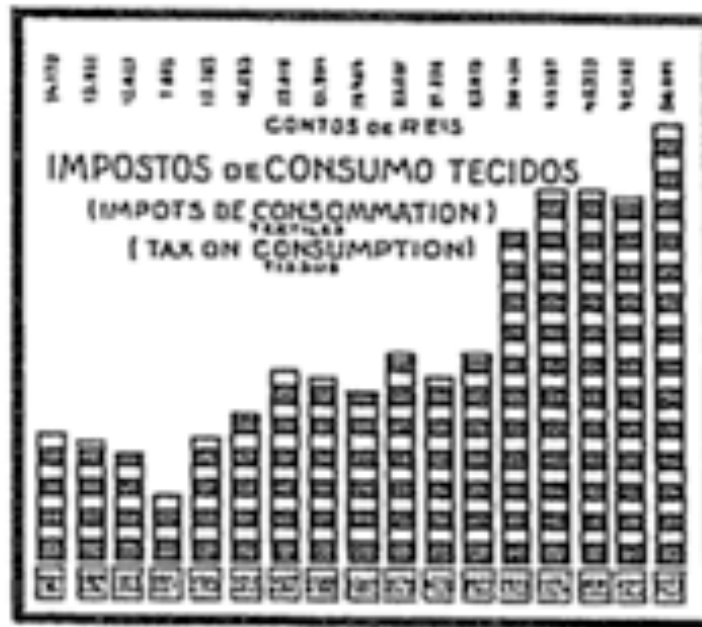
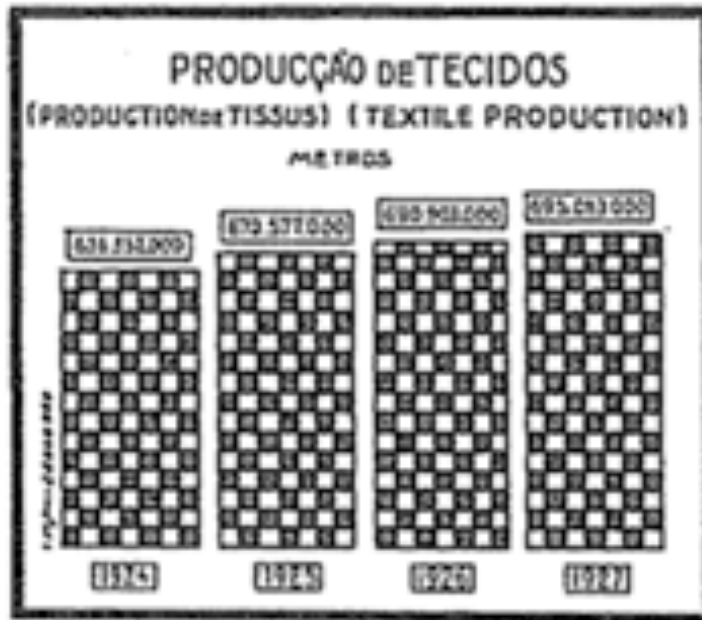


SOTHEBY'S



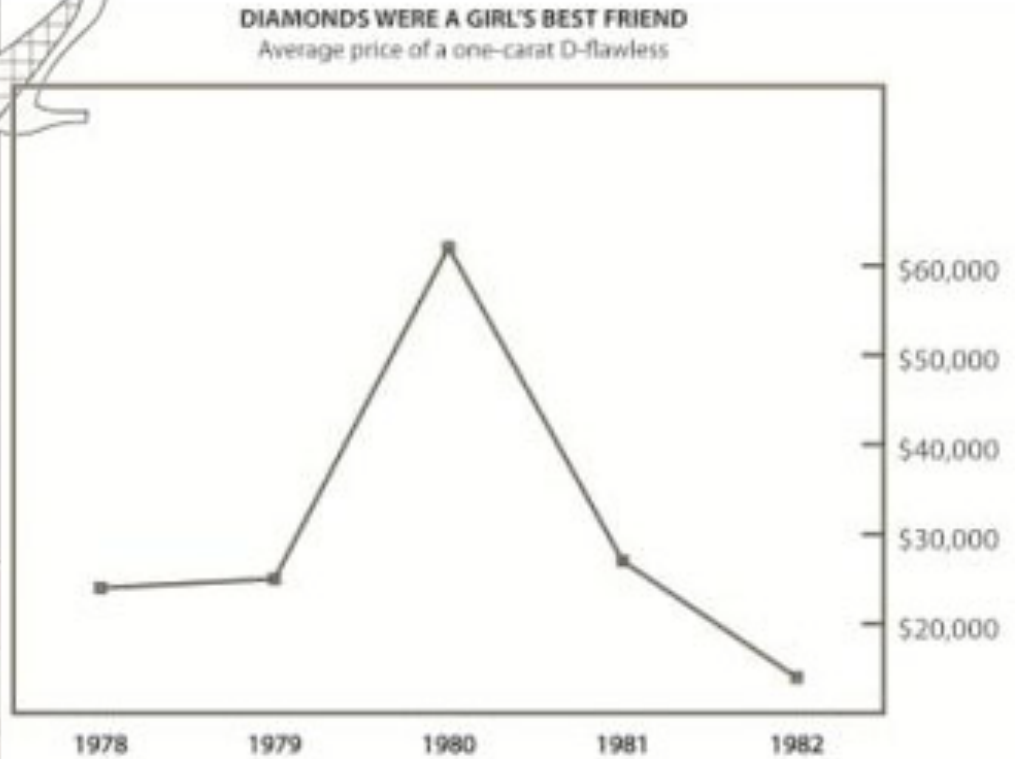
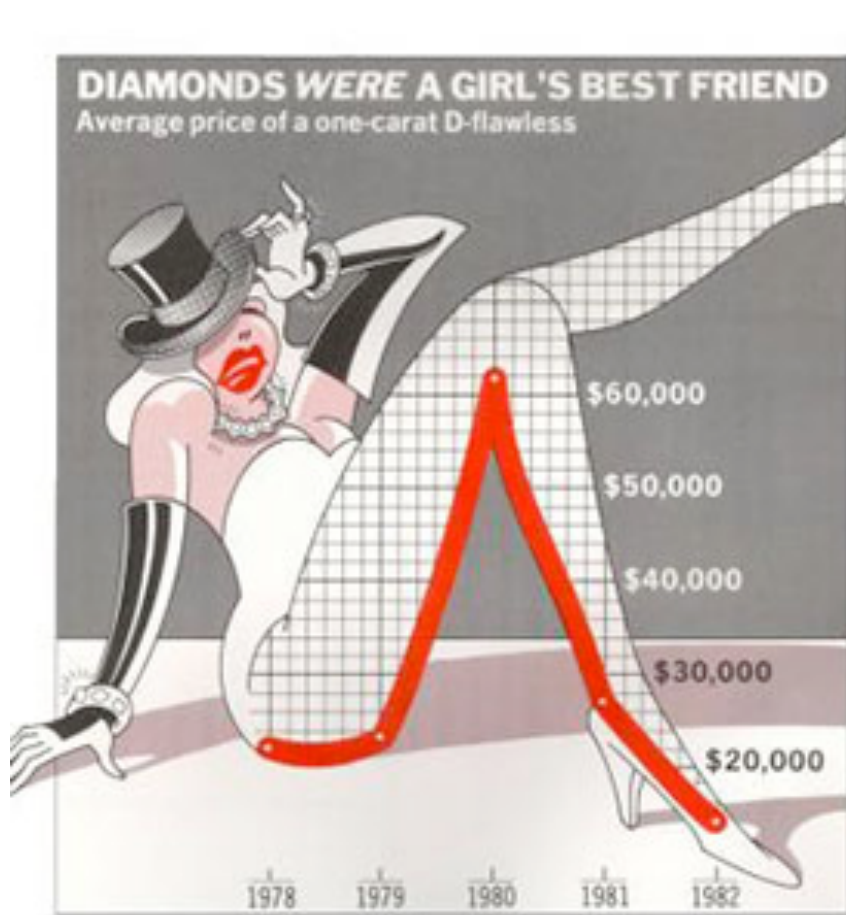
CHRISTIE'S

Market Share Analysis With Buyer's Premium



Carta Estatística
1991

[Source: How to lie with statistics]

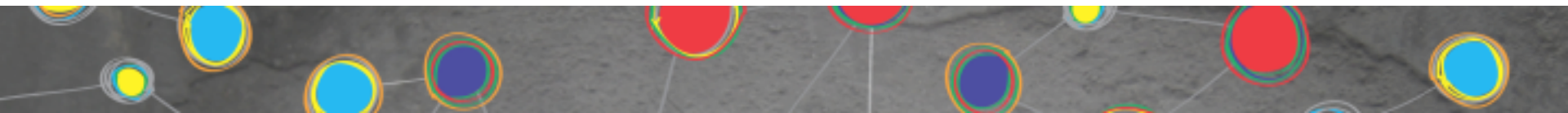


Bateman, S. et al. *Useful Junk? The Effects of Visual Embellishment on Comprehension and Memorability of Charts*, CHI 2010

<http://hci.usask.ca/publications/view.php?id=173>

Je ne crois que ce que je vois !

Biais de notre perception



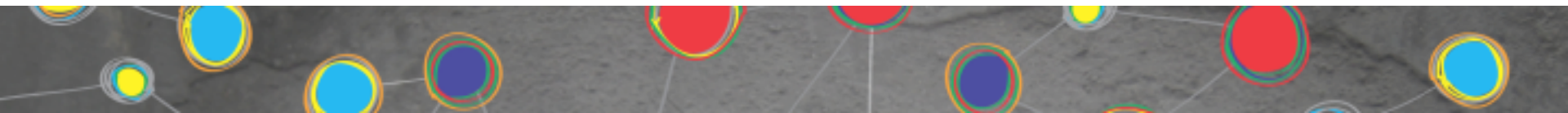


[Rensing, 2002]

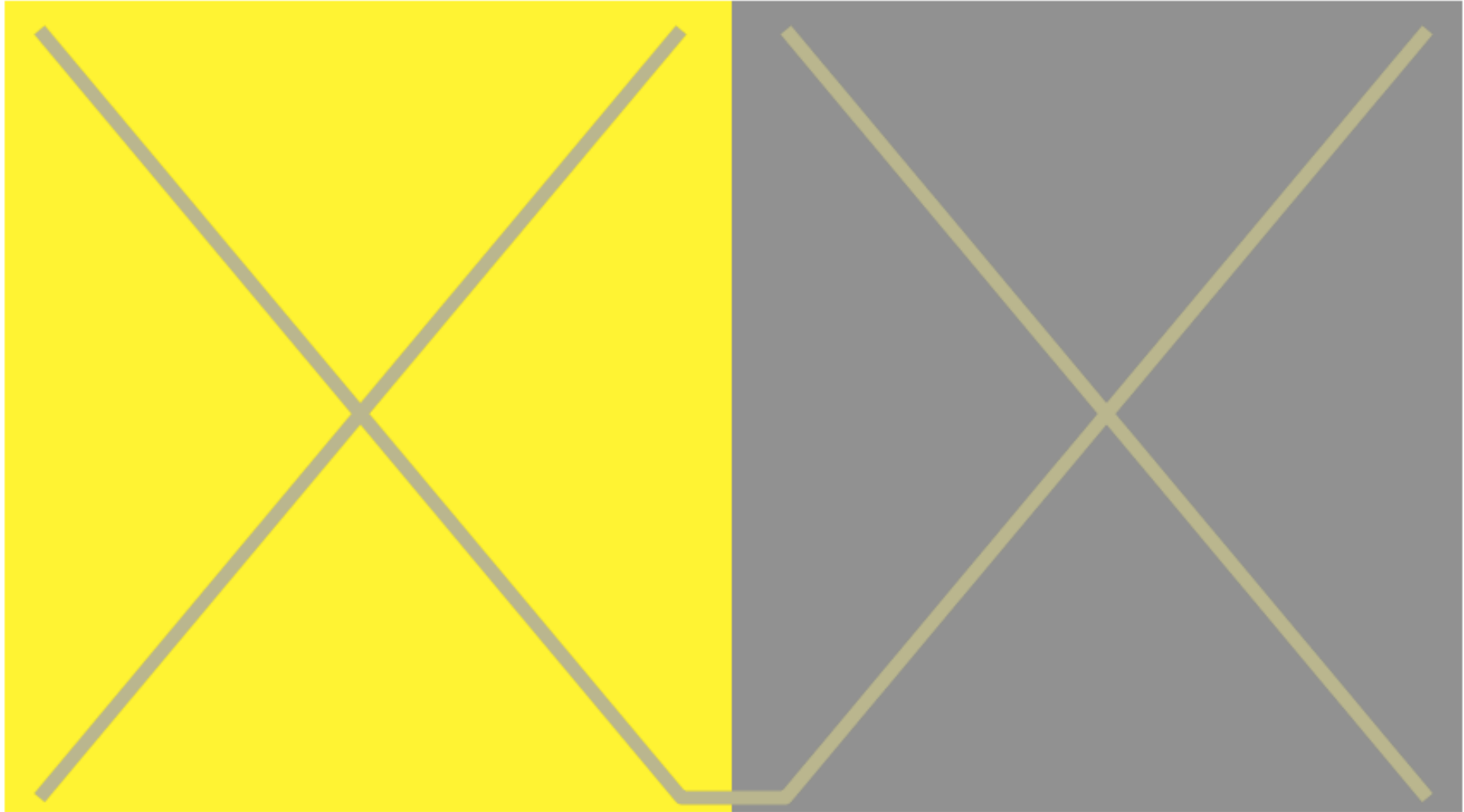


[Rensing, 2002]

