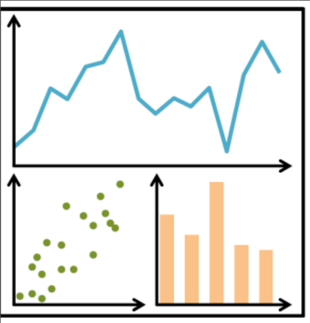
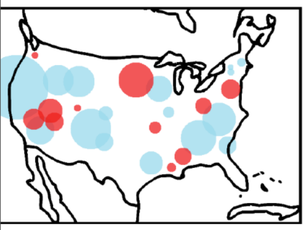
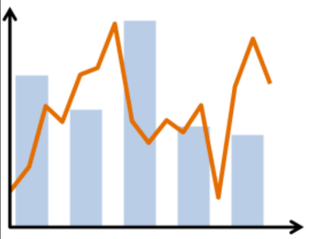
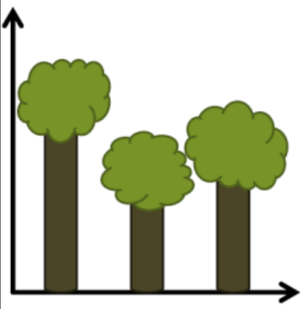
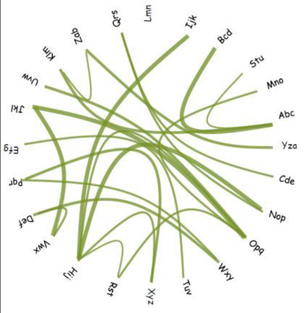










BEYOND MEMORABILITY: VISUALIZATION RECOGNITION AND RECALL

Michelle A. Borkin, Zoya Bylinskii,
Nam Wook Kim, Constance Bainbridge, Chelsea Yeh, Daniel Borkin,
Hanspeter Pfister and Aude Oliva

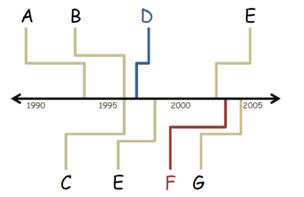
PRESENTED AT IEEE INFOVIS - OCTOBER 29, 2015

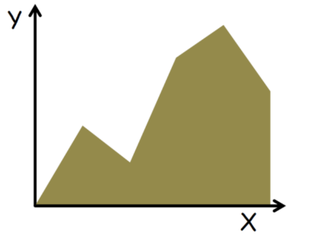


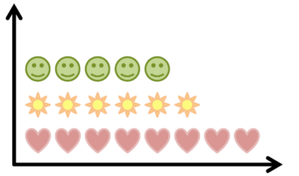
HARVARD
School of Engineering
and Applied Sciences

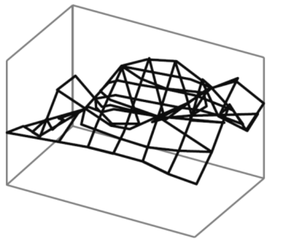




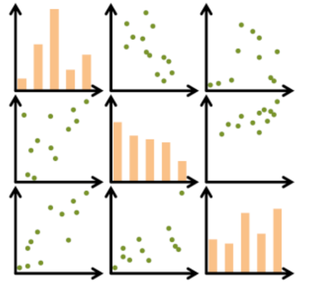








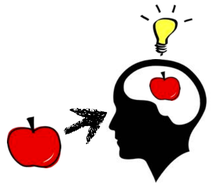




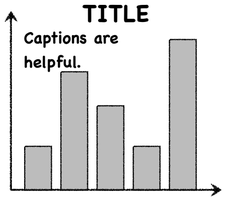
GOAL

What makes a visualization effective?

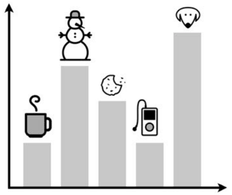
What makes a visualization effective?



"At-a-glance" **memorable** visualizations have memorable content



Titles and text are key elements

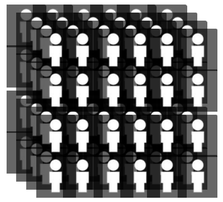


Human recognizable objects (e.g., pictograms) can add to effectiveness

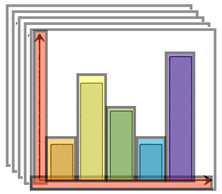


Redundancy helps with visualization understanding

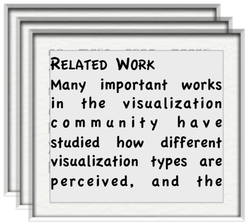
Empirical evidence in support of many conventional qualitative visualization design guidelines



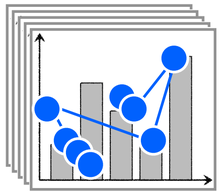
The Experiment



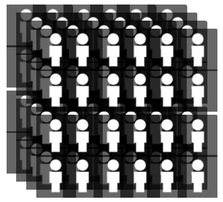
The Data



Related Work



Results



The Experiment

The Data



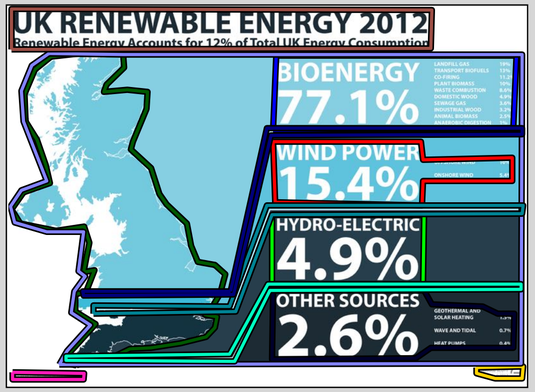
Related Work

Results

The Experiment

Experiment Design

Labeled Visualization Database

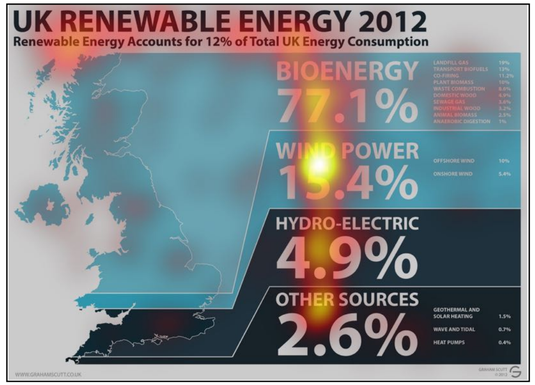


393 visualizations

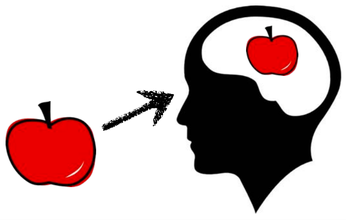
33 participants

"Encoding"

10 seconds / image

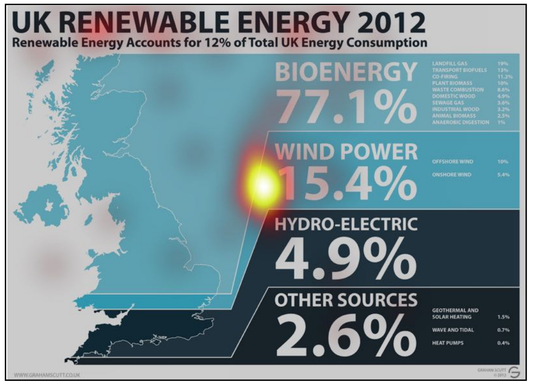


Eye-Tracking Data

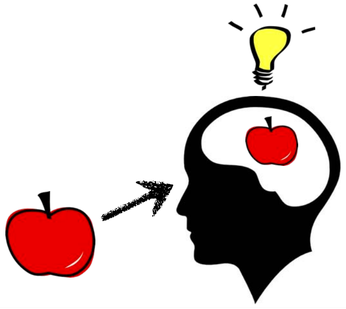


"Recognition"

2 seconds / image



Eye-Tracking Data

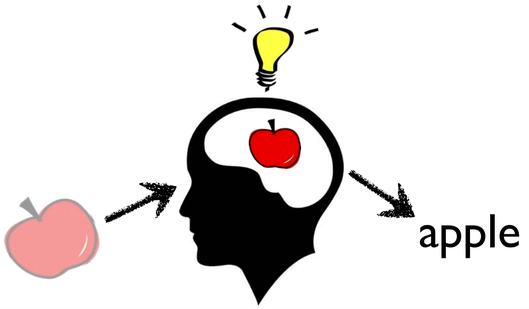


"Recall"

20 minutes

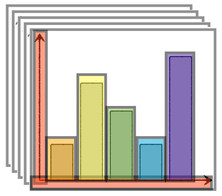


Text Descriptions



~60 minutes

The Experiment



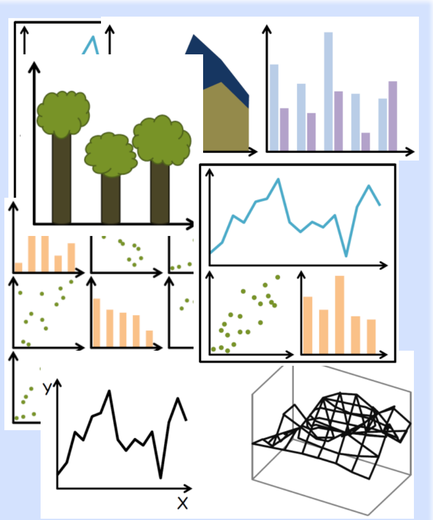
The Data



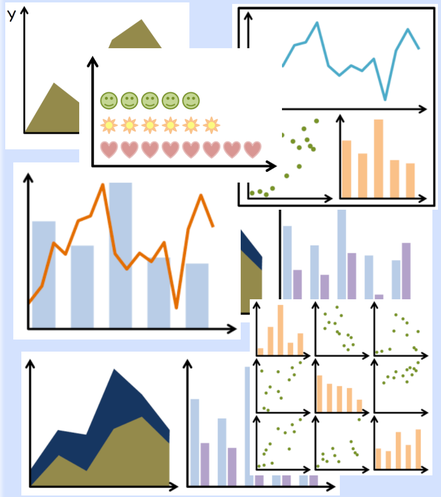
Related Work

Results

Data available at massvis.mit.edu

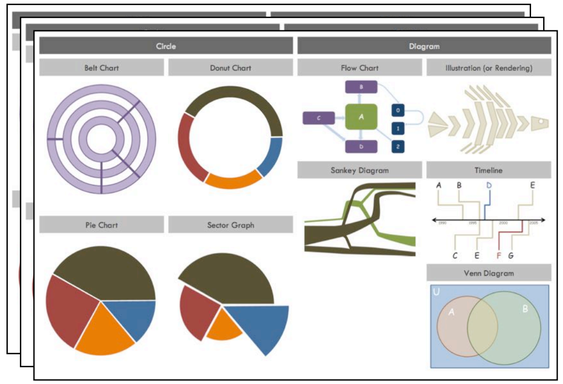


Visualization Database (5,814 images)



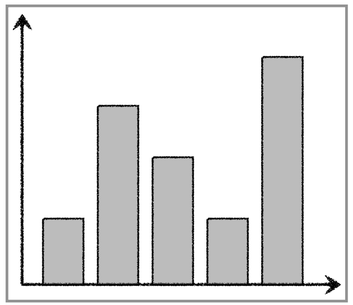
Borkin et al. (2013)

