Can all patients understand?

Extent and implications of
low numeracy and graph literacy

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Measuring numeracy in the general population

- Imagine that we flip a fair coin 1000 times. What is your best guess about how many times the coin would come up heads in 1000 flips? **500** times out of 1000

  **Incorrect**: 27% in Germany, 27% in US

- Which of the following numbers represents the biggest risk of getting a disease: 1 in 100, 1 in 1000, or 1 in 10?

  **Incorrect**: 28% in Germany, 25% in US

- If the chance of getting a disease is 20 out of 100, this would be the same as having a **20**% of getting the disease.

  **Incorrect**: 27% in Germany, 30% in US

Average percent of correct answers (of total 9 questions)

Germany: 68.5% ± 2 SE
U.S.: 64.5% ± 2 SE

Numeracy and gender

Average percent of correct answers

Germany

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
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<tbody>
<tr>
<td>74%</td>
<td>63%</td>
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</table>

U.S.

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
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<tbody>
<tr>
<td>69%</td>
<td>60%</td>
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</tbody>
</table>

Error bars: +/- 2 SE

Numeracy and age

Average percent of correct answers

Germany

U.S.

25–39
40–54
55–69

73%
68%
64%

67%
68%
58%

Error bars: +/- 2 SE

Numeracy and education

Average percent of correct answers

Germany

- College or more: 79%
- Some college: 67%
- High school: 62%
- Less than high school: 40%

U.S.

- College or more: 81%
- Some college: 56%
- High school: 65%
- Less than high school: 40%

Error bars: +/- 2 SE

Numeracy and income

Average percent of correct answers

Germany

U.S.

Lower third (up to ~$30,000)

Middle third (~$30–60,000)

Upper third (more than ~$60,000)

Effects of low numeracy
Impaired understanding of benefits of treatments and screenings

“Of 1000 people, how many fewer people die from a heart attack after taking a drug that reduces risk from 8% to 5%?”

Impaired recall of health related information

“People who are overweight have life expectancy that is 60 months shorter than an average person”

Stronger effects of irrelevant factors on decision making

- **Positive vs. Negative Framing**
  - „Emily answered 74% questions correctly“ (Positive Frame)
  - „Emily answered 26% questions **incorrectly**“ (Negative Frame)

How would you rate Emily’s work? Scale: -3 (very poor) … +3 (very good)

Stronger effects of irrelevant factors on decision making

- **Percentage vs. Frequency format**
  - 10% of patients get a bad blistering rash (Percentage format)
  - 10 out of every 100 patients get a bad blistering rash (Frequency format)

How risky is a medication with this side-effect?

![Graph showing difference in risk perception between percentage and frequency formats for low and high numeracy](image)

Lower desire to engage in shared decision making

<table>
<thead>
<tr>
<th></th>
<th>Low numeracy</th>
<th>High numeracy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Germany</td>
<td>USA</td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td>More passive</td>
<td>29.8%</td>
<td>13.1%</td>
</tr>
<tr>
<td>No change</td>
<td>51.6%</td>
<td>72.3%</td>
</tr>
<tr>
<td>More active</td>
<td>18.5%</td>
<td>14.6%</td>
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<tr>
<td></td>
<td>34.6%</td>
<td>10.9%</td>
</tr>
<tr>
<td></td>
<td>47.1%</td>
<td>71.9%</td>
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<tr>
<td></td>
<td>18.3%</td>
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Can graphical representations help?
Graphs are a recent invention

- William Playfair first used bar, line, and pie charts

*Commercial and Political Atlas (1786), Statistical Breviary (1801)*
Graphs are a recent invention

- Otto Neurath used icons to educate public in 1920s
Measuring graph literacy

Here is some information about cancer treatments:

What percentage of patients recovered after chemotherapy?

**Incorrect**: 17% in Germany, 15% in the US

In a magazine you see two advertisements… Each is for a different drug for treating heart disease, and each includes a graph showing the effectiveness of the drug compared to a placebo (sugar pill).

Compared to the placebo, which treatment leads to a larger decrease in the percentage of patients who die?

*Crosicol – Hertinol - They are equal - Can't say*

*Incorrect: 63% in Germany, 66% in the US*

Average percent of correct answers (of total 13 questions)

Error bars: +/- 2 SE

Graph literacy and gender

Average percent of correct answers

Error bars: +/- 2 SE

Graph literacy and age

Average percent of correct answers

Graph literacy and education

Average percent of correct answers

Error bars: +/- 2 SE

Low graph literacy AND low numeracy?

- **Germany:**
  - Low numeracy: 49%
  - Low graph literacy: 33%
  - High numeracy: 51%
  - High graph literacy: 16%
  - Low graph literacy: 11%
  - High graph literacy: 40%
  - All: 100%

- **United States**
  - Low numeracy: 53%
  - Low graph literacy: 35%
  - High numeracy: 47%
  - High graph literacy: 18%
  - Low graph literacy: 6%
  - High graph literacy: 41%
  - All: 100%

Who profits from visual aids?

Accuracy of low numeracy participants, with different formats

Some remedies
Intuitive visual and numerical representations

- Using natural correspondences between spatial and quantitative relationships
  
  → Yasmina Okan’s work

- Natural frequencies instead of conditional probabilities

Analogies

One often hears that medical screenings can help in the early detection of diseases. However, getting a positive result from a screening test does not always mean you have the disease.

Which one of the following questions would best help you determine how much a woman can profit from mammography screening?

- How many women who have breast cancer get a positive mammogram?
- What percentage of women go to mammography screening?
- *How many women who get a positive mammogram actually have breast cancer?*
- How much does mammography screening cost?

Analogies

One often hears that medical screenings can help in the early detection of diseases. However, getting a positive result from a screening test does not always mean you have the disease.

Similarly, not all activated metal detectors mean that somebody is carrying a weapon.

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Similarly, not all activated car alarms mean that somebody is trying to steal that car.

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Similarly, not all people who cough have pneumonia.

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Similarly, not all people with stomach pain have an ulcer.

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Analogies

Summary

- Many patients have problems understanding basic numerical and graphical formats
  - In particular: lower education, lower income, women, older people
  - Unless communications are sensitive to these differences, there is a risk of increasing health disparities

- **Challenge**: find formats suitable for people with both low numeracy and low graph literacy
  - Numerical and visual formats that exploit pre-existing knowledge about the world (frequencies, spatial relationships)
  - Verbal formats such as analogies using everyday experiences