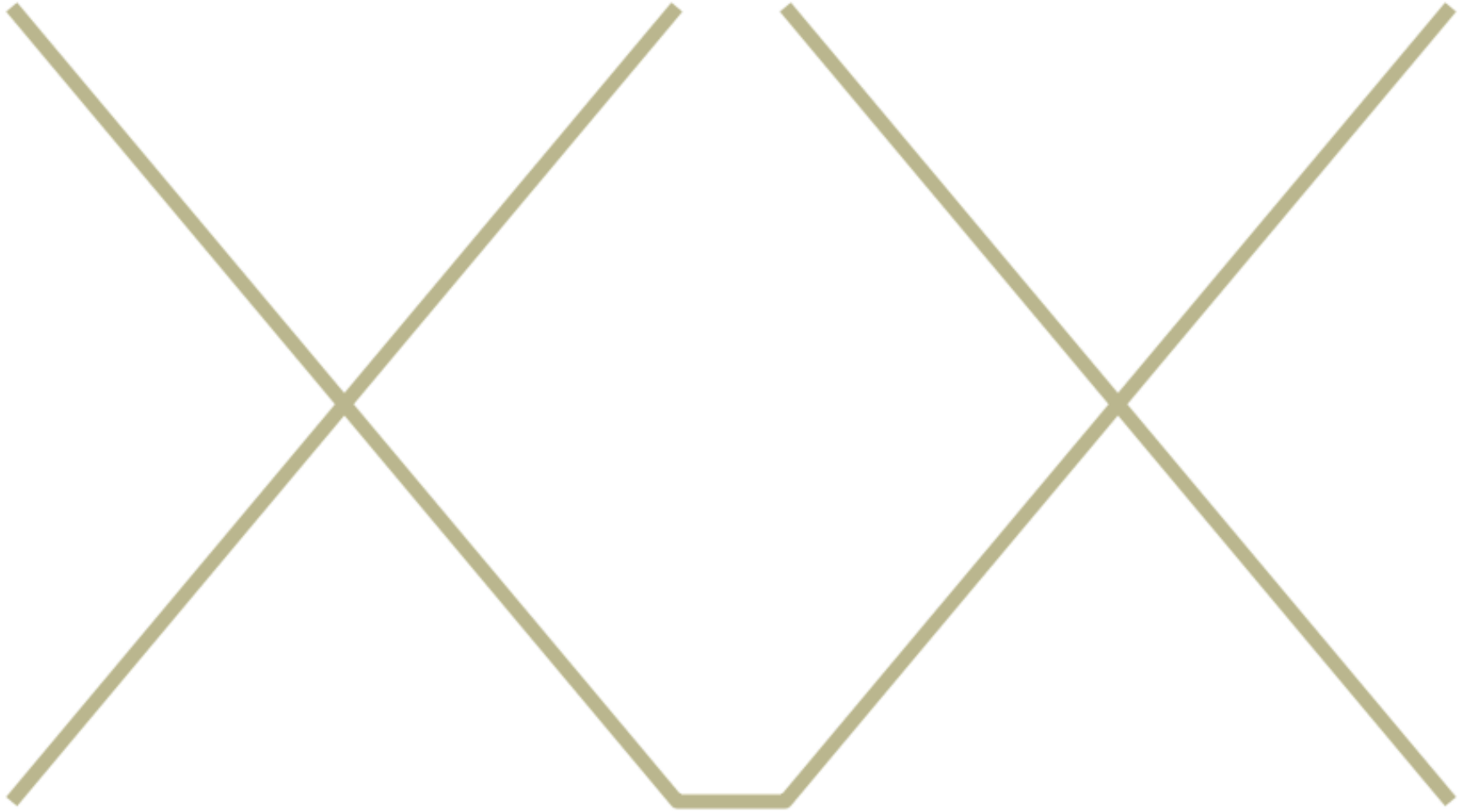
Peut-on vraiment croire
ce que l'on voit ?



