BEYOND MEMORABILITY: VISUALIZATION RECOGNITION AND RECALL

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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

RESULTS

RELATED WORK

THE DATA

Many important works in the visualization community have studied how different visualization types are perceived, and the
**The Experiment**

**Experiment Design**

**Labeled Visualization Database**

393 visualizations

**33 Participants**

- **Encoding**: 10 seconds/image
- **Recognition**: 2 seconds/image
- **Recall**: 20 minutes

**Eye-Tracking Data**

**Text Descriptions**

~60 minutes
The Experiment

The Data

Related Work

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Results
Visualization Database (5,814 images)

“Single” visualizations (2,068 images)

“Targets” (393)

“single”

Data available at massvis.mit.edu

Borkin et al. (2013)
Data available at massvis.mit.edu

Visualization Database (5,814 images)

“Single” visualizations (2,068 images)

“Targets” (393)

Black & White
Yes  No

Number of Distinct Colors
1  2-6  ≥ 7
good  medium  bad

Data-Ink Ratio
low  medium  high

Visual Density

Human Recognizable Objects
Yes  No

Borkin et al. (2013)
FOR EACH VISUALIZATION:

• Labels

Covered Transactions from the Wholesale, Retail, and Transportation Sector
FOR EACH VISUALIZATION:

• Labels

• Title transcription

“TOP 10 MOST READ BOOKS IN THE WORLD”
FOR EACH VISUALIZATION:

• Labels
• Title transcription
• Data and message redundancy
Gender equality in labor force participation:

- **China** leads in female labor force participation whereas India lags significantly behind in 2013.

Source: Gender Statistics 2013, World Bank

Data Redundancy:

- **China** leads in female labor force participation whereas India lags significantly behind in 2013.

Data & Message Redundancy:

- **China** leads in female labor force participation whereas India lags significantly behind in 2013.

Source: Gender Statistics 2013, World Bank
For each visualization:

- Labels
- Title transcription
- Data and message redundancy
EXPERIMENT

“Single” visualizations (2,068 images) → “Targets” (393)
The Experiment

The Data

Related Work

Many important works in the visualization community have studied how different visualization types are perceived, and the

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

Many important works in the visualization community have studied how different visualization types are perceived, and the

Results
**MOST MEMORABLE**

**LEAST MEMORABLE**

**ENCODING (10 SEC)**

**Visualization Associations**

**Semantic Associations**
**Visual Associations**

**For Example...**

- **Human Recognizable Objects**
- **Visual annotations**
- **Visualization/plot**

**Semantic Associations**

**For Example...**

- **Titles**
- **Textual descriptions**
- **Labels**
- **Axis labels**

Captions are helpful.

Percent

79%  100%
“AT A GLANCE” ENCODING (1s)
Borkin et al. (2013)

PROLONGED ENCODING (10s)
This Paper

Memorability

Visualizations ranked by memorability score.

Visual Associations

Semantic Associations

no distinct visual or semantic associations

100%

Percent

Bins

Borkin et al. (2013)

This Paper
“Describe the visualization in as much detail as possible.”

For all 2,773 text descriptions:

Labels mentioned

Description quality

Good 3
Bad 1
RECALL

Total number of mentions:
- Title: 1,252
- Label: 751
- Paragraph: 648
- Data: 530
- Legend: 455
- Axis: 422
- Human Recognizable Object: 317
- Annotation: 108
- Text: 56
- Source: 19
Good titles help with recall!

“Election Debate”
vs.

“66% of Americans feel Romney Performed Better Than Obama in Debates”
**HIGH QUALITY DESCRIPTION**

- **Memorable**
  - Visual Associations
  - Semantic Associations
  - Message redundancy
  - Data redundancy
  - Titles/Annotations

- **Forgettable**

**LOW QUALITY DESCRIPTION**

**Visual**

**Semantic**

**Message**

**Data**

**Title/Annotations**
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 Tyrannosarcae 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.
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