# Communicating data: interactive infographics, scientific data and credibility

Read & presented by Martine Jansen, for the Reading Group "Statistics Communication and (in)numeracy"

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# Article

Discussed will be:

**Title** - Communicating data: interactive infographics, scientific data and credibility
**Authors** - Nan Li, Dominique Brossard, Dietram A. Scheufele, Paul H. Wilson, Kathleen M. Rose
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**DOI** - https://doi.org/10.22323/2.17020206 **Data etc** - alas

# Summary

- Experiment with 517 participants
- Perceptions of data credibility were tested by
  - manipulating data visualizations related to the issue of nuclear fuel cycle based on three characteristics:
    - graph format
    - graph interactivity
    - and source attribution
- Results
  - viewers tend to rely on preexisting levels of trust and peripheral cues, such as source attribution, to judge the credibility of shown data
  - whereas their comprehension level did not relate to perception of data credibility
- Implications for science communicators and design professionals are discussed

# Hypotheses

# Visual format, Interactivity and Source Attribution

**Visual format**
Perceived credibility vizualized data is higher when presented in traditional graph (e.g., area graph) than presented in innovative graph (e.g., proportional area graph)

**Interactivity**
Perceived credibility of visualized data is higher when presented in interactive graph than in a static graph

**Source attribution** Perceived credibility of visualized data varies as a function of source attribution
Relationship between perceived credibility of visualized data and source attribution varies for people with different levels of trust in the given sources

## Fuel Cycle Costs

Operating any energy system, including a nuclear energy system, has a variety of different costs, including the costs of the nuclear fuel cycle. Different nuclear fuel cycle choices result in both different total fuel cycle costs and different distributions of those costs.

These figures show the impact on the fuel cycle cost of different fuel cycle options, broken down by the cost for different ways to store and manage spent nuclear fuel. (Hover over the legend for more details.)

Massachusetts Institute of Technology

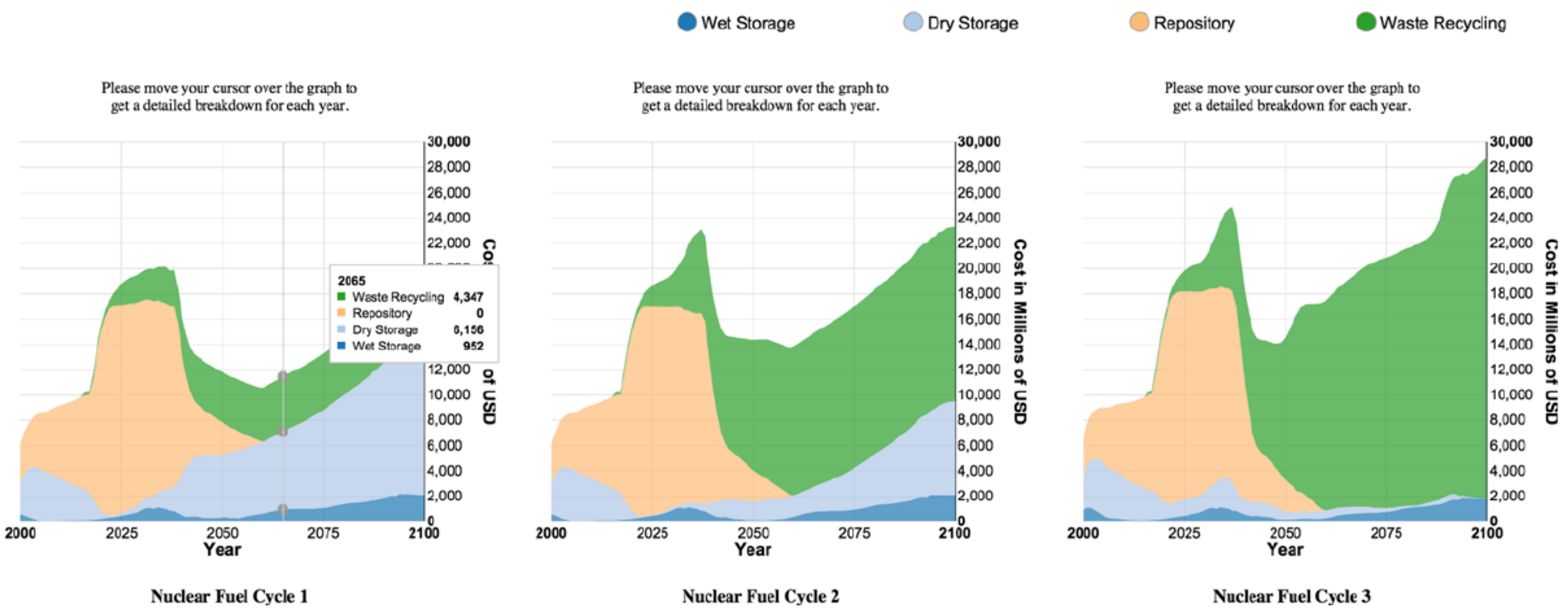


**Figure 1.** Dynamic area chart showing the costs of waste storage and disposal for three nuclear fuel cycles between 2000 and 2010.