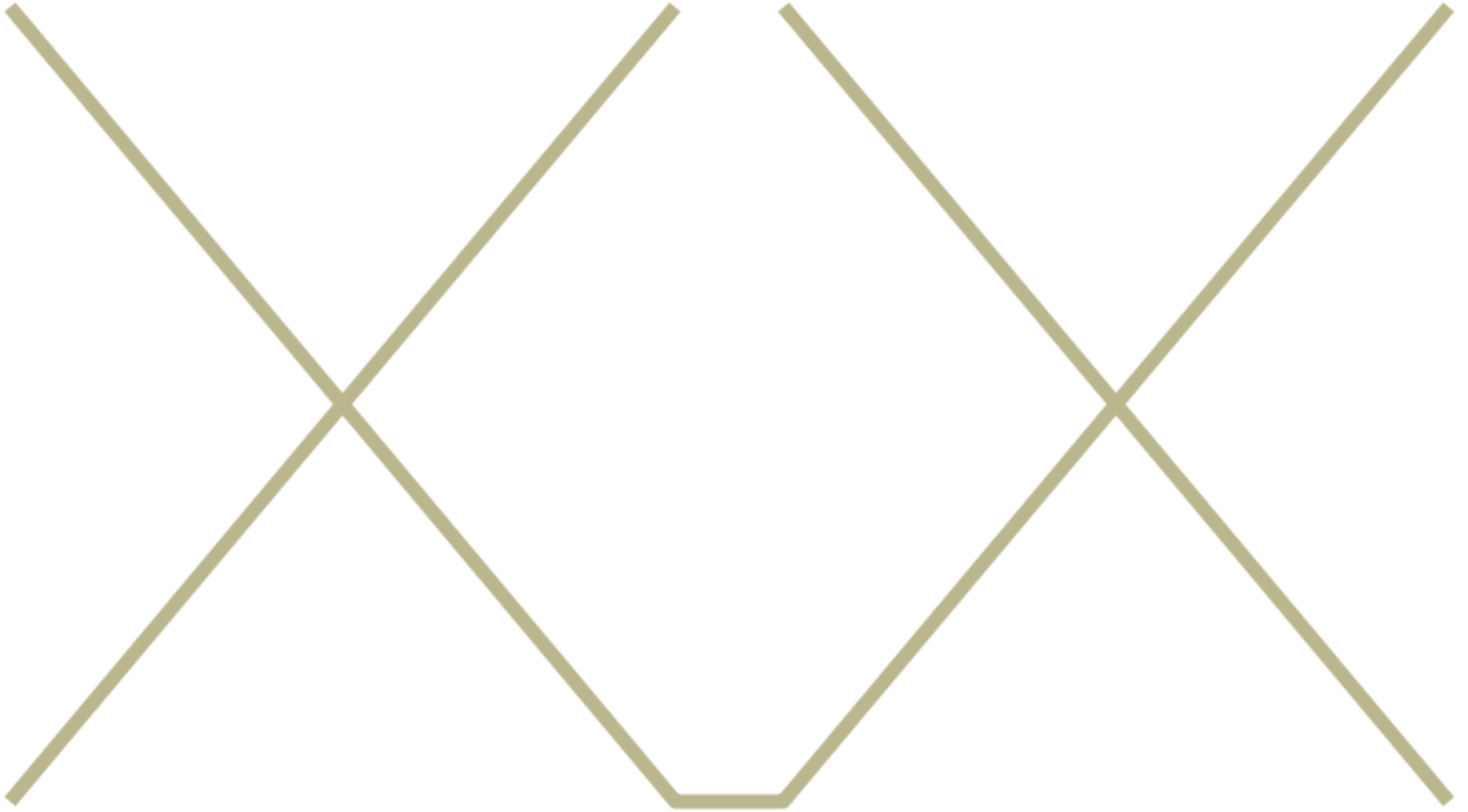
Perception des couleurs



Perception des couleurs



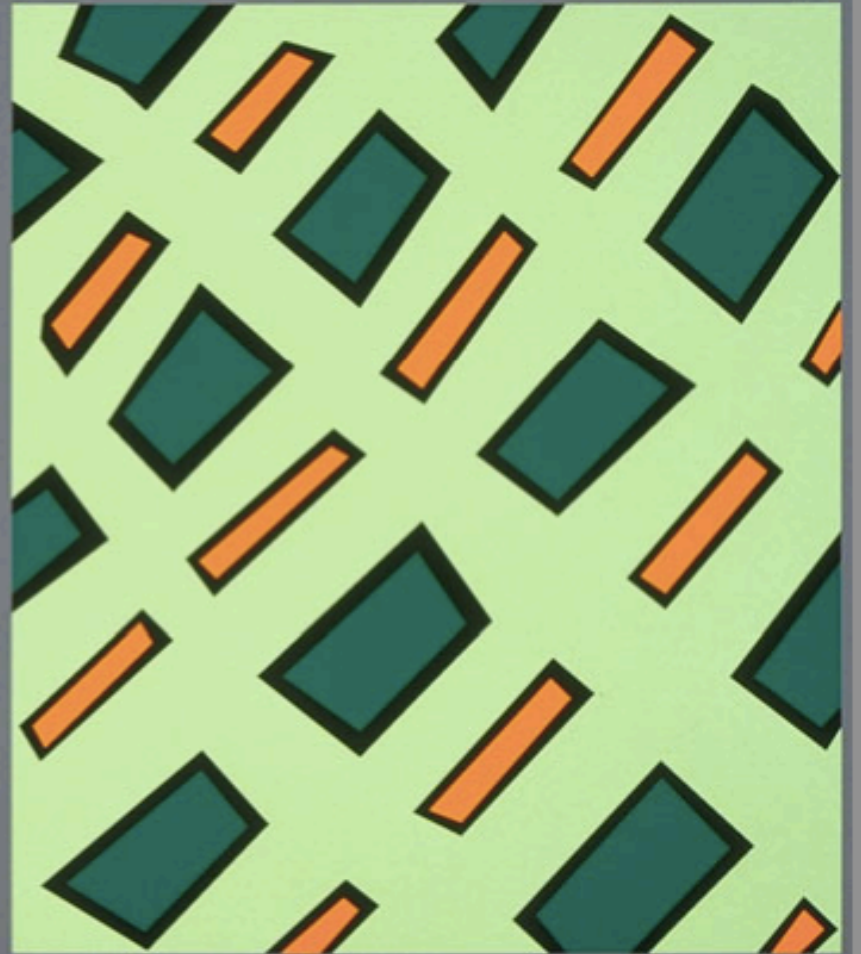
Contraste simultané

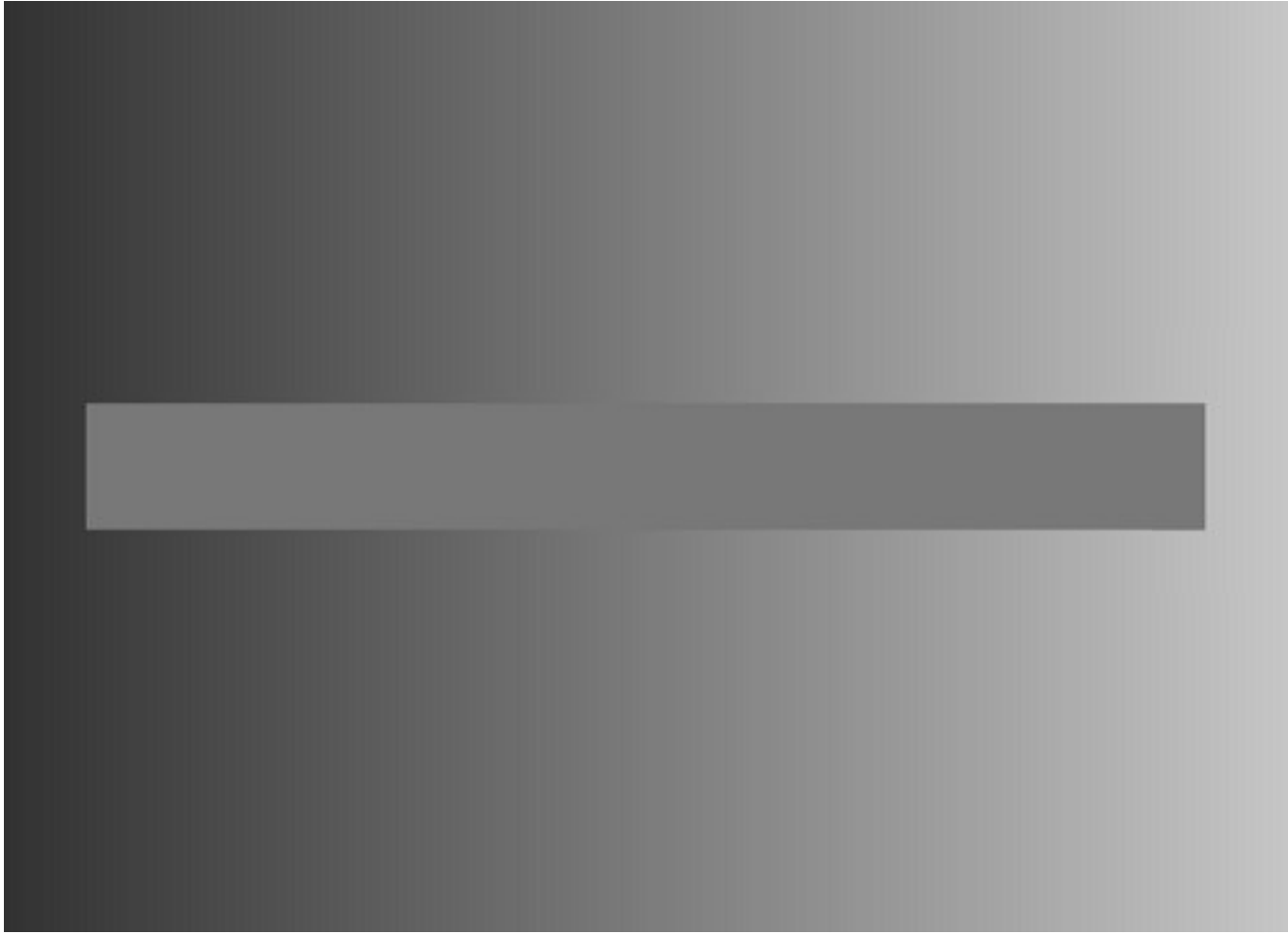


Contraste simultané

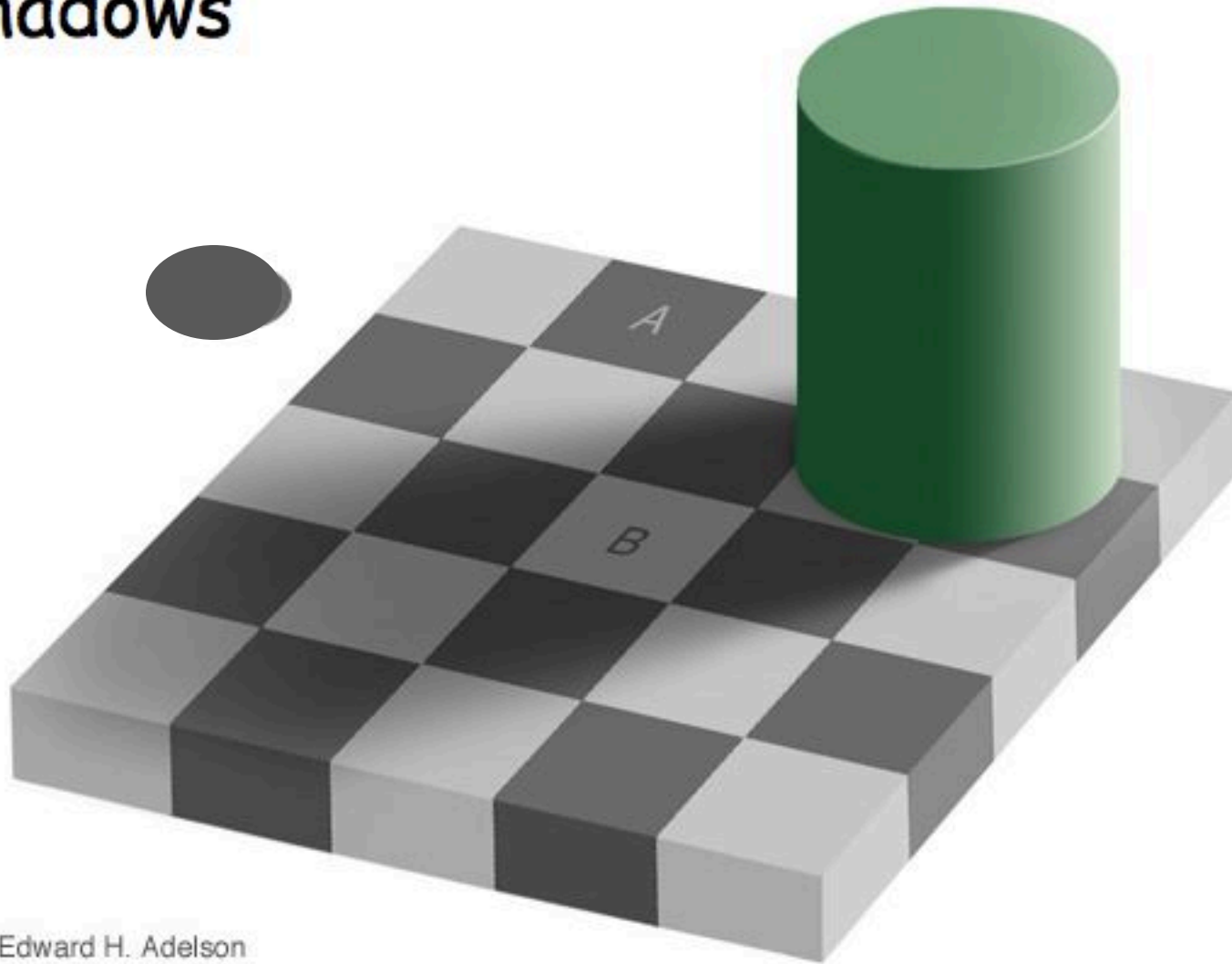


Effet de Bezold





Shadows



Edward H. Adelson

Koffka ring illusion

Top: A gray ring on a light/dark background looks uniform.

Middle: But when the halves are split they look quite different. This is like a variant of the simultaneous brightness contrast illusion.

Bottom: A version in which the halves are slid vertically, giving an impression of transparency.

Even though the half-rings are set against the same backgrounds, their appearance depends on the overall spatial configuration.



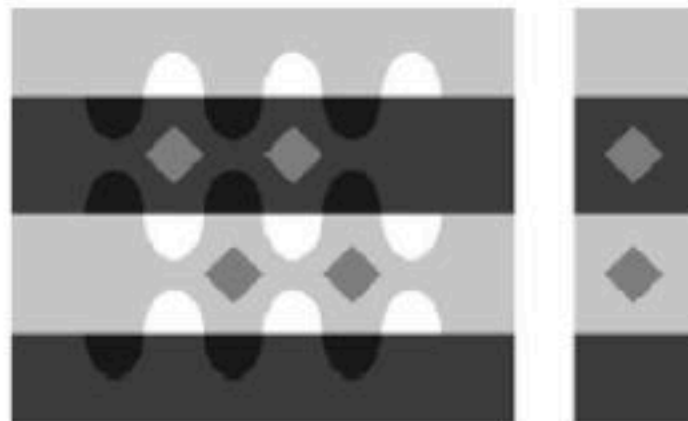
Adelson snake illusion

Top: Strong illusion. The lightness of the diamonds are compared with the other grays in the same horizontal strip. The diamonds are the brightest features within the dim strip at the top, but they are the darkest feature within the light strip at the bottom.

Bottom: Weak illusion without the horizontal strips, from simultaneous brightness contrast.

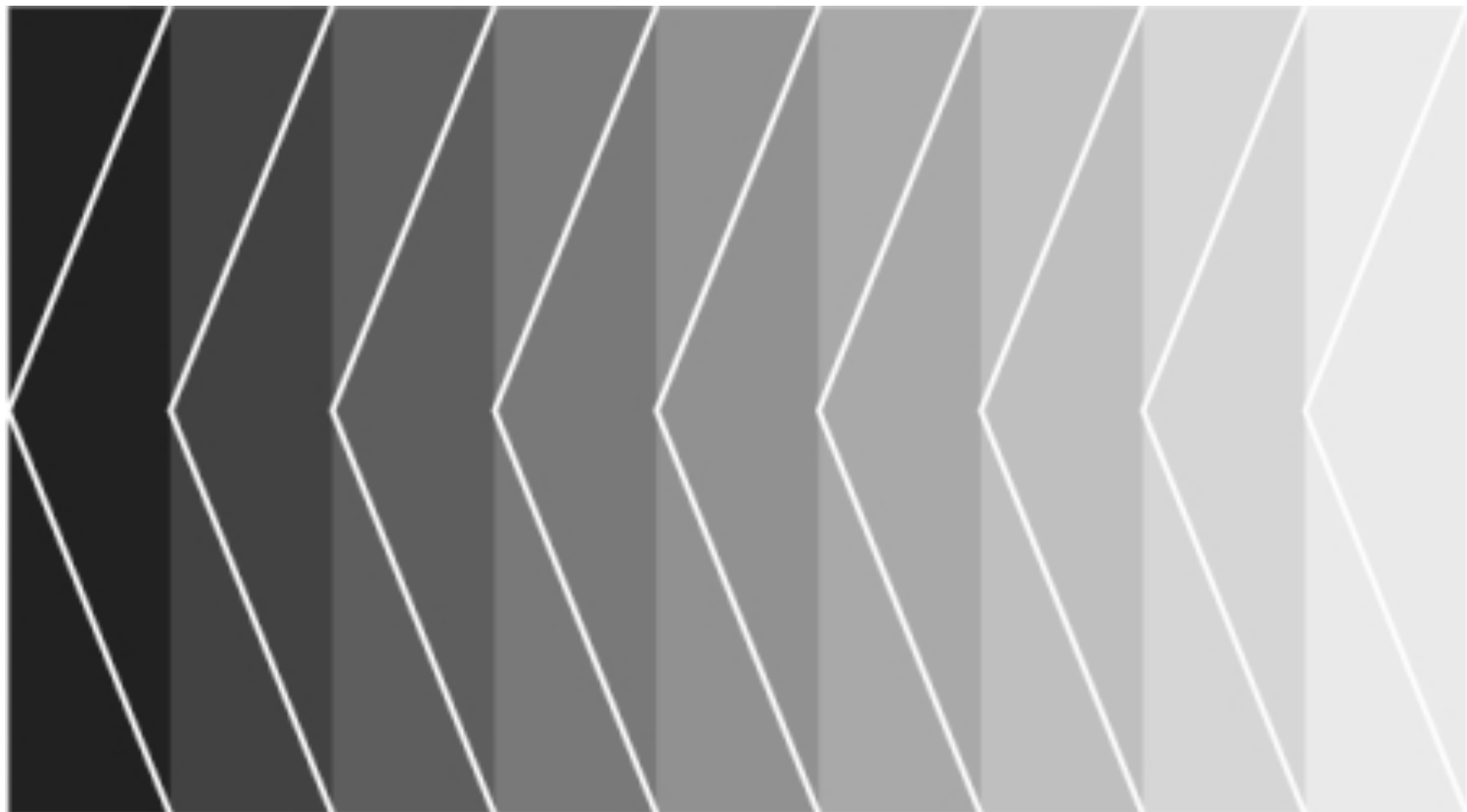
The only difference between the snake and anti-snake is the addition of some half-ellipses that define the horizontal strips.