Taxonomy



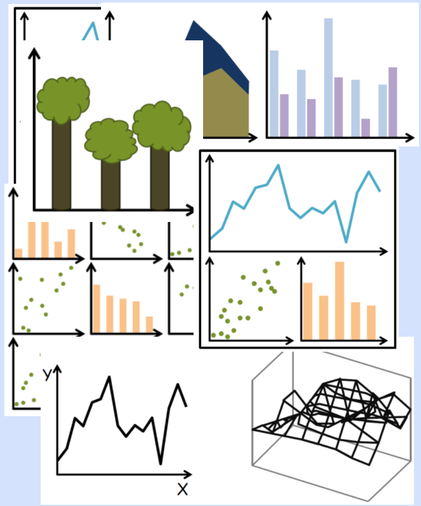
"Single" visualizations (2,068 images)

"Targets" (393)

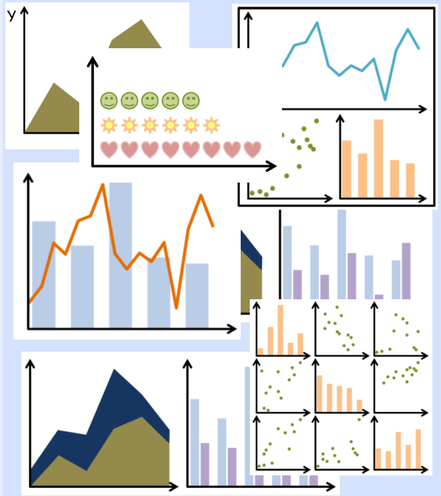


"single"

Data available at massvis.mit.edu

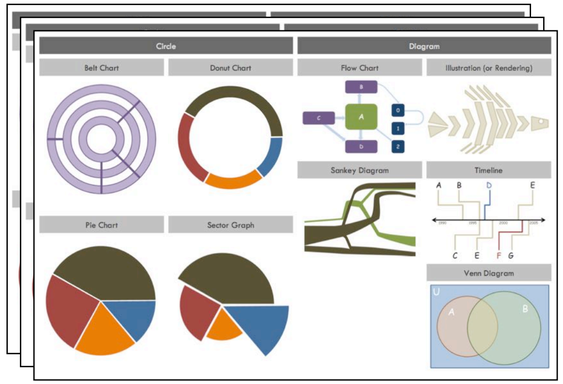


Visualization Database (5,814 images)

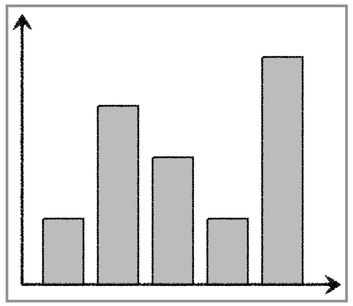


Borkin et al. (2013)

Taxonomy

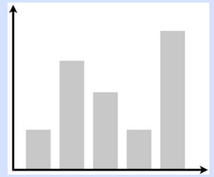
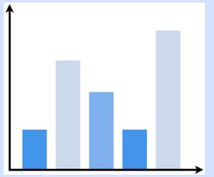
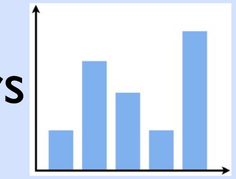
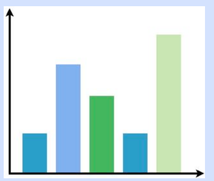
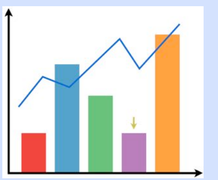
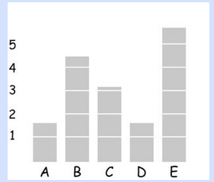
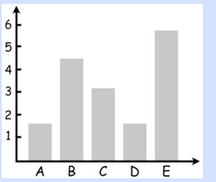
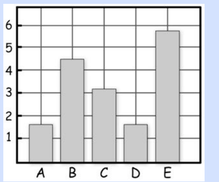
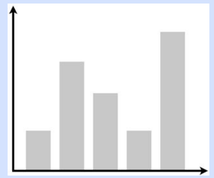
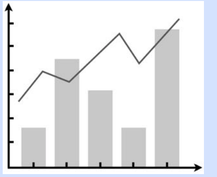
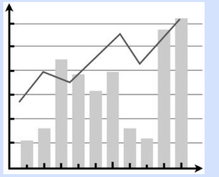
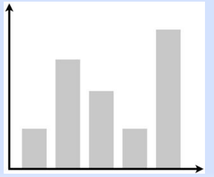


"Single" visualizations (2,068 images)



"single"

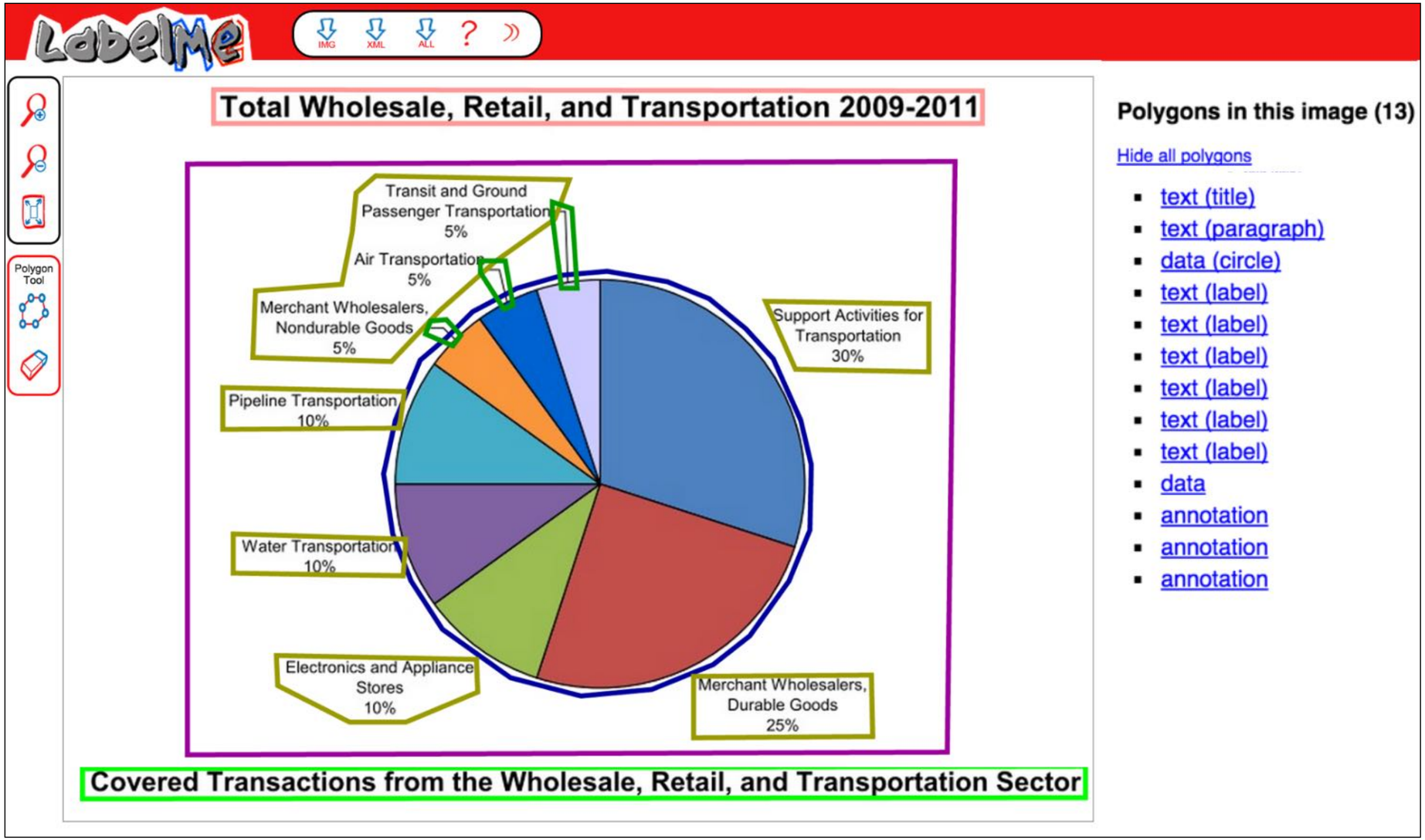
"Targets" (393)

	Yes	No		
Black & White				
Number of Distinct Colors	*1* 	*2-6* 	*≥7* 	
Data-Ink Ratio	*good* 	*medium* 	*bad* 	
Visual Density	*low* 	*medium* 	*high* 	
Human Recognizable Objects	*Yes* 	*No* 		

"Targets" (393)

FOR EACH VISUALIZATION:

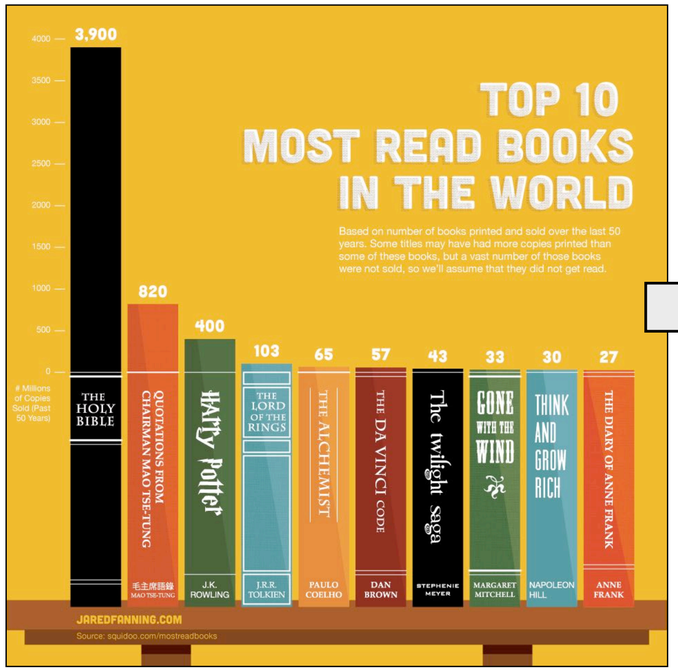
- Labels



“Targets” (393)

FOR EACH VISUALIZATION:

- Labels
- Title transcription

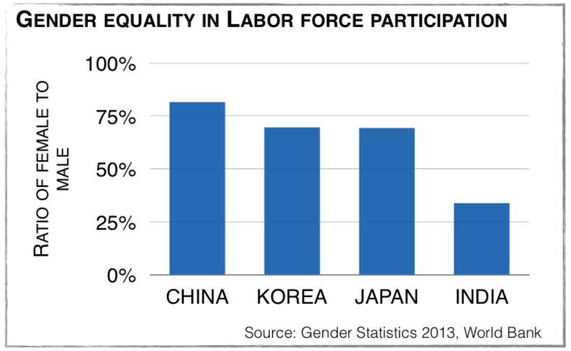


“TOP 10 MOST READ BOOKS IN THE WORLD”

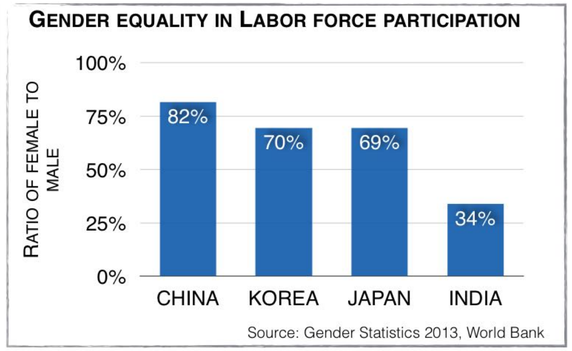
"Targets" (393)