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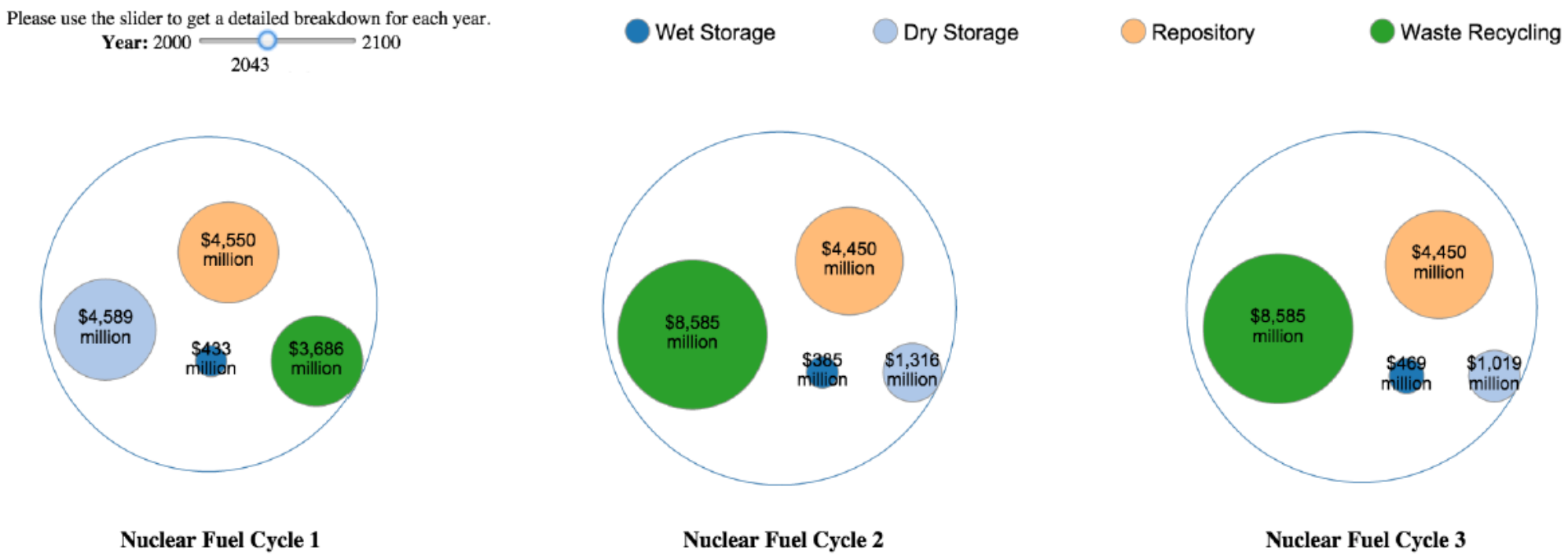


**Figure 2**. Dynamic proportional area chart showing the costs of waste storage and disposal for three nuclear fuel cycles between 2000 and 2100.

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# Self-assessed design quality

Perception of credibility for visualized data positively relates to viewers' subjective evaluation of the graph's design quality.

Measured by seven items using a five-point scale (1 = strongly disagree, 3 = neither agree nor disagree, 5 = strongly agree), asking participants if they think the graph "is interpretable," "shows a clear picture of the data," "is easy to understand," "is readable," "represents the data well," "is concise," and "organizes the data well."
Items averaged to form an index, ranging from 1 to 5 (M = 3.82, SD = .71, Cronbach's alpha = .91).

# Not hypotheses

# Comprehension

what is the relationship between viewers' perceived credibility of visualized data and their comprehension?

Comprehension measured by six multiple-choice questions.
3Q asked participants to identify specific data points, such as "(What was the cost of wet storage and dry storage/How much wet storage and dry storage generated) for the Nuclear Fuel Cycle 1 in 2000?"
3Q asked participants to interpret the graph by comparing data points, such as "Among the three nuclear fuel cycles, which one (costs most/generates the most total waste) in 2000?" and "On average, which nuclear fuel cycle costs most over time? Nuclear Fuel Cycle 1, 2, or 3."
An index (range 0–6) was created based on the cumulative number of correct answers (M = 4.77, SD = 1.46, Kuder-Richardson Formula 20 = .622).