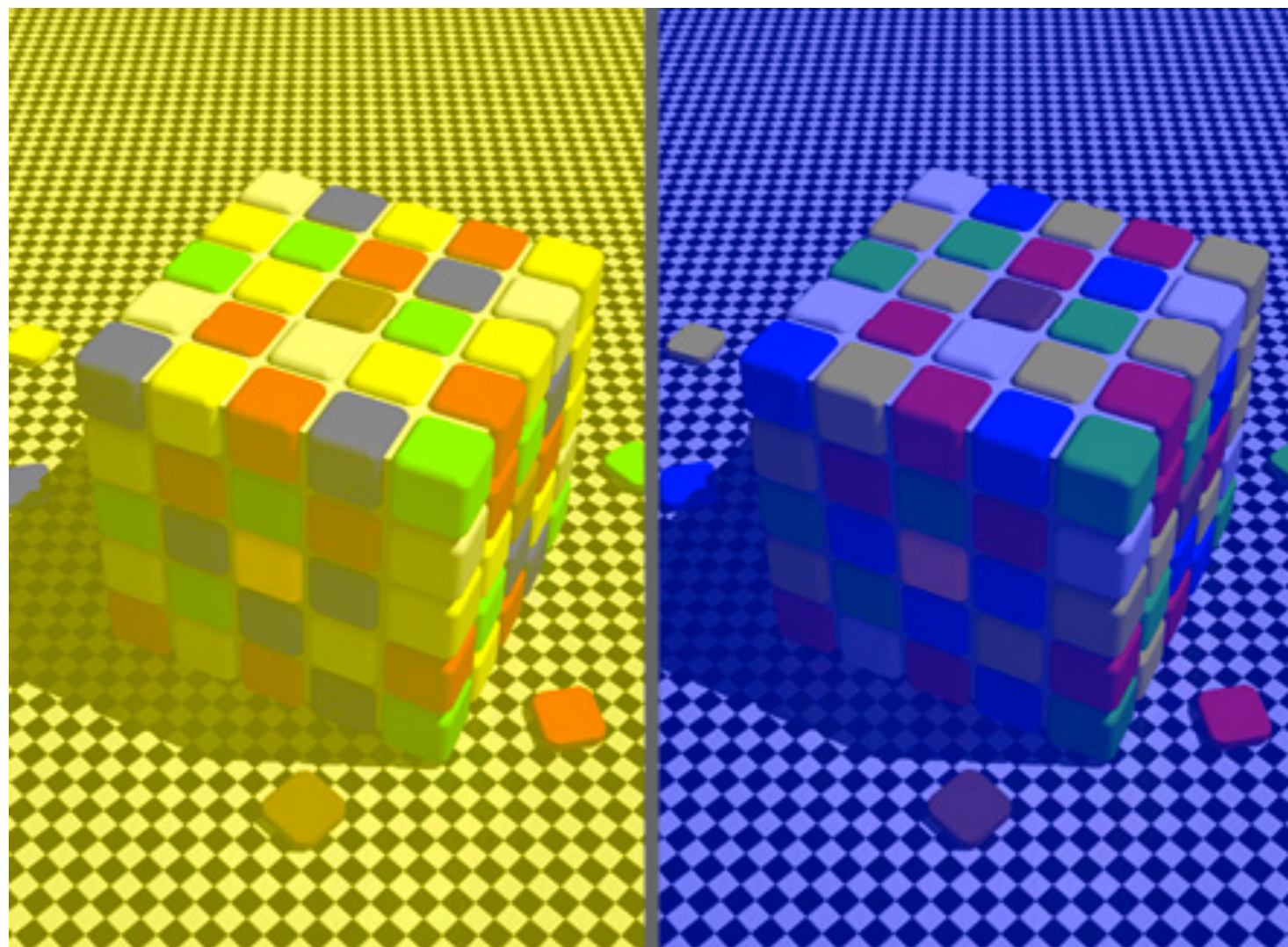
snake



anti-snake



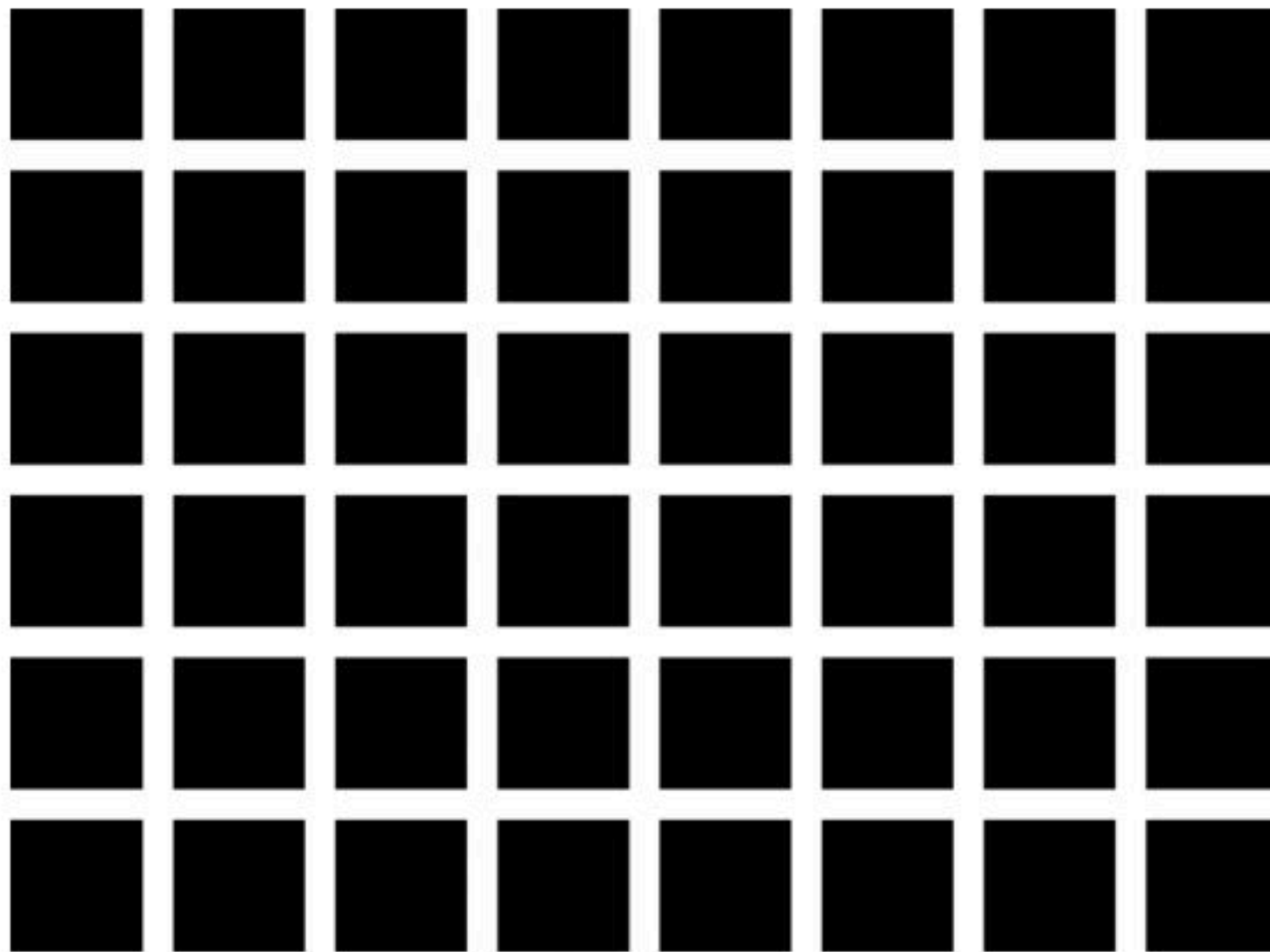




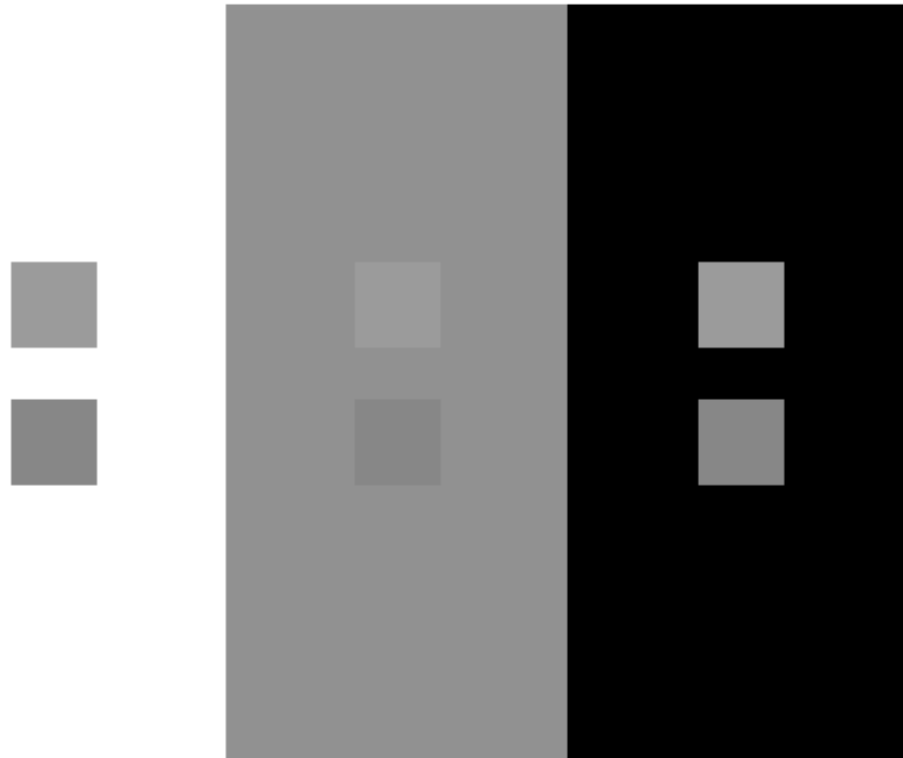
Chromatic adaptation

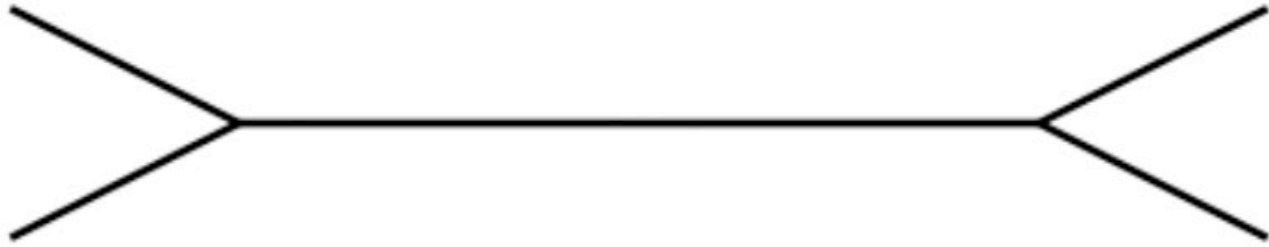
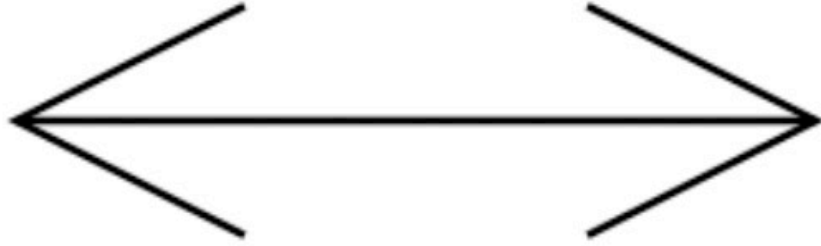