FOR EACH VISUALIZATION:

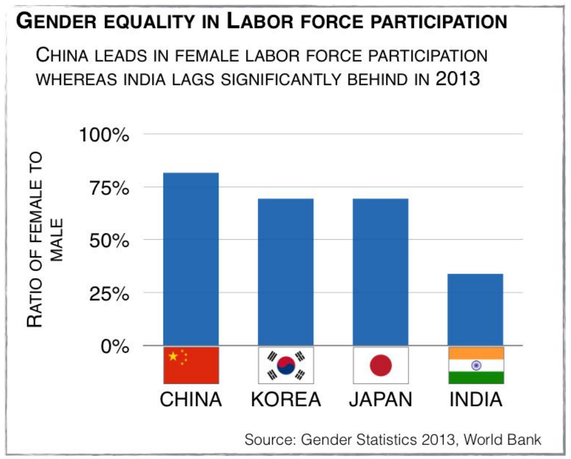
- Labels
- Title transcription
- Data and message redundancy



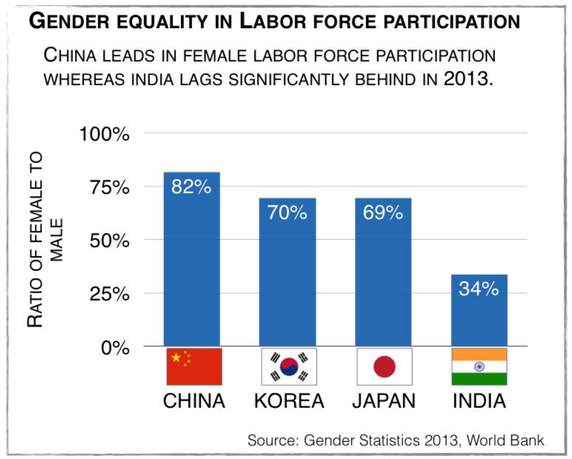
ORIGINAL



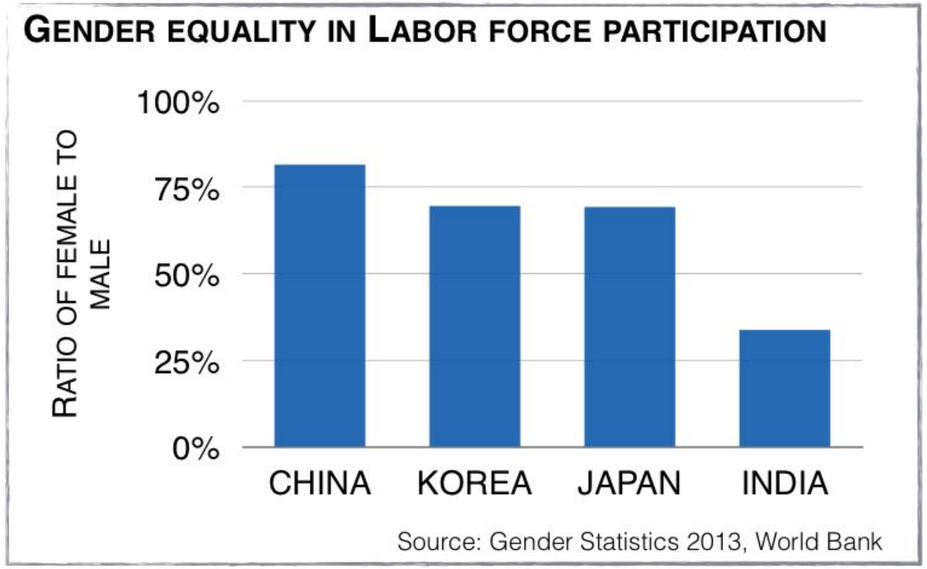
DATA REDUNDANCY



MESSAGE REDUNDANCY



DATA & MESSAGE REDUNDANCY



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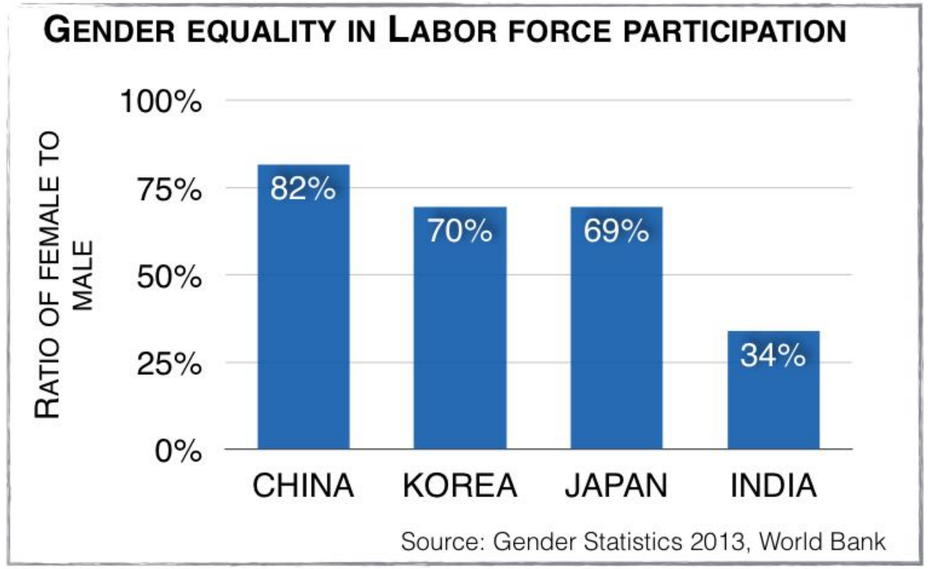

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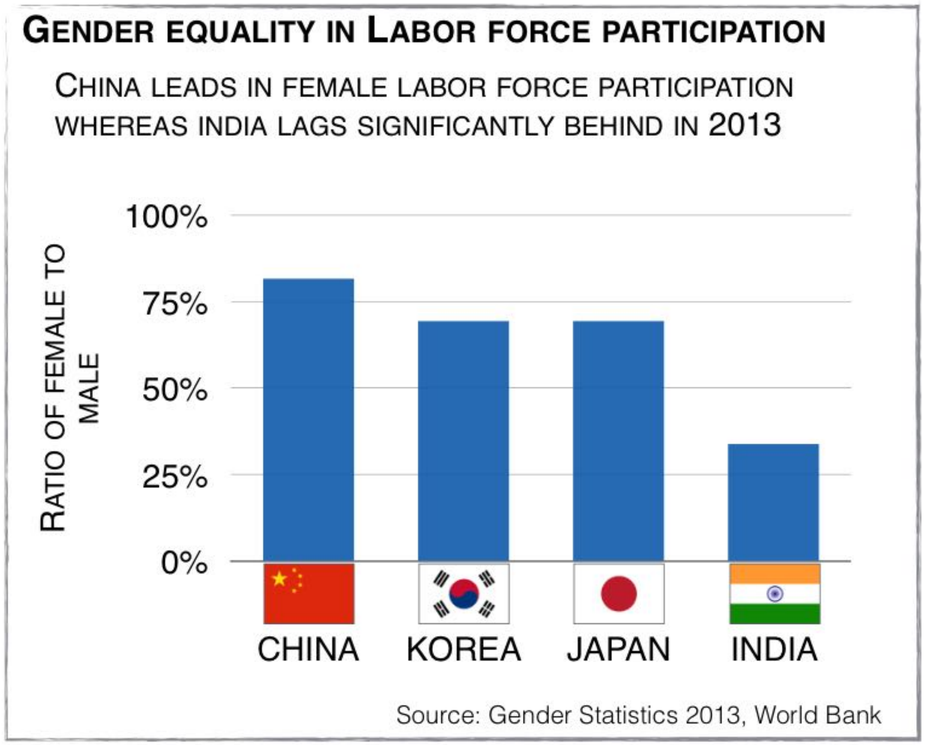
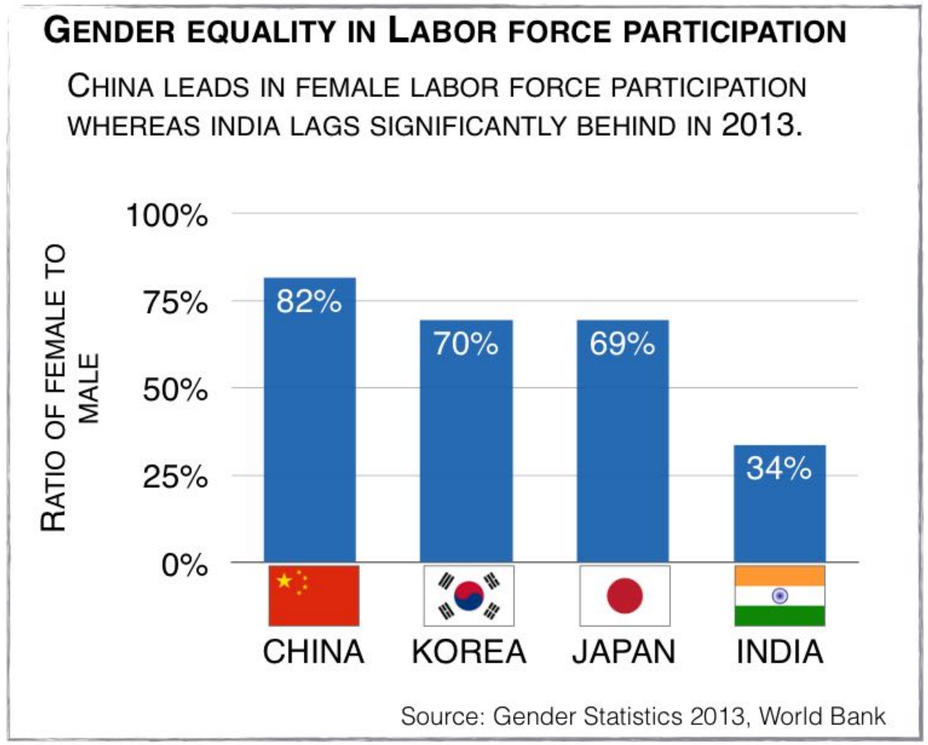


MESSAGE REDUNDANCY

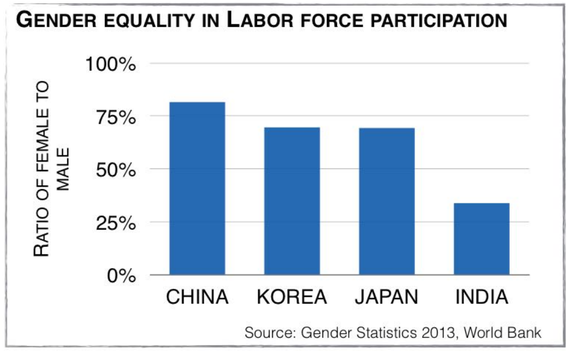


DATA & MESSAGE REDUNDANCY

"Targets" (393)

FOR EACH VISUALIZATION:

- Labels
- Title transcription
- Data and message redundancy



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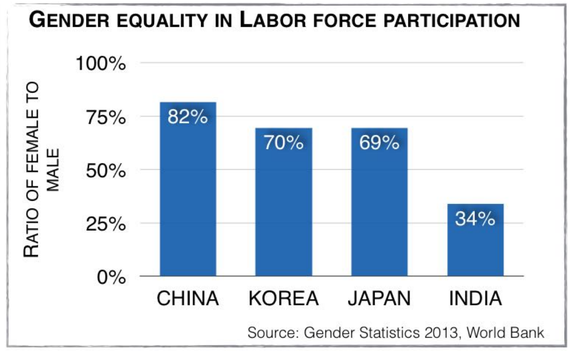
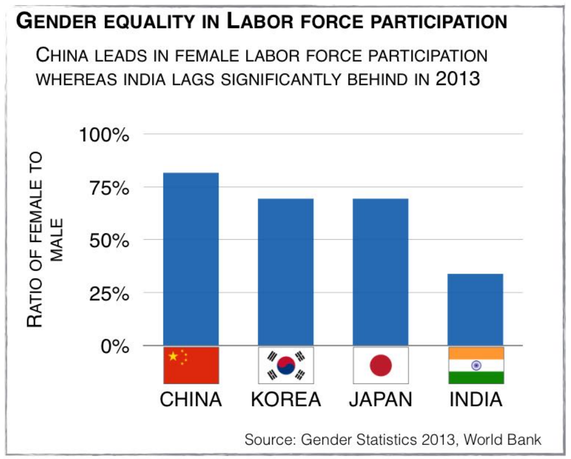
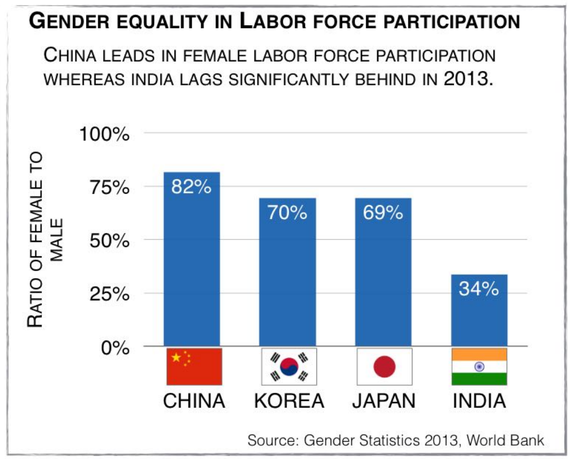


DATA REDUNDANCY

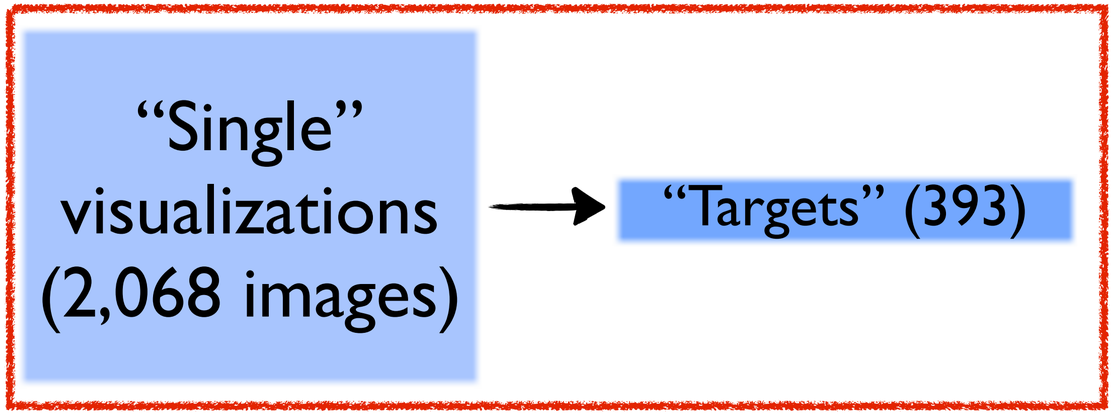


MESSAGE REDUNDANCY



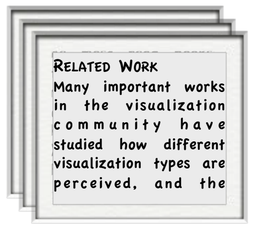
DATA & MESSAGE REDUNDANCY

EXPERIMENT



The Experiment

The Data

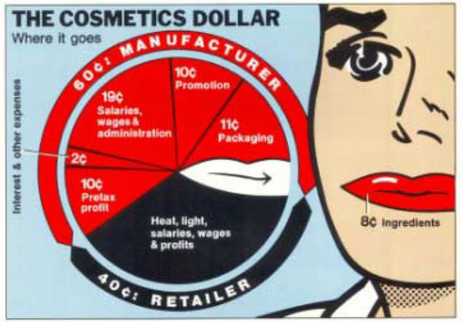


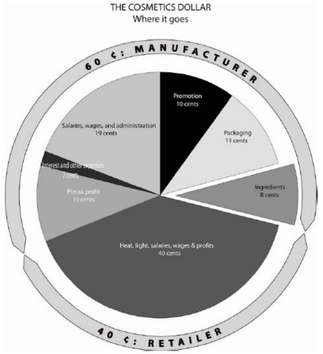
Related Work

Results

Related Work

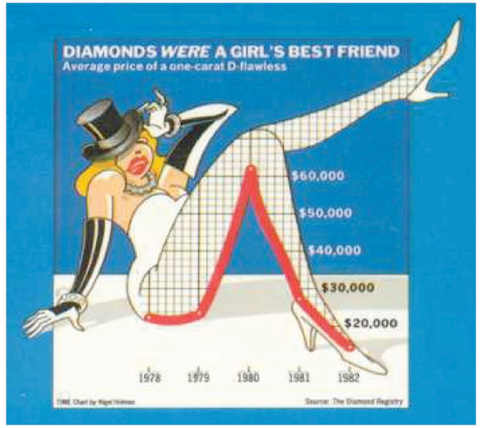
Useful Junk? The Effects of Visual Embellishment on Comprehension and Memorability of Charts





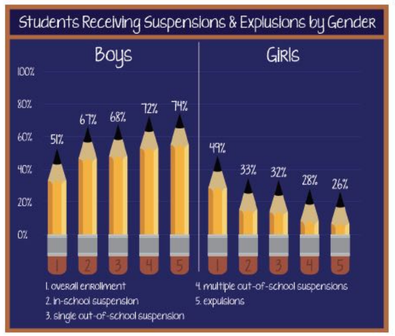
Bateman, et al. (2010)

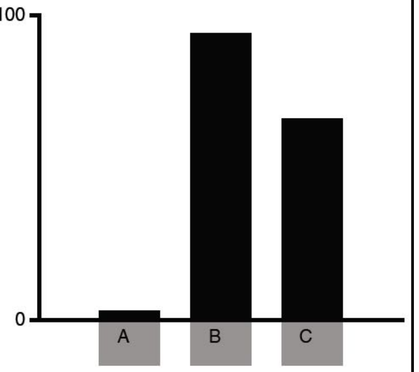
Benefitting InfoVis with Visual Difficulties



Hullman, et al. (2011)

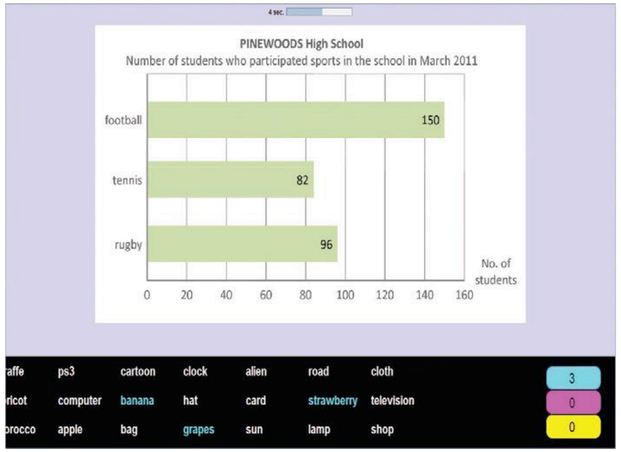
An Evaluation of the Impact of Visual Embellishments in Bar Charts





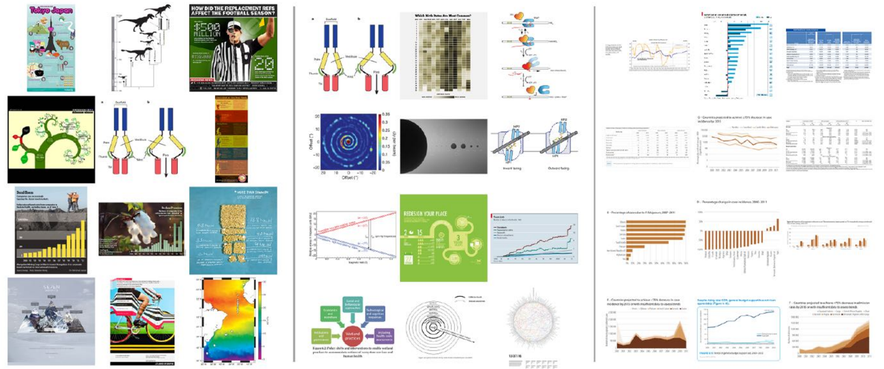
Skau, et al. (2015)

An Empirical Study on Using Visual Embellishments in Visualization



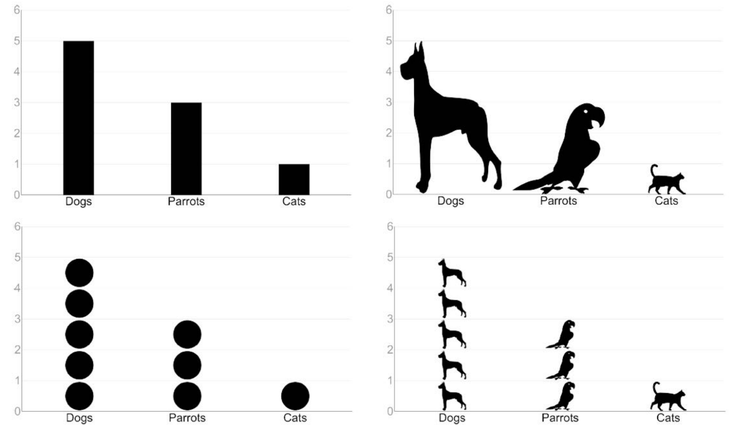
Borgo, et al. (2012)

What makes a visualization memorable?