# Predispositions

Predispositions, including graph efficacy, numeracy skills, and domain knowledge, may potentially influence perception of credibility given their intrinsic relationships with comprehension

To factor this out included as independent variables in the model:

- a self-reported measure of graph efficacy,
- numeracy skills
- and domain knowledge as independent variables in the model

To factor out confouding effects of
participants having had more formal education in scientific fields (might be more familiar with data visualization and its conventions), the number of science courses was included as a control variable .

# Numeracy skills

- adapted from Fagerlin et al. [2007]'s subjective numeracy scale
- 3 questions asked participants to indicate their agreement with:
  - "I am good at (working with fractions/working with percentages/calculating a 15% tip)"
  - "when people tell you the chance of something happening, do you prefer that they use words or number"
  - "when you hear a weather forecast, do you prefer predictions using percentages or predictions using only words?"
- An index was created based on the average score (M = 3.58, SD = .72, Cronbach's alpha = .69).

# The model

# Dependent variable: Perceived data credibility PDC

- The average of the scores of statements
  - the data are trustworthy
  - the data are produced by a reputable source
  - the data are accurate
  - the data are error-free
  - the data are incorrect (reverse coded),
  - the data are unbiased
  - the data are objective
- Measured each using a five-point scale
  (1 = strongly disagree, 3 = neither agree nor disagree, 5 = strongly agree)
- M = 3.33, SD = .43, Cronbach's alpha = .72).

# Independent variables

1. Experimental treatment (3 vars dichotomous): graph format, interactivity, and source attribution
2. Control variables, including age, gender, major field, the number of science courses
3. Predispositions
4. Graph comprehension and perceived design quality
5. Interaction term source attribution * standardized score of relative trust

# Method & Results

- Hierarchical regression
  - Independent variables entered per block
  - Why blockwise regression?
  - Why this specific order?
- Results
  - show the \(\beta\)'s and significance stars, no sd
  - when entered and after final block
  - conclusions based on final model
  - desciption presented in another order
  - overall 14.9% explained variation in PDC

# Results

# Results - Experimental conditions

| | Before-entry β | Final β |
|---|---|---|
| **Block 1: experimental condition** | | |
| Visual format (Bubble chart = 1) | .03 | .01 |
| Interactivity (Dynamic = 1) | -.06 | -.09* |
| Source attribution (DOE = 1) | -.13** | -.14*** |
| *Incremental* $R^2$ | | 2.1%* |

*Note*: ***p < .001, **p < .01, *p < .05. The original experiment included a manipulation of graph content (waste versus cost), which was controlled in the model but did not significantly related to the dependent variable (Beta=0).

- Interactivity is worse on PCS than static
  - Difference per visual format?
  - In Disucssion is stated no effect?
- MIT was considered more credible than DOE

# Results - Demographics

| | | |
|---|---|---|
| **Block 2: demographics** | | |
| Age | -.17*** | -.14*** |
| Gender | -.08 | -.08 |
| Number of science course taken | -.02 | -.02 |
| Field of major (science = 1) | -.04 | -.07 |
| *Incremental* $R^2$ | | 3.7%*** |

- Younger participants score higher on PCS
- Age and number of science courses associated?

# Results - Predispositions

| | | |
|---|---|---|
| **Block 3: predispositions** | | |
| Graph efficacy | .16*** | .10* |
| Numeracy skill | .11* | .06 |
| Domain knowledge | .02 | -.03 |
| Relative trust in university scientists versus governmental agencies | 0.00 | -.01 |
| *Incremental* $R^2$ | | 2.6%** |

- Graph efficacy (self-reported ability to read and use graphical tools) was positively related to the outcome variable

# Results - Comprehension and design quality

| Block 4: comprehension and design quality | | |
|---|---|---|
| Comprehension | .13* | .05 |
| Design quality | .22*** | .16*** |
| *Incremental* $R^2$ | | 2.7*** |

- PCS positively related to self-assessment of design quality
- Not so for graph comprehension (accuracy of viewers' understanding of the stimuli)

# Results - Interaction

| | |
|---|---|
| **Block 5: interaction** | |
| Relative trust * Source attribution | -.27*** |
| *Incremental* $R^2$ | 3.8%*** |

- People who trusted university scientist more than governmental agency more likely to think the data was credible when it was attributed to MIT than to DOE.
- For others, their perceived data credibility does not differ

# Conclusion

Insight

- Perceived design quality, a credited source from university, and static viz adds PCS

Limitation

- Only one contextual issue
- Lack of diversity in respondents (young academic students)
  - Maybe less spread in answers on trust MIT/DOE
- Interactivity was operationalized with animation and precision, more options
  - Animation for bubble chart, precision for area chart (?)
- Only small % explained, more factors
- TBR: Differentiating impact of objective and perceived design quality on PDC

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