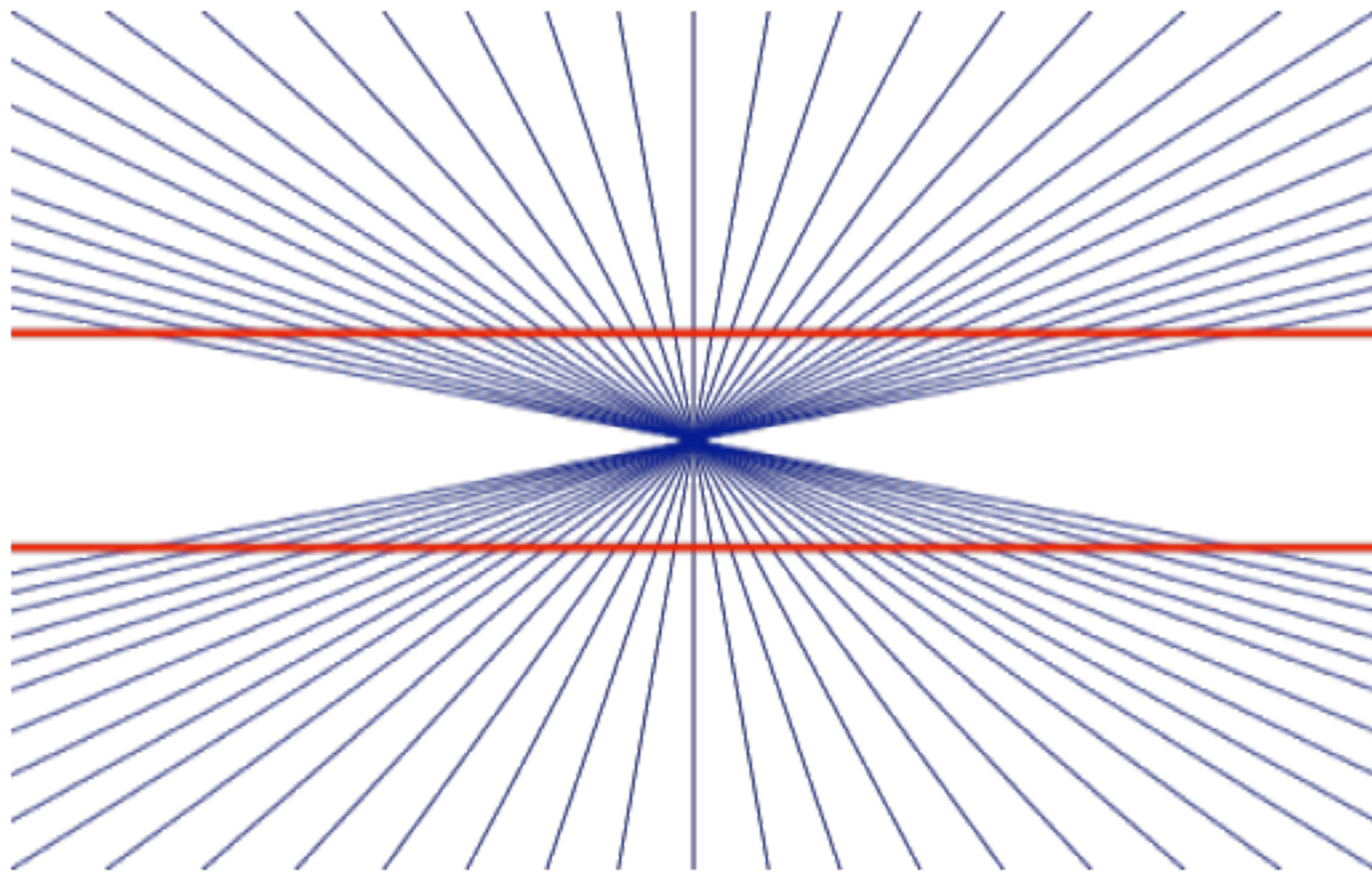
Hermann grid



La perception de différences dépend du background (contexte)

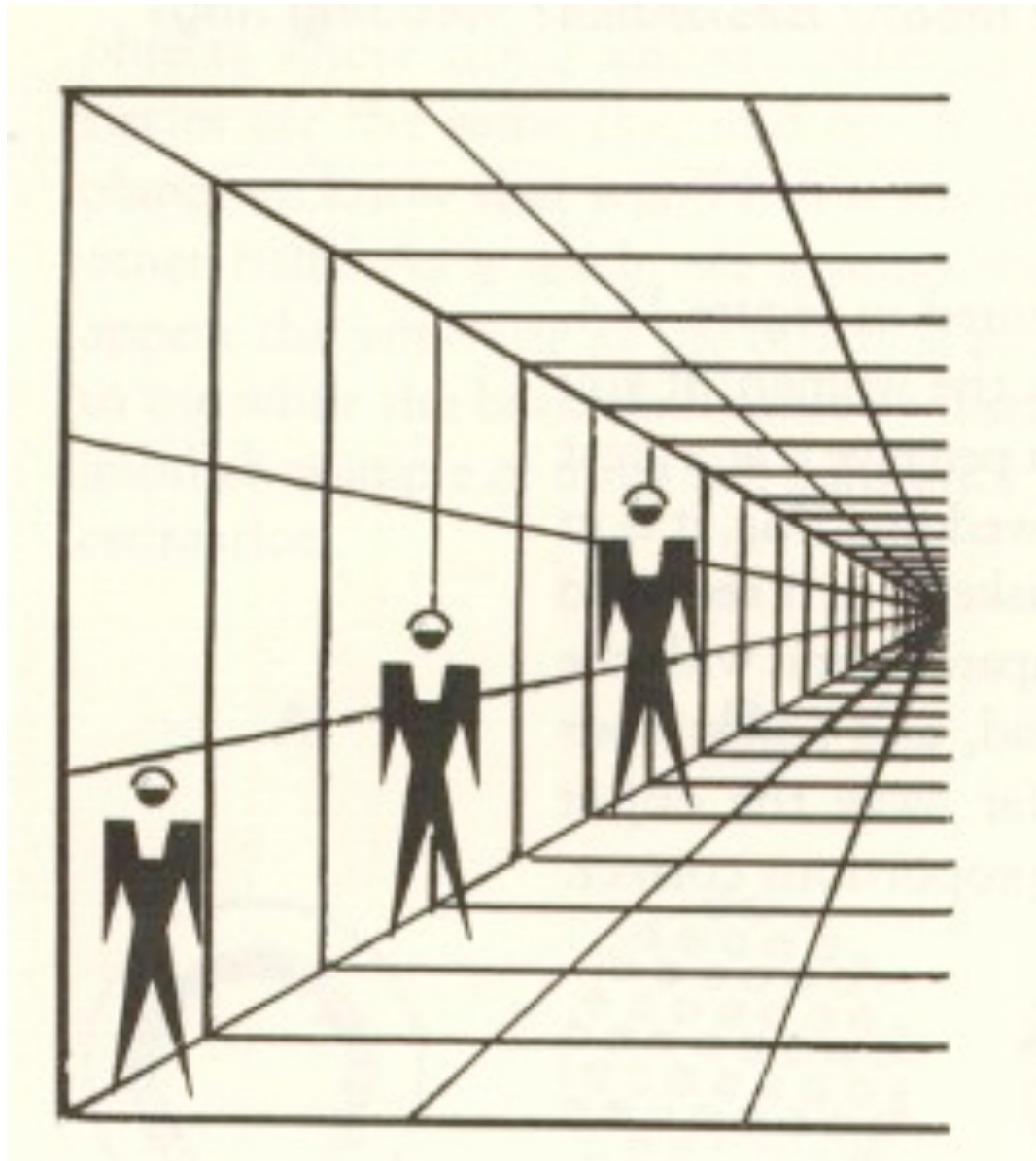




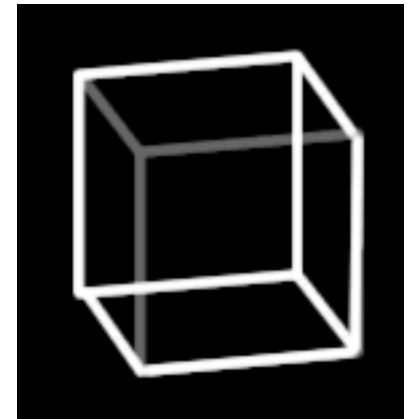
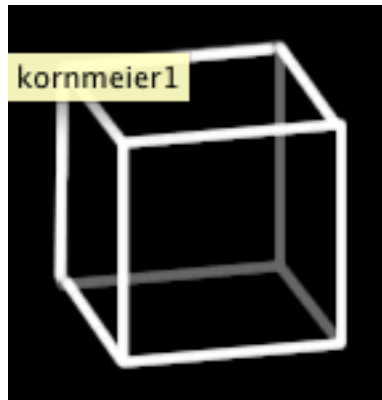
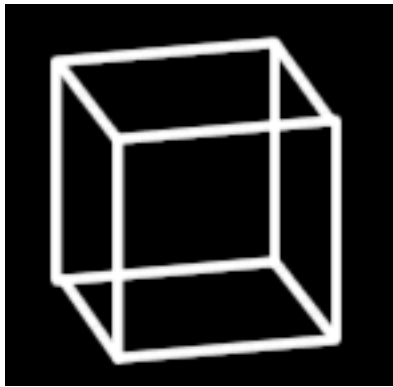




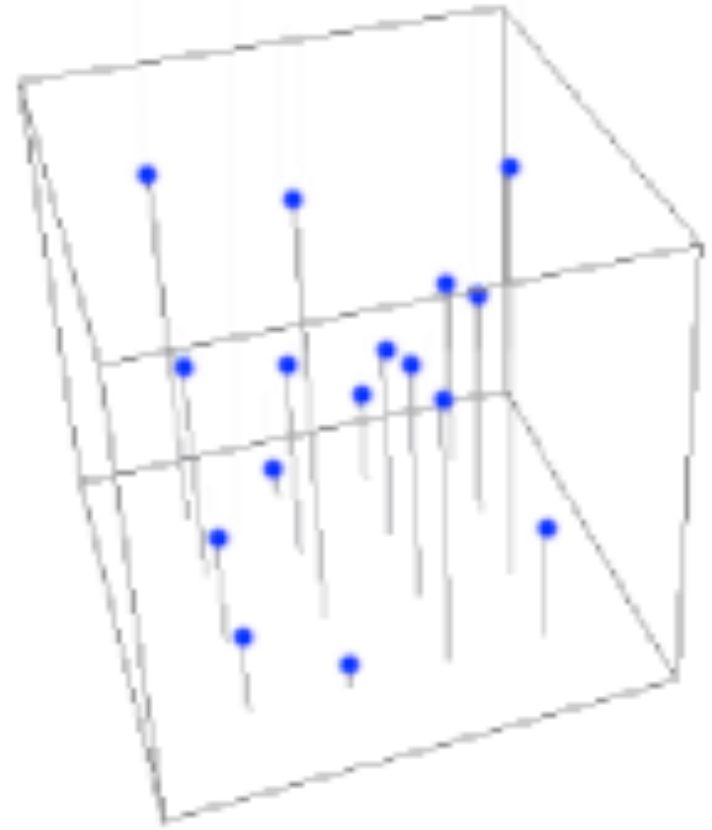
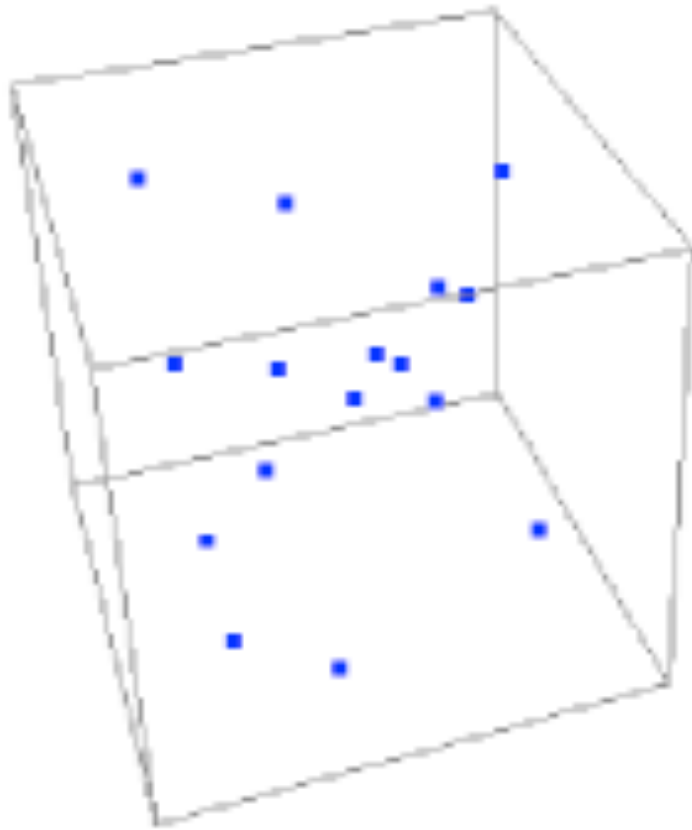
Perception de profondeur