Borkin, et al. (2013)

ISOTYPE Visualization – Working Memory, Performance, and Engagement with Pictographs



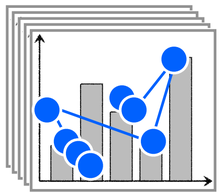
Haroz, et al. (2015)

The Experiment

The Data



Related Work

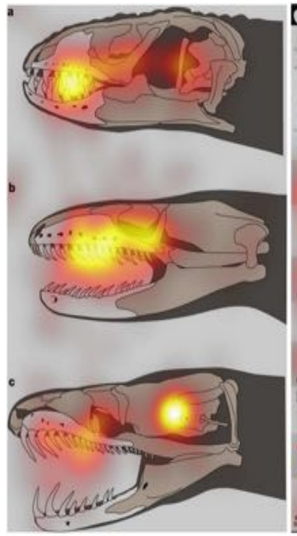


Results

Most Memorable

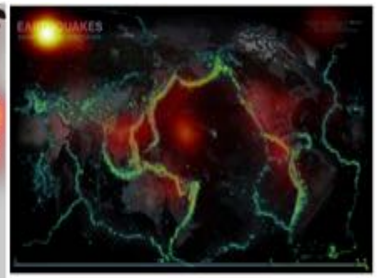
Least Memorable

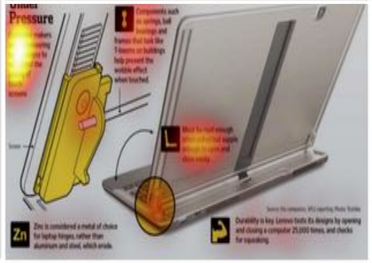
Encoding (10 sec)

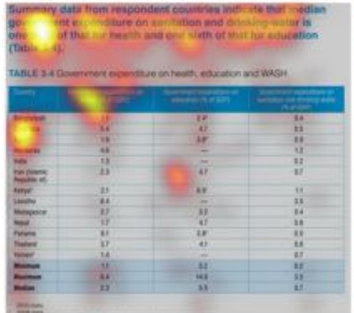




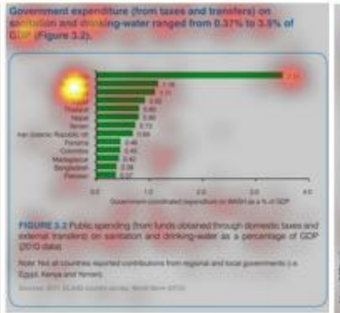




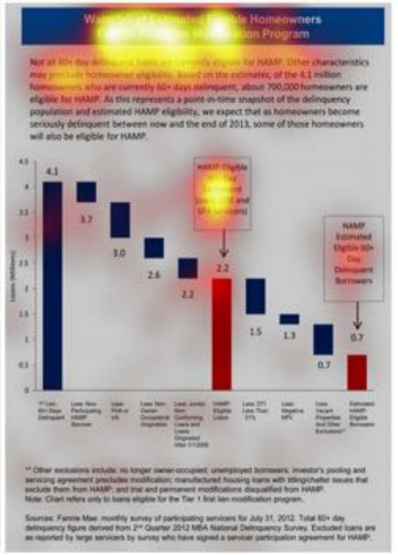




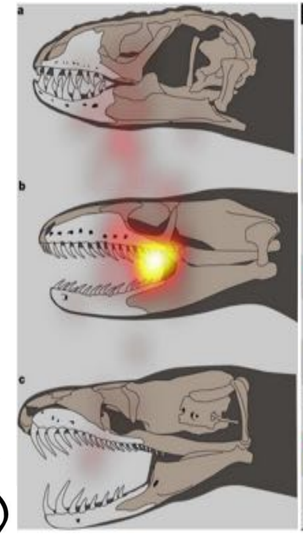




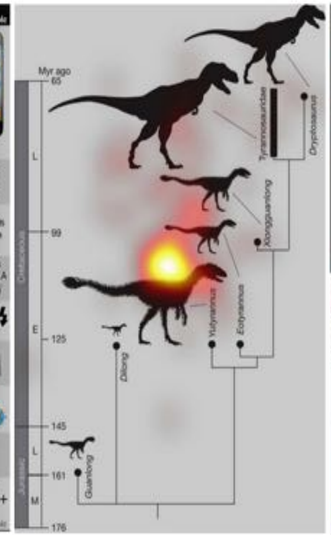


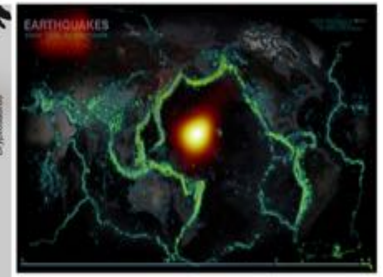


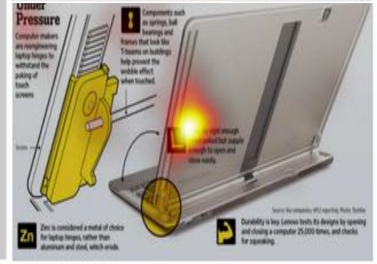
Recognition





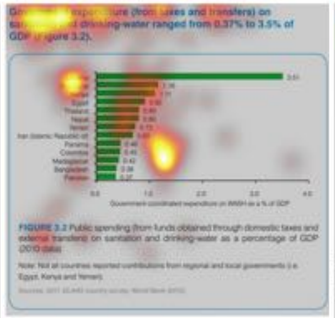


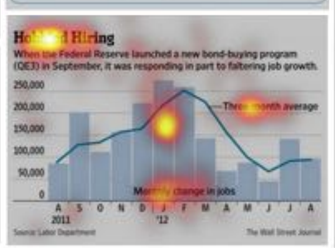


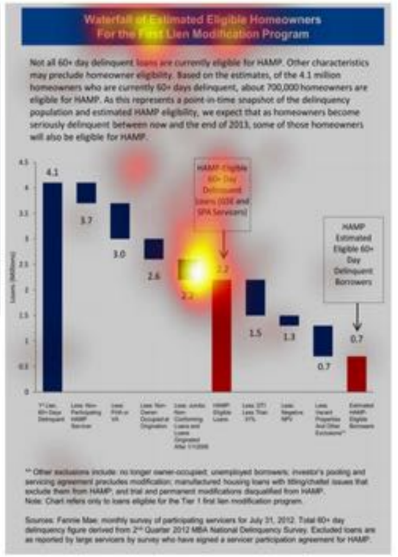




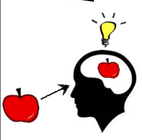












ENCODING (10 SEC)

RECOGNITION

MOST MEMORABLE

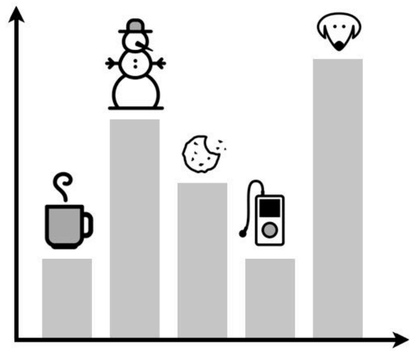
LEAST MEMORABLE

Visual Associations

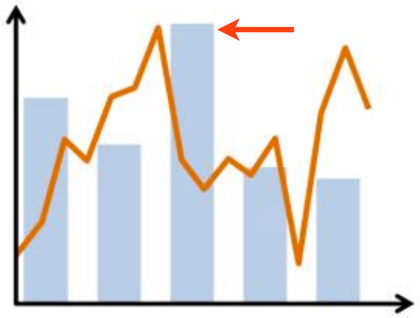
Semantic Associations

Visual Associations

FOR EXAMPLE...



Human Recognizable Objects

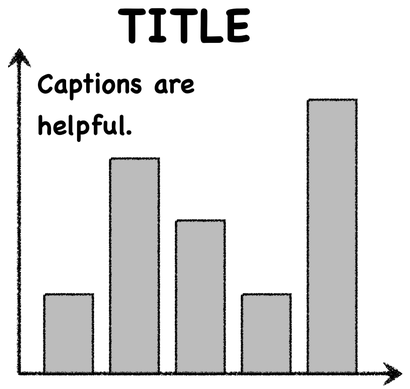


Visual annotations

Visualization/plot

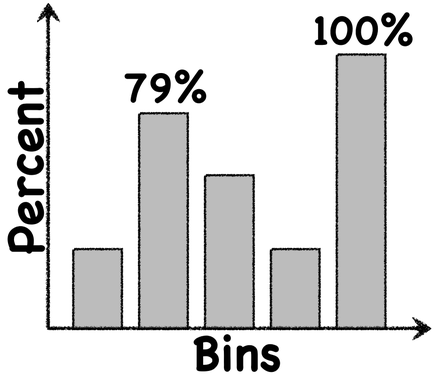
Semantic Associations

FOR EXAMPLE...



Titles

Textual descriptions



Labels

Axis labels

RECOGNITION

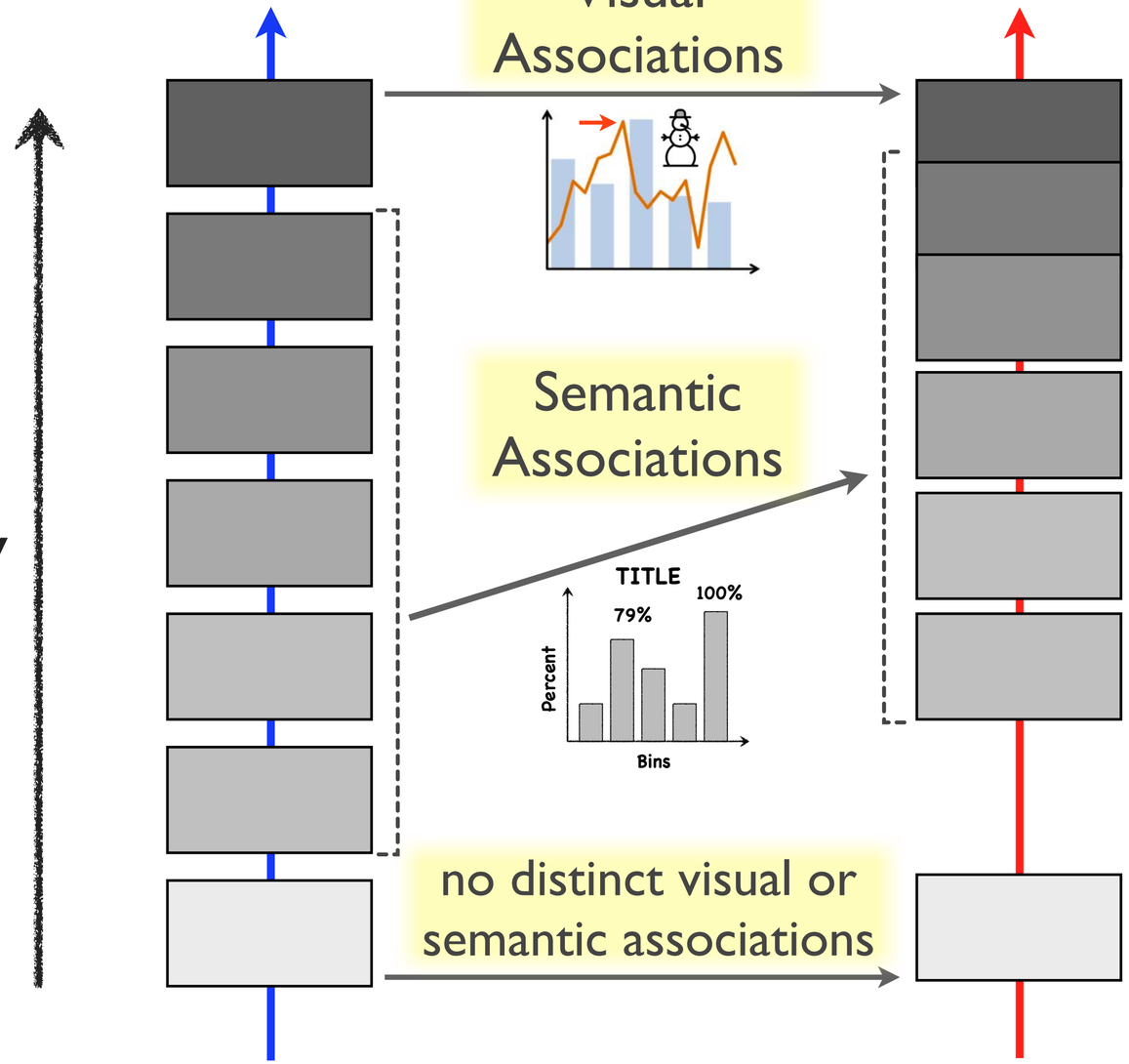
"AT A GLANCE" ENCODING (1S)

Borkin et al. (2013)

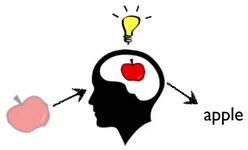
PROLONGED ENCODING (10S)

This Paper

Memorability



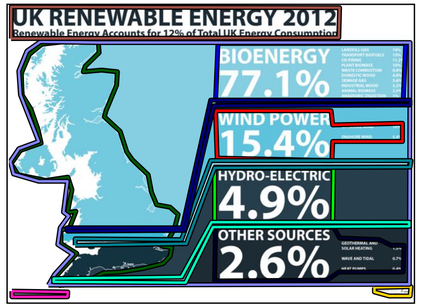
Visualizations ranked by memorability score.