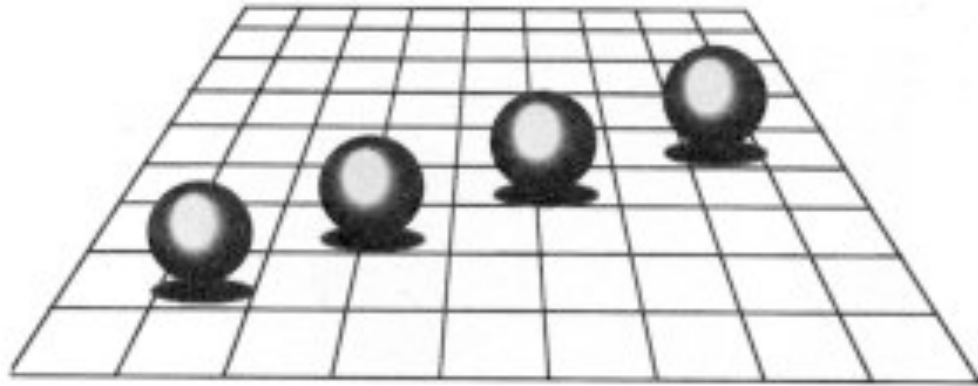
Perception de profondeur



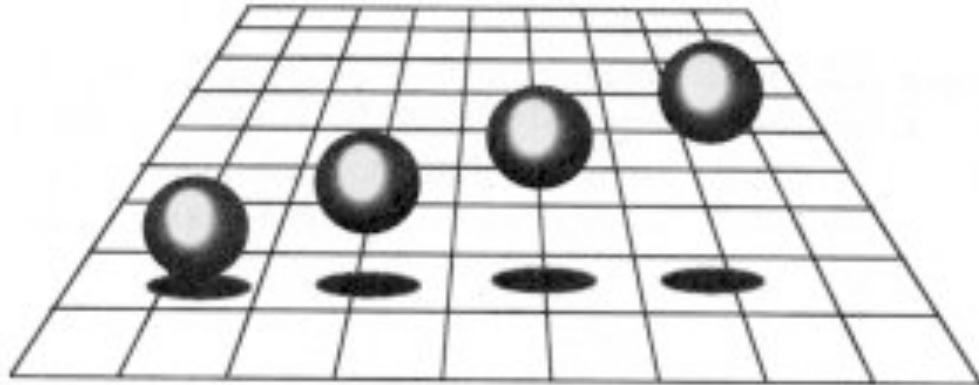
Perception de profondeur



Perception de profondeur

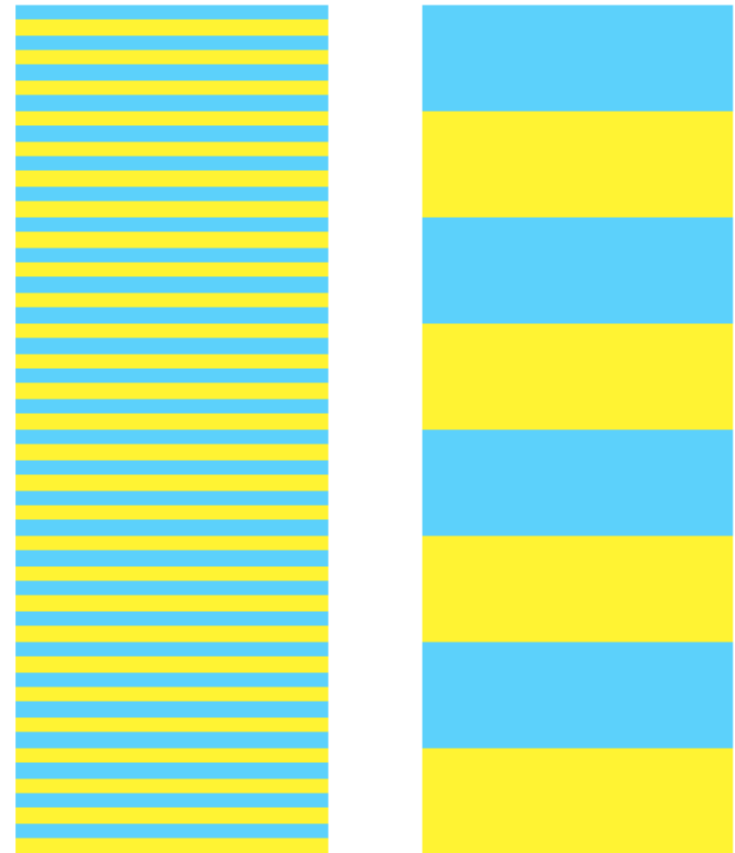


A



B

Les couleurs adjacentes, lorsqu'elles sont placées à plus haute fréquence spatiale, se mélangent



Redrawn from *Foundations of Vision*
© Brian Wandell, Stanford University

gestalt laws of grouping



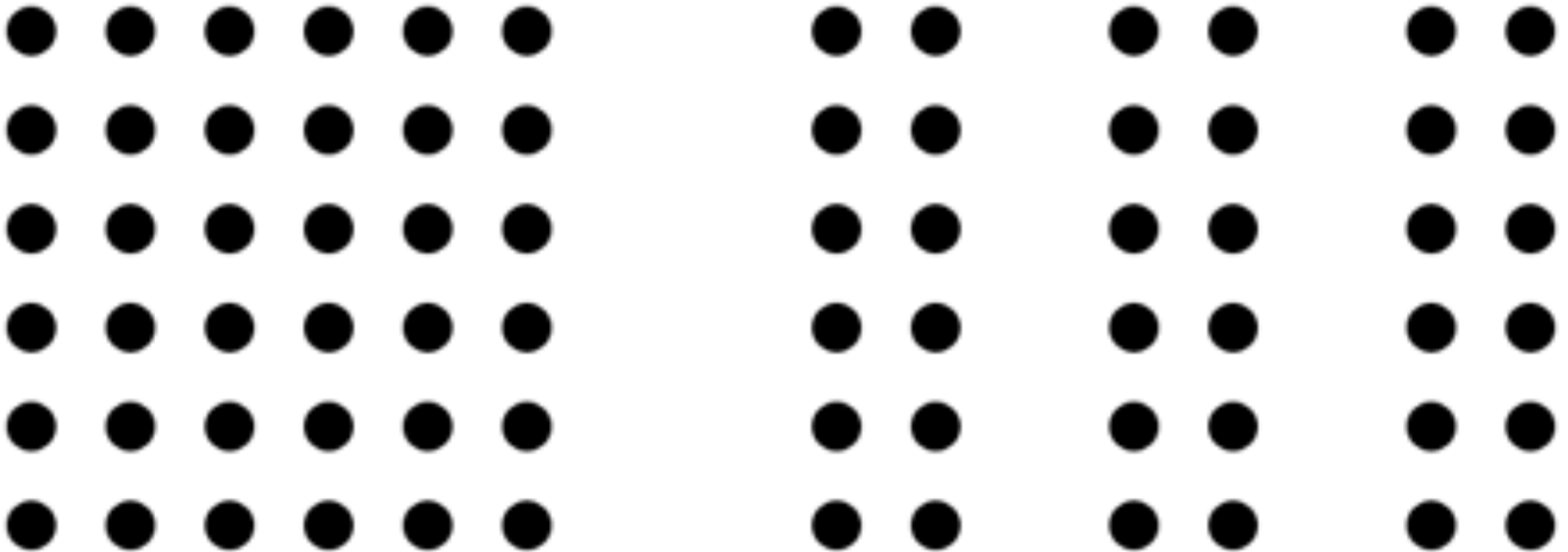
The **laws of grouping** state how **low-level perceptions** are **grouped** into higher-level objects.

Good Gestalt

We tend to order our experience in a manner that is regular, orderly, symmetric, and simple.

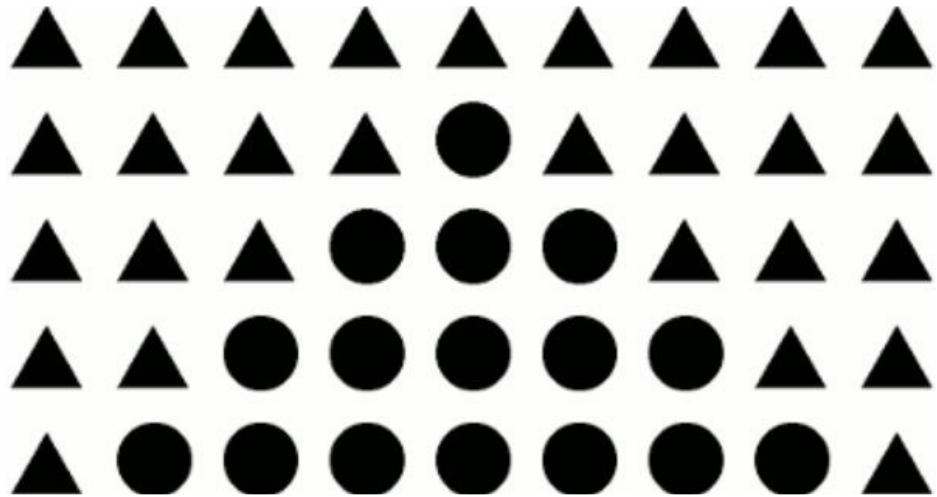
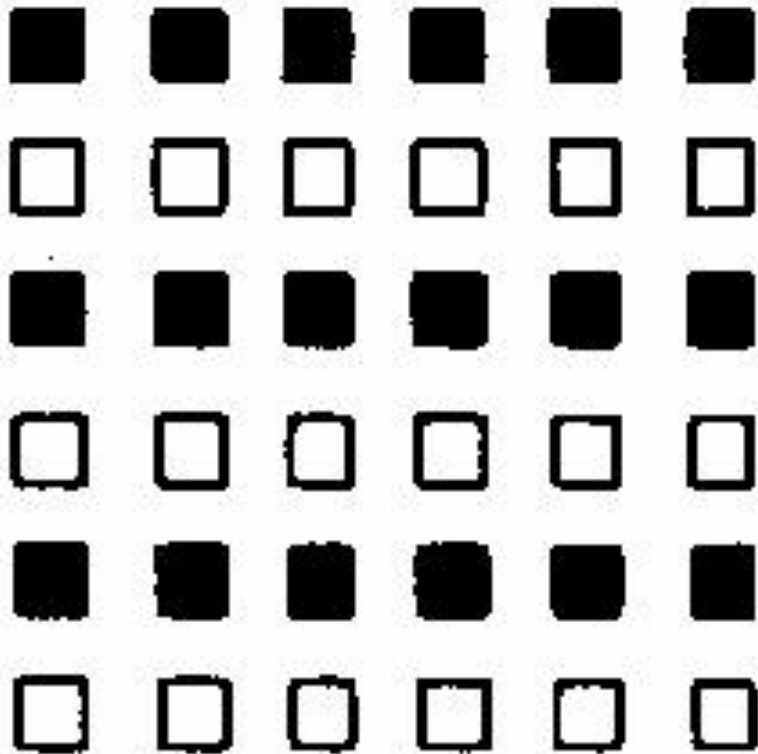
law of Proximity

Objects that are close tend to be perceived as a group.



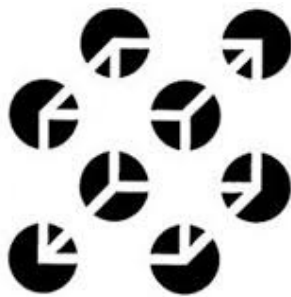
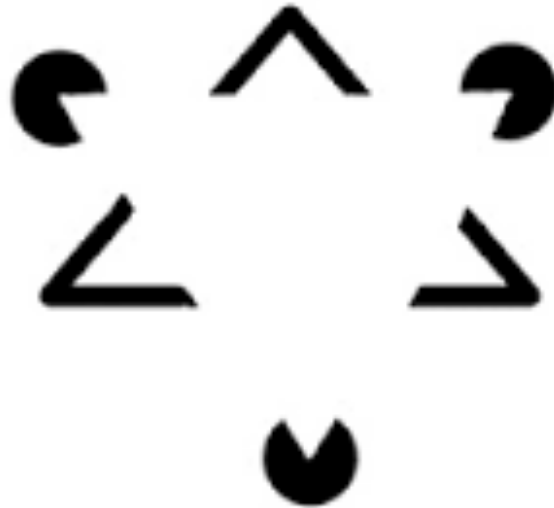
Law of SIMILARITY

Objects that are similar (in shape, color, shading, etc.) tend to form a group.



Law of CLOSURE

The perception fills gaps in stimuli.