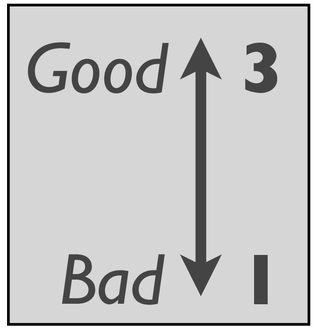
RECALL

"Describe the visualization in as much detail as possible."

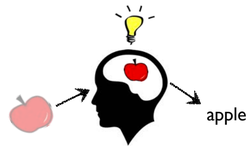
FOR ALL 2,773 TEXT DESCRIPTIONS:



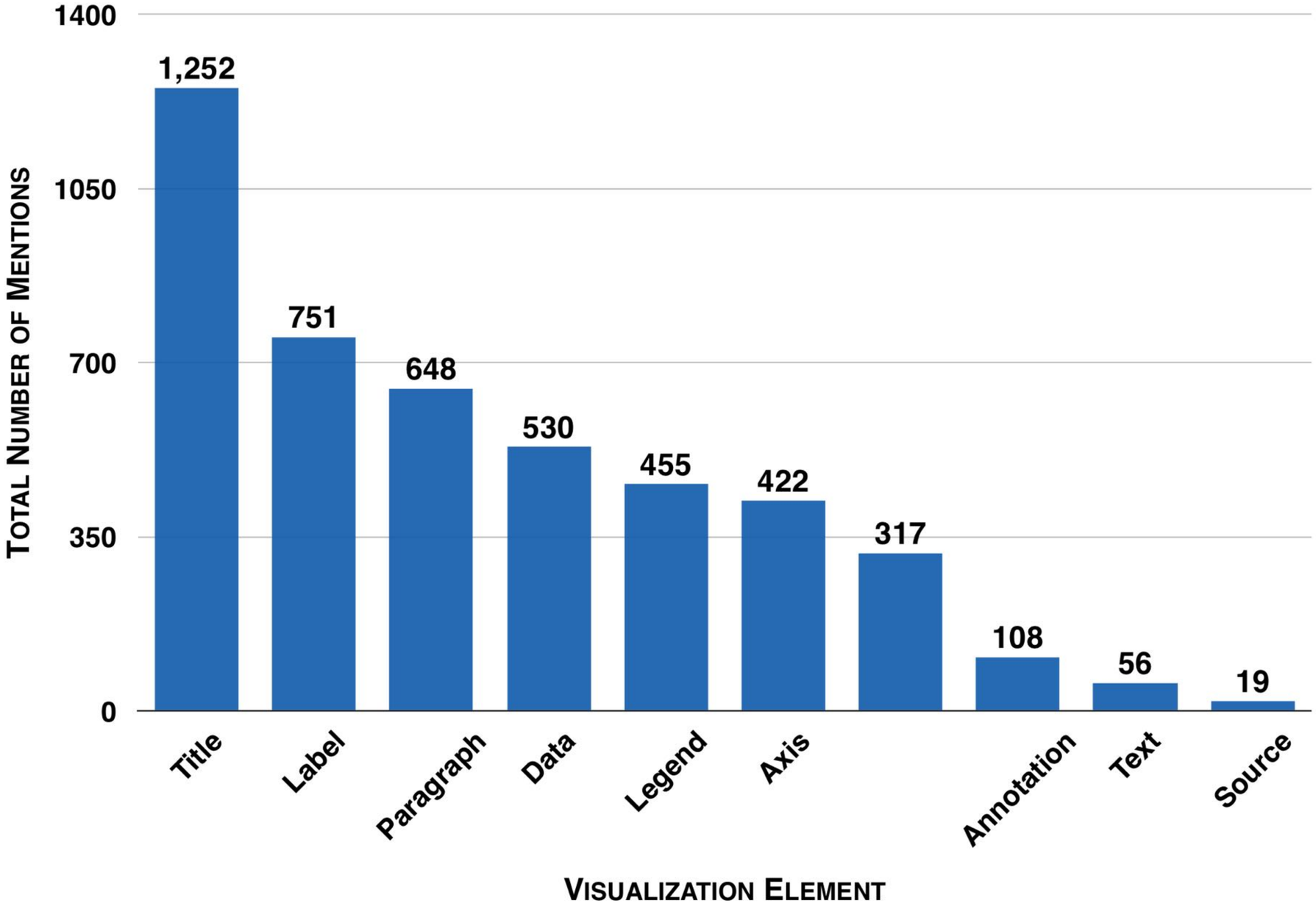
Labels mentioned



Description quality


apple

RECALL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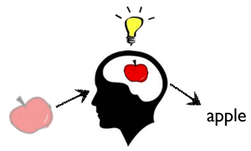
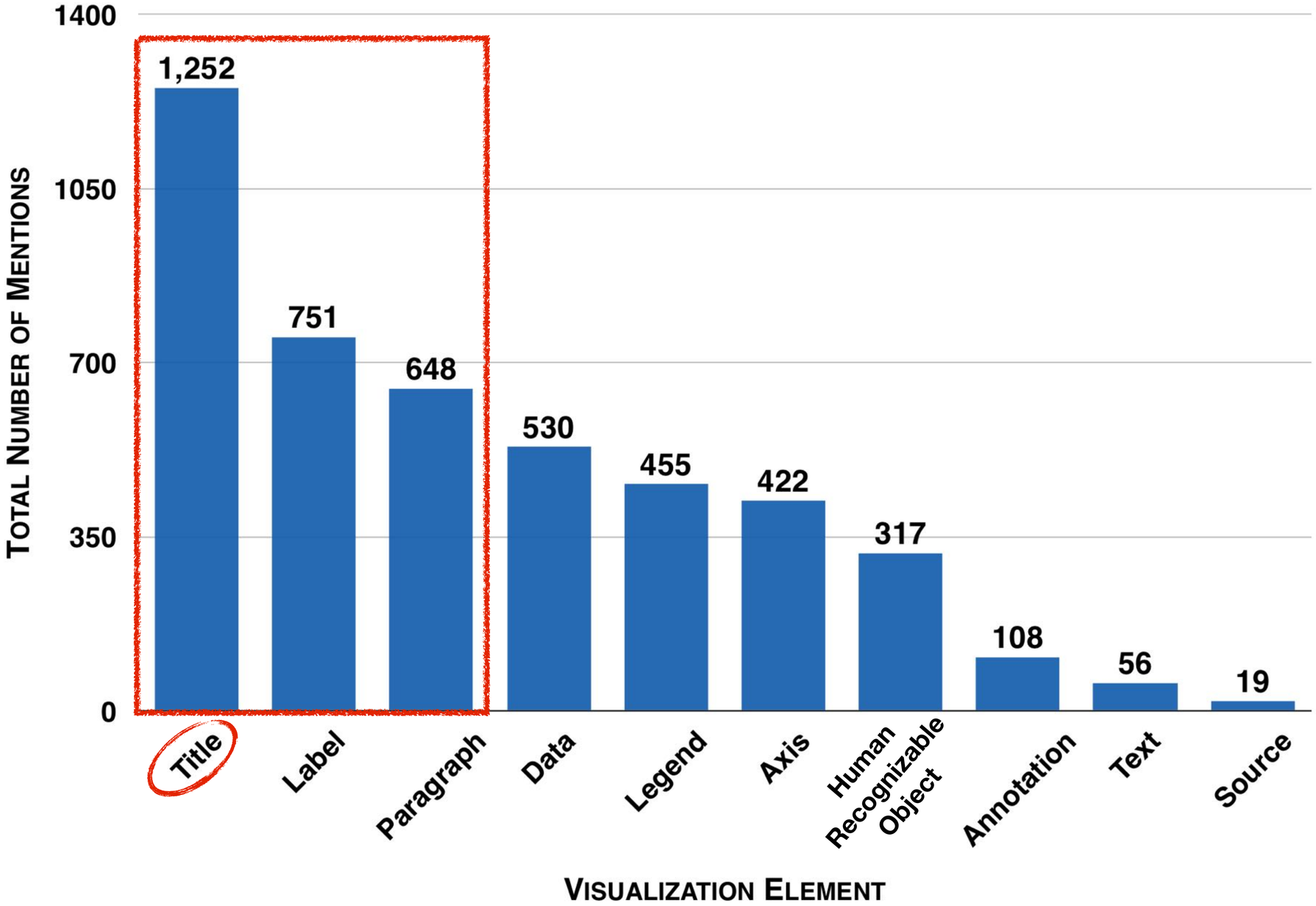
Paragraph
Data
Legend
Axis
Annotation
Text
Source
VISUALIZATION ELEMENT


apple

RECALL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TOTAL NUMBER OF MENTIONS
1,252
751
648
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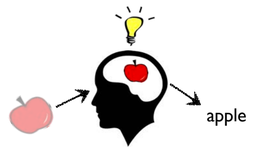

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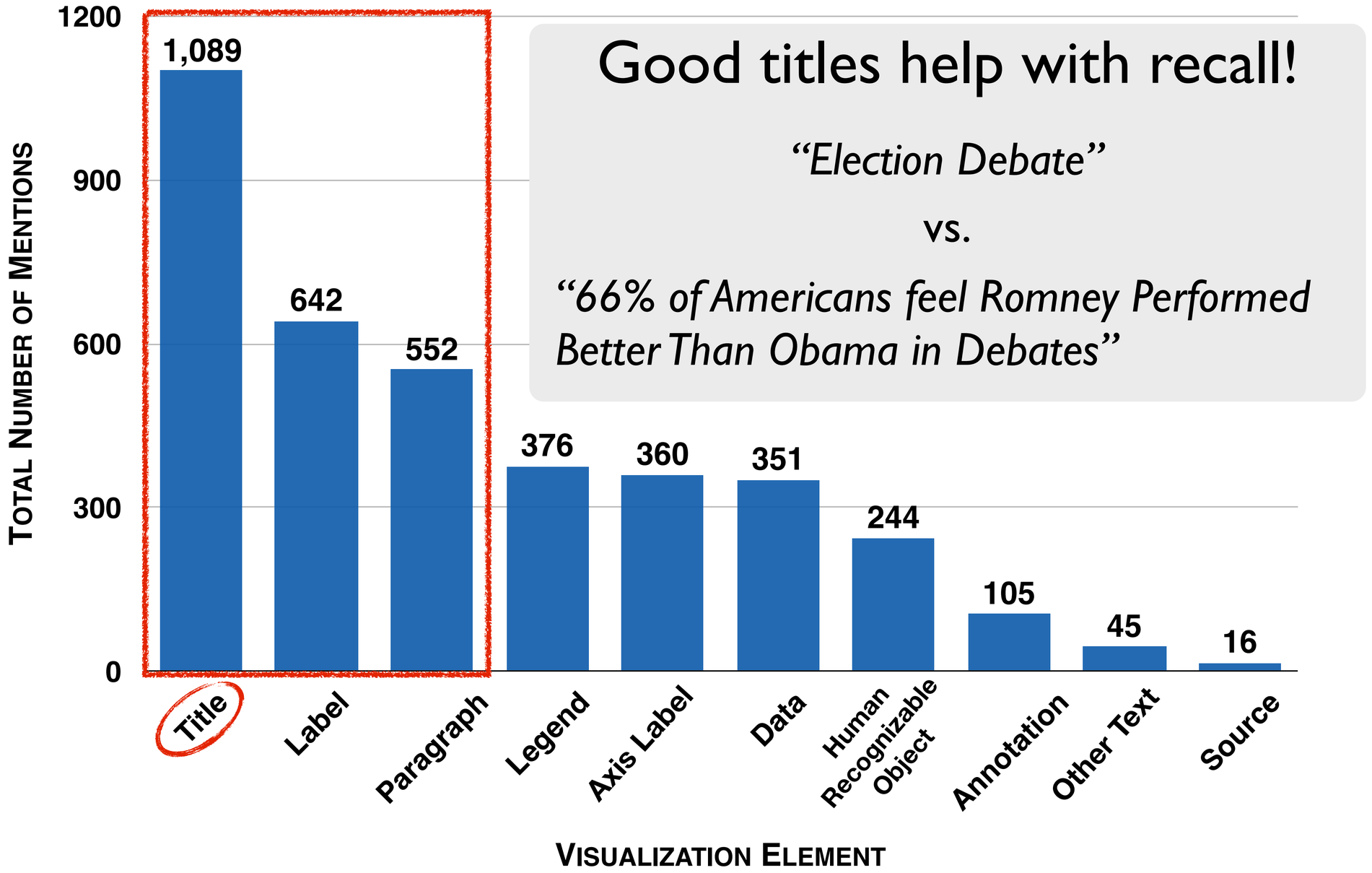


Good titles help with recall!