Law of Symmetry

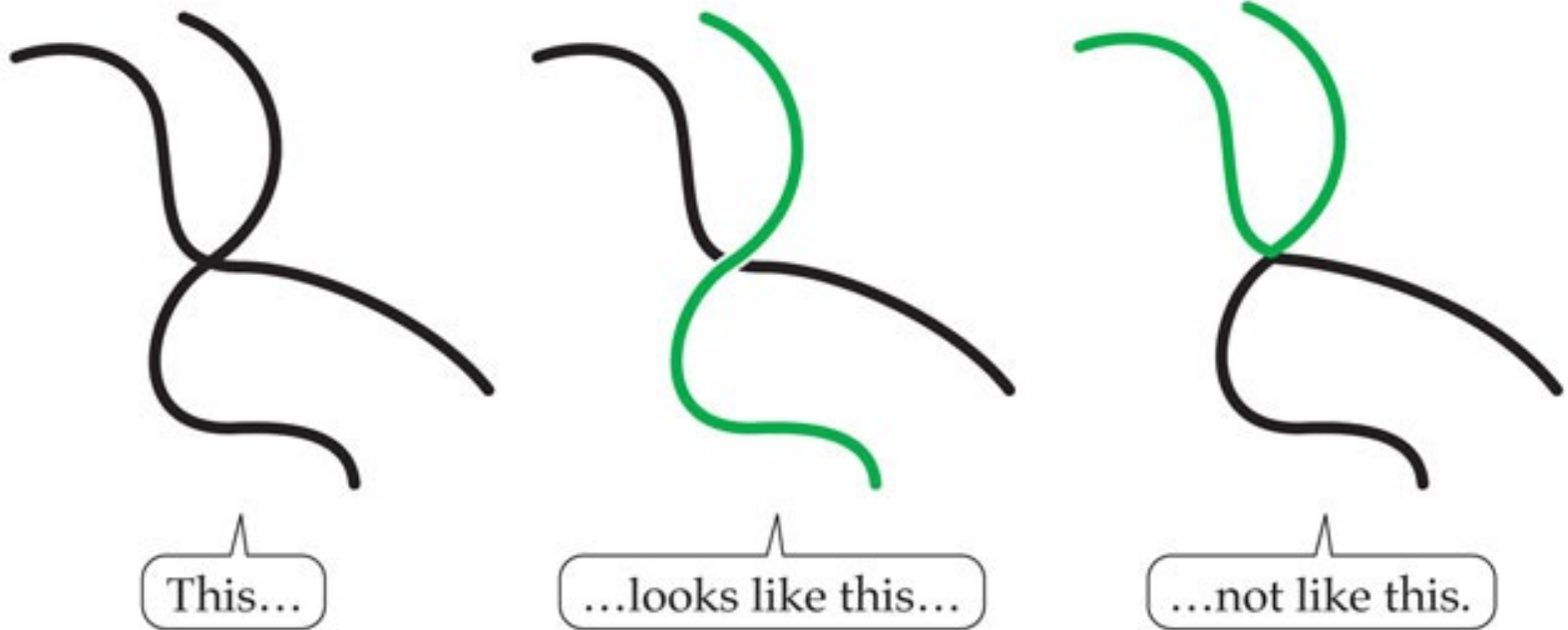
Objects with symmetric disposition tend to be perceived as forming a whole.

[] { } []

How many groups of elements are there?

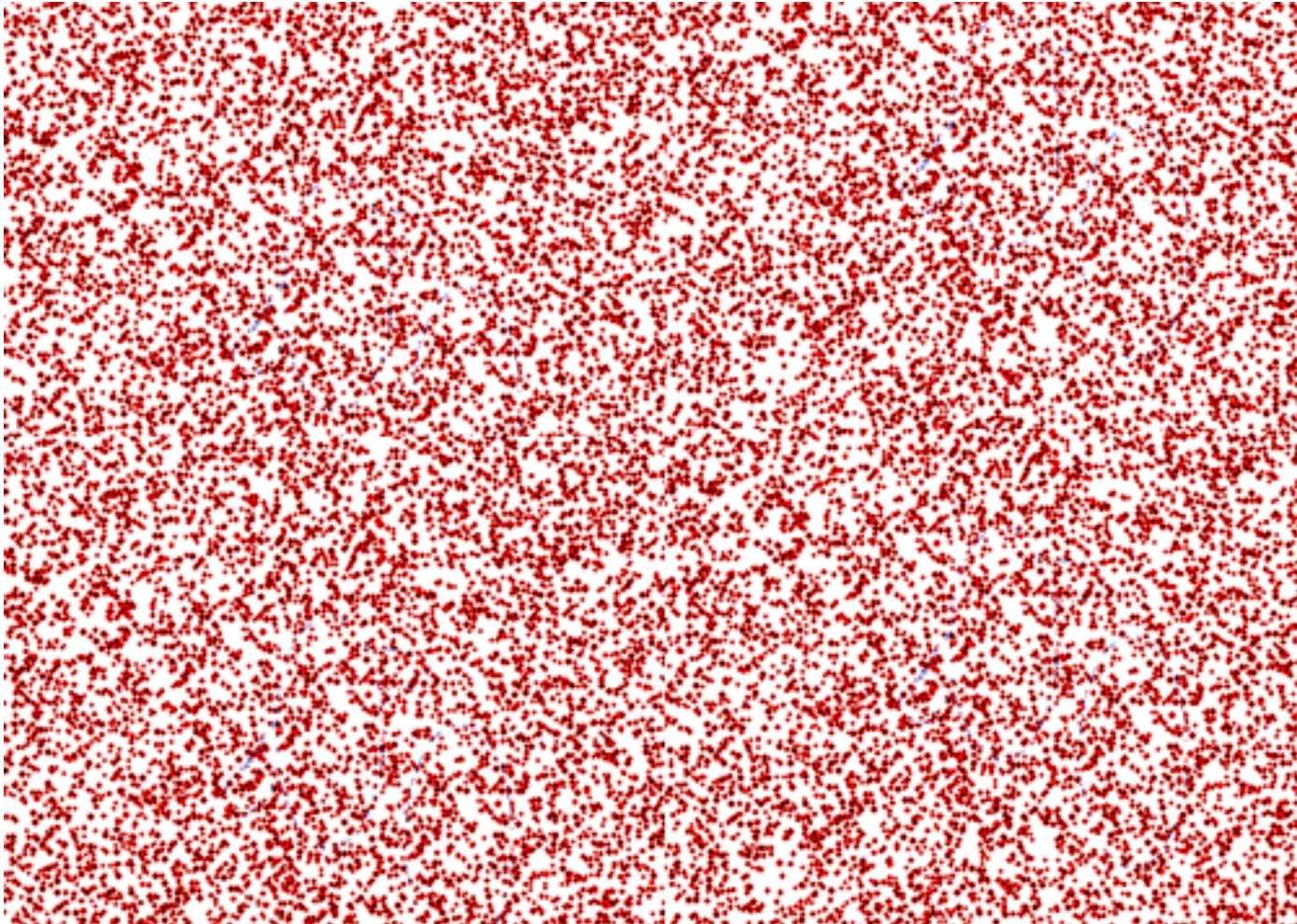
Law of Continuity

Ambiguous stimuli are perceived preferentially with the interpretation that is the most continuous.



Law of common fate

Objects evolving together are perceived as a group.



LAW of Figure & Ground

Elements are perceived as either a **figure** (element of focus) or **ground** (background on which the figure sits)

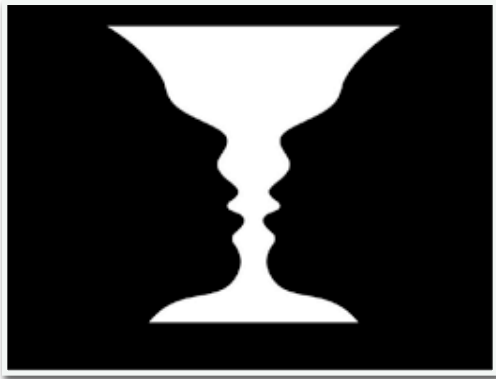


Figure & Ground in art



Figure & Ground in art

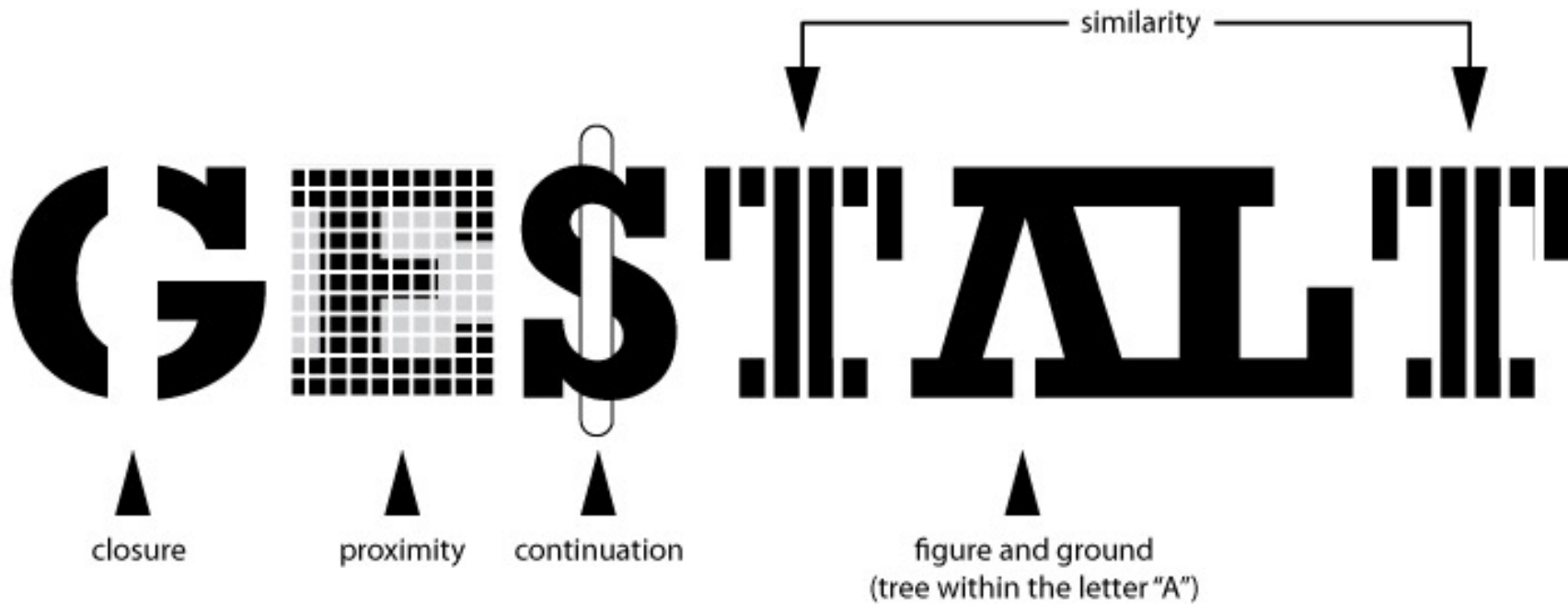


Figure & Ground in design



Figure & Ground: before gestalt

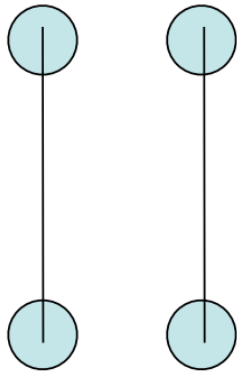




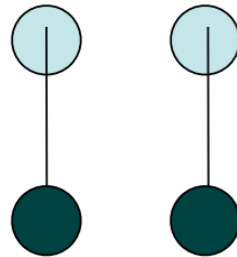
More Laws!

law of Connectedness

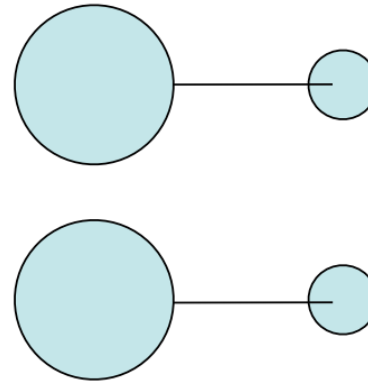
Things that are linked are perceived as belonging to the same group.