"Election Debate"

vs.

"66% of Americans feel Romney Performed Better Than Obama in Debates"

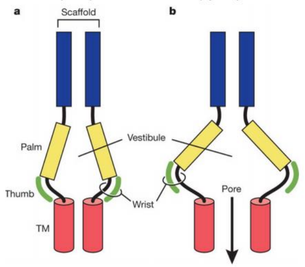
MEMORABLE

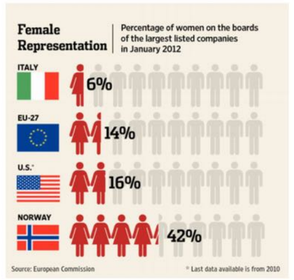
LOW QUALITY DESCRIPTION

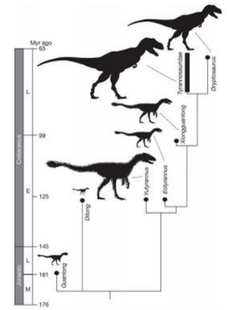
HIGH QUALITY DESCRIPTION

FORGETTABLE











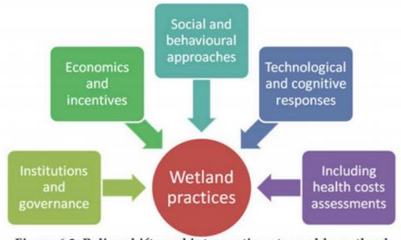
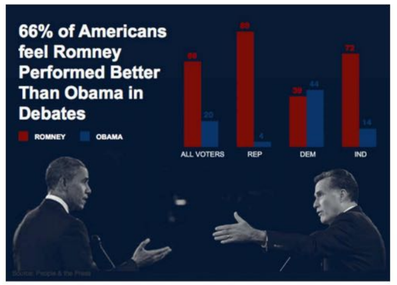
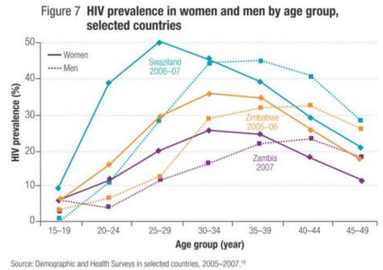
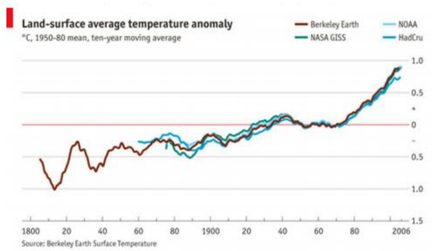
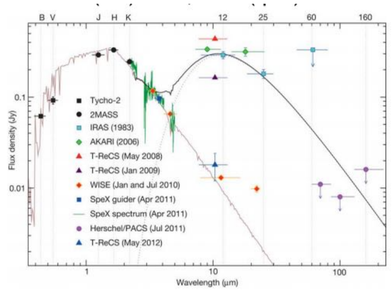


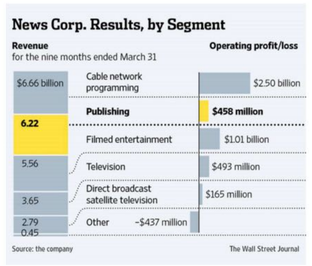
Figure 6.2: Policy shifts and interventions to enable wetland practices to accommodate notions of ecosystem services and human health

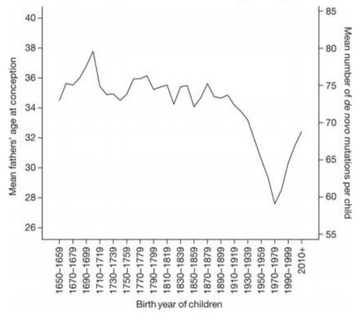


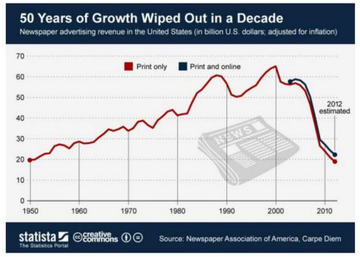




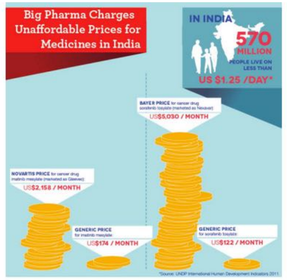


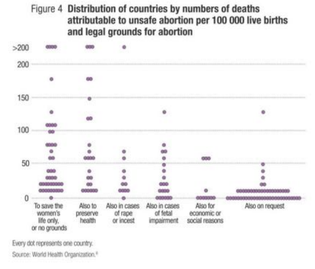












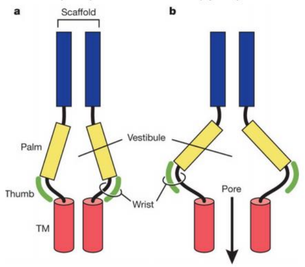
MEMORABLE

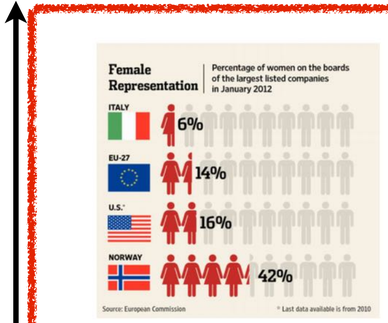
LOW QUALITY DESCRIPTION

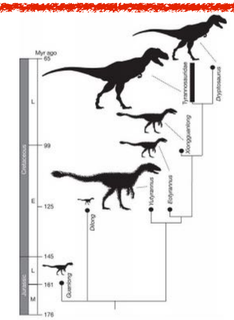
HIGH QUALITY DESCRIPTION

FORGETTABLE











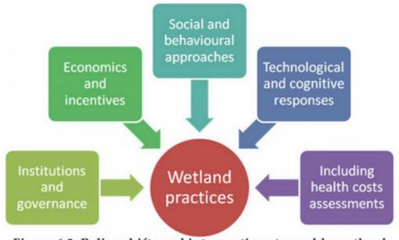
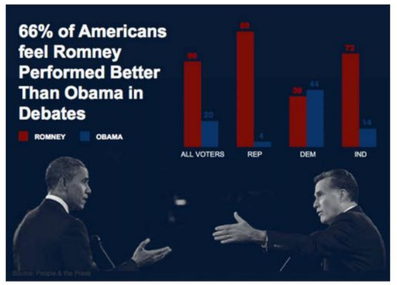
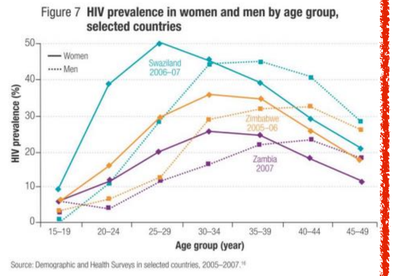
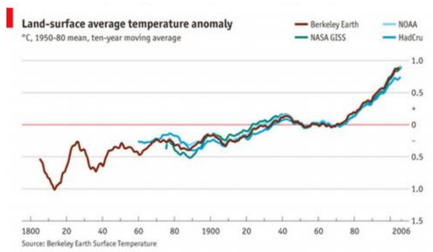
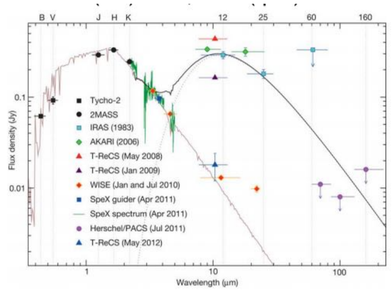


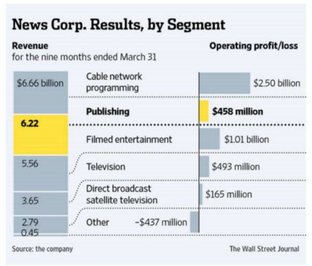
Figure 6.2: Policy shifts and interventions to enable wetland practices to accommodate notions of ecosystem services and human health

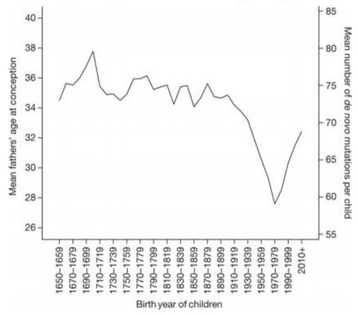


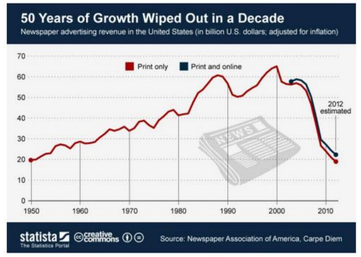




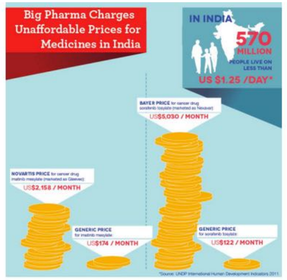


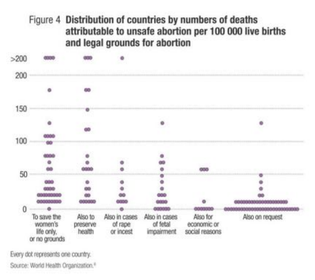












MEMORABLE

"Effective"