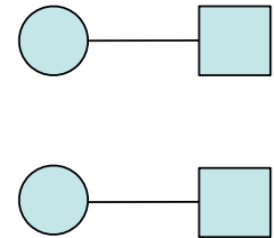
proximity



color



size



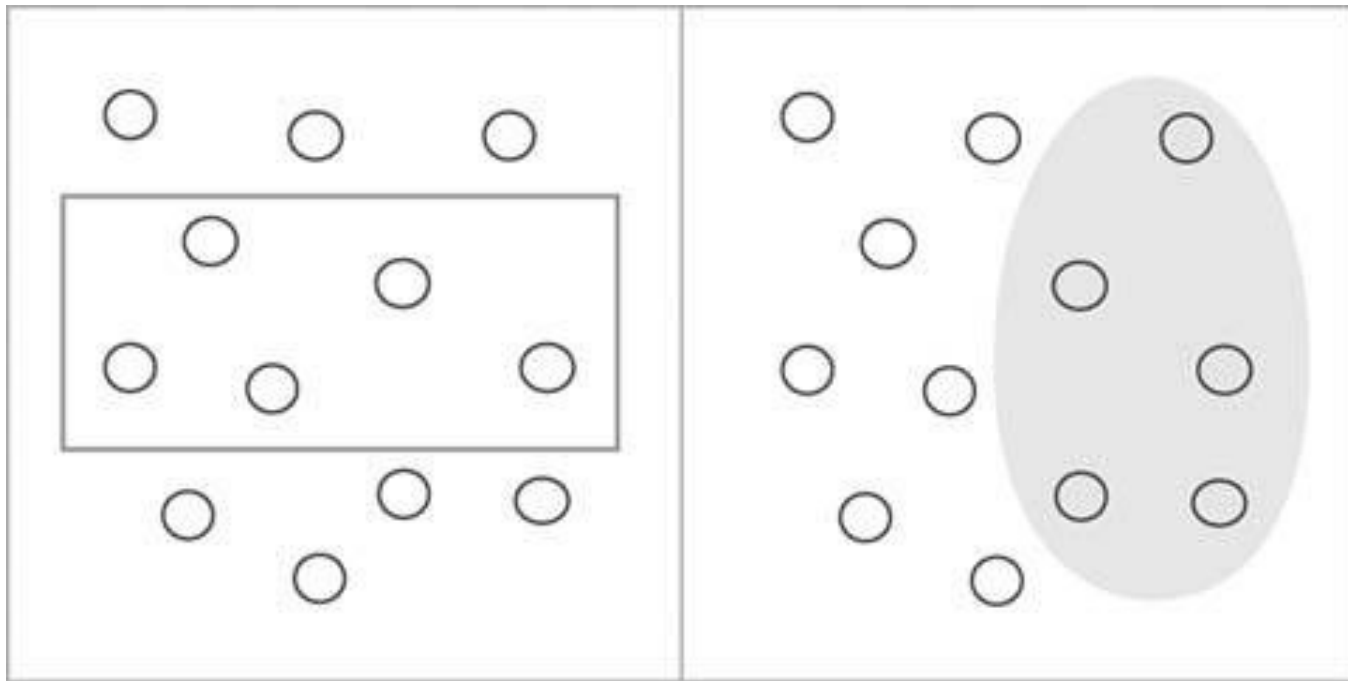
shape

More powerful than proximity, color, size, shape...

More Laws!

law of ENCLOSURE

Objects that are enclosed are perceived as a group



Again, more powerful than proximity, color, size, shape...

in Summary

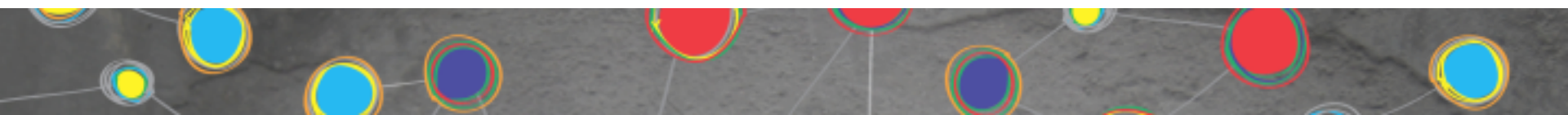
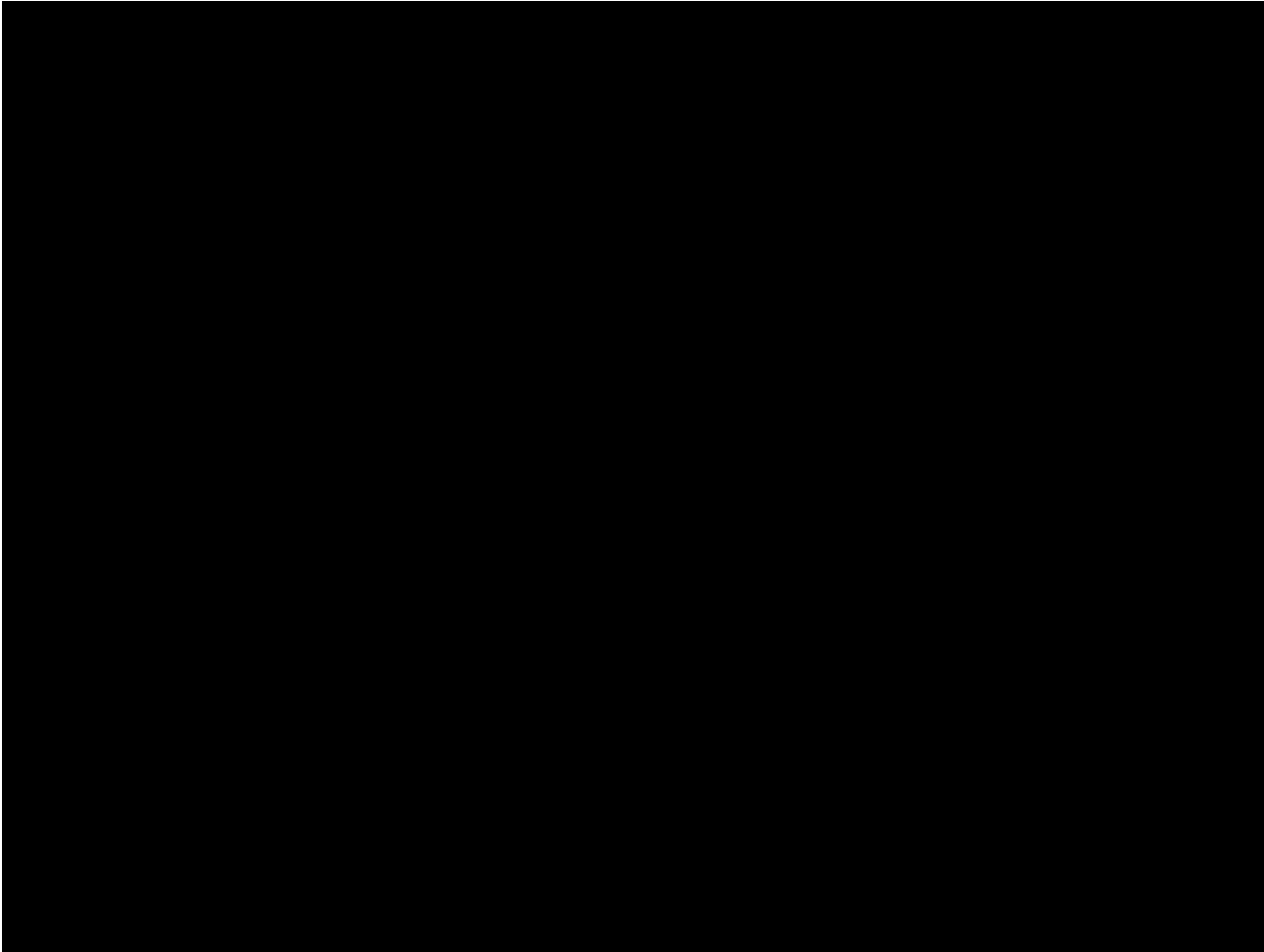
Our brains take lots of perceptual “shortcuts” ...

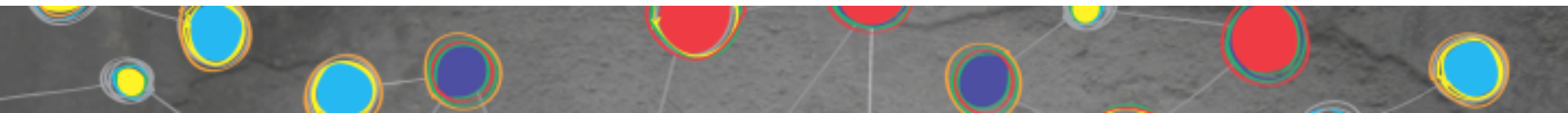
... which can either help or harm our visualizations!

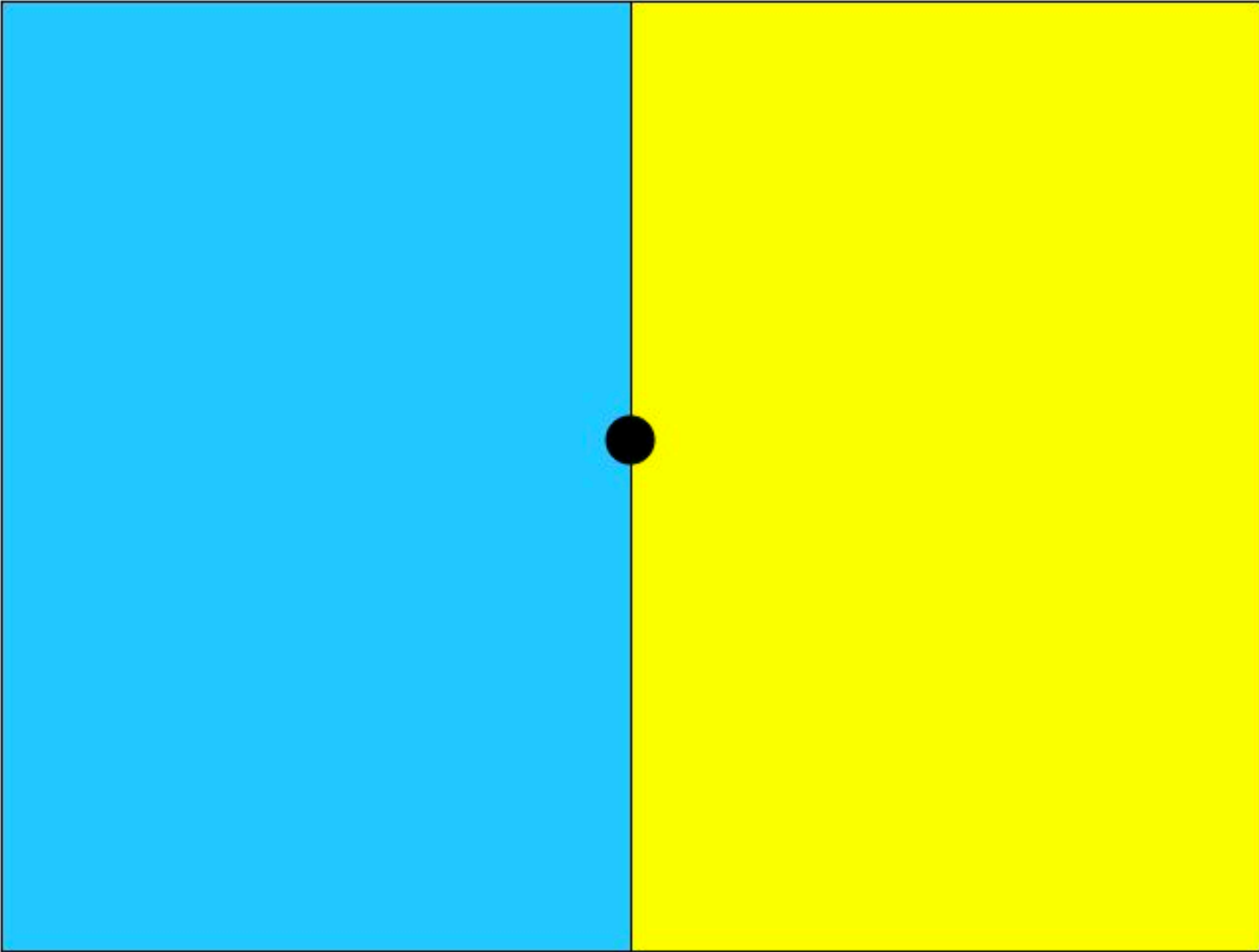
It is not enough to simply show something, we need to pay attention when and how it is shown.

A GOOD UNDERSTANDING OF PERCEPTUAL AND COGNITIVE PROCESSES IS CRITICAL!

Pour finir







Chromatic adaptation