Visual Associations

Semantic Associations

Message redundancy

Data redundancy

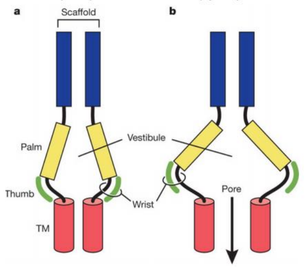
Titles/annotations

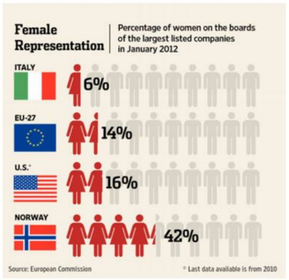
LOW QUALITY DESCRIPTION

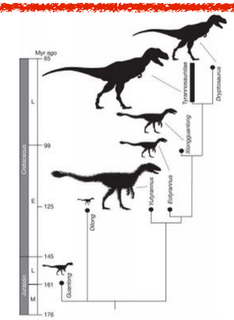
HIGH QUALITY DESCRIPTION

FORGETTABLE











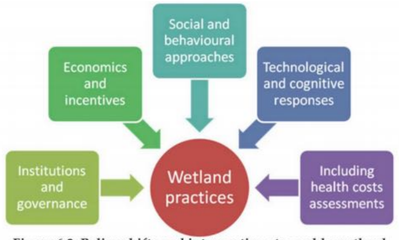
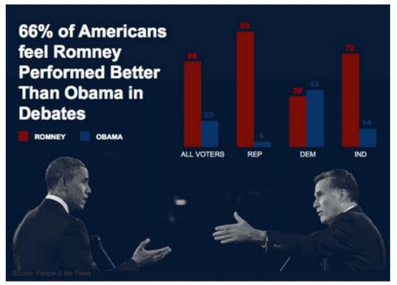
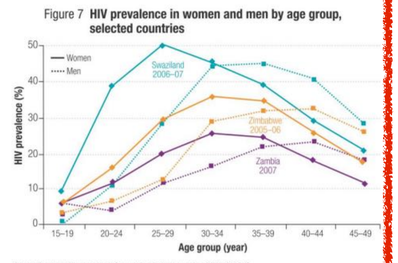
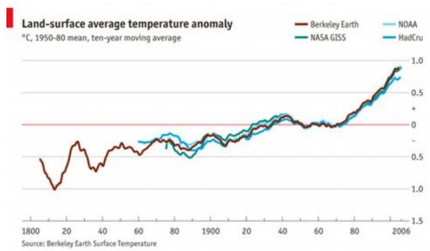
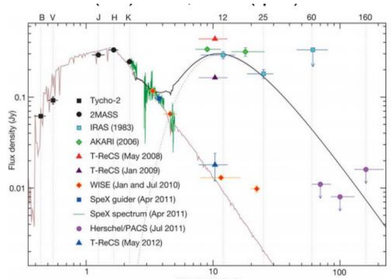


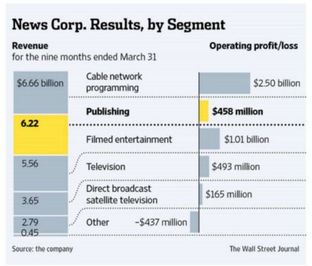
Figure 6.2: Policy shifts and interventions to enable wetland practices to accommodate notions of ecosystem services and human health

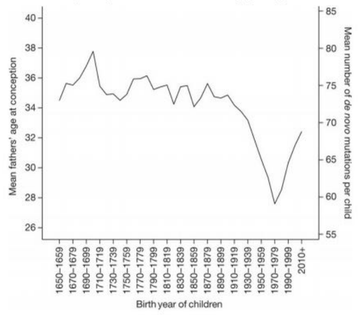


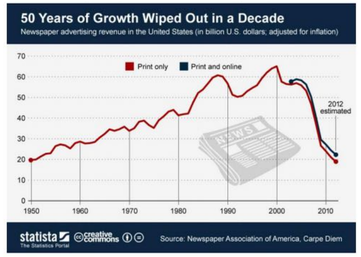




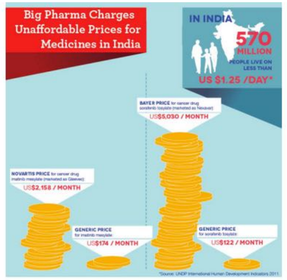


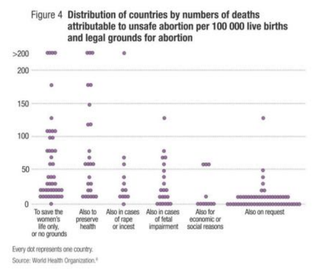




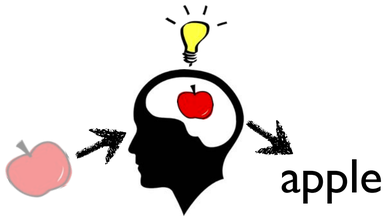




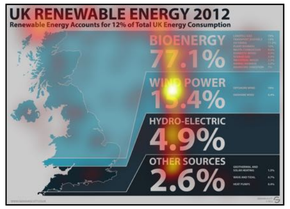




HUMAN RECOGNIZABLE OBJECTS (HRO)



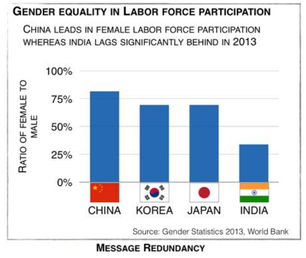
HROs did not hinder visualization recall



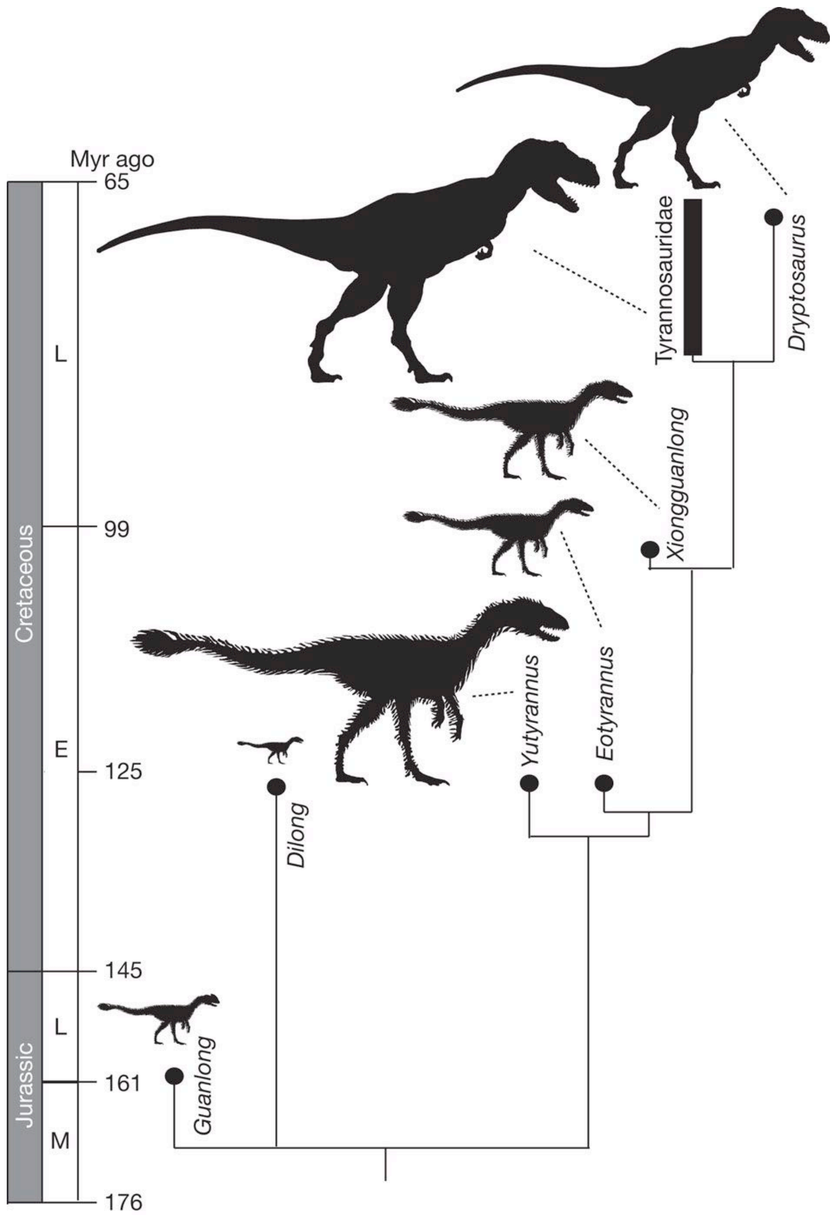
Fixation time least of all visual elements



Recall description quality higher



HROs can help with message redundancy



"Evolution from jurassic period to cretaceous T-Rex is towards the top"

"Dinosaur types Tyrannosarae feathered bird-like species development in relation to time"

"A clade chart showing evolutionary divergence and relationships between various dinosaurs. Prehistoric time is presented on the left axis."

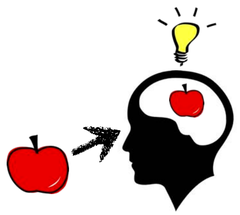
NOTE: Pictograms can *hurt* visualization understanding



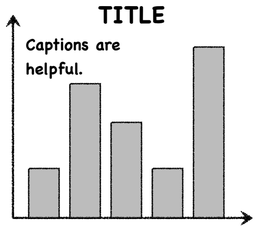
"Had a dinosaur on the top, starbucks"

"Codes started in Japan which also is home to Godzilla."

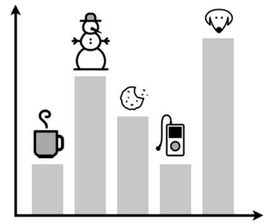
KEY FINDINGS



Visualizations that are memorable "at-a-glance" have memorable content.



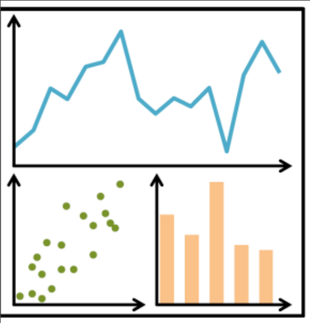
Titles and text are key elements in a visualization and help recall the message.

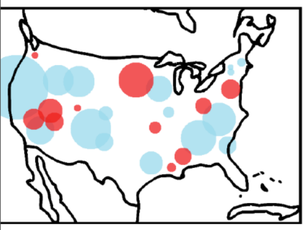


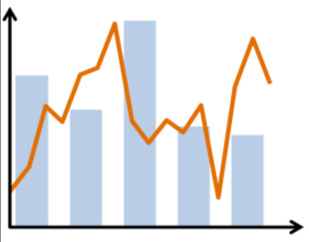
Human recognizable objects (e.g., pictograms) can help with the recognition or recall of a visualization.

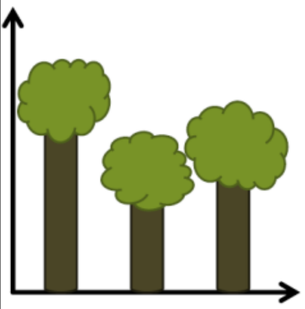


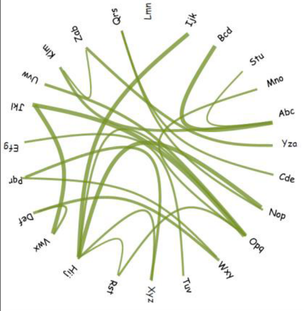
Redundancy helps with visualization recall and understanding.











FOR MORE INFORMATION... AND ALL OF OUR DATA:

MASSVIS DATASET

MASSACHUSETTS (MASSIVE) VISUALIZATION DATASET

massvis.mit.edu

This work was supported by the National Science Foundation (NSF) under grant 1016862, Google, and Xerox. Additional support was made possible through the NSF Graduate Research Fellowship Program, the Natural Sciences and Engineering Research Council of Canada (NSERC) Postgraduate Doctoral Scholarship (NSERC PGS-D) as well as Discovery grant, and the Kwanjeong Educational Foundation.

