



# 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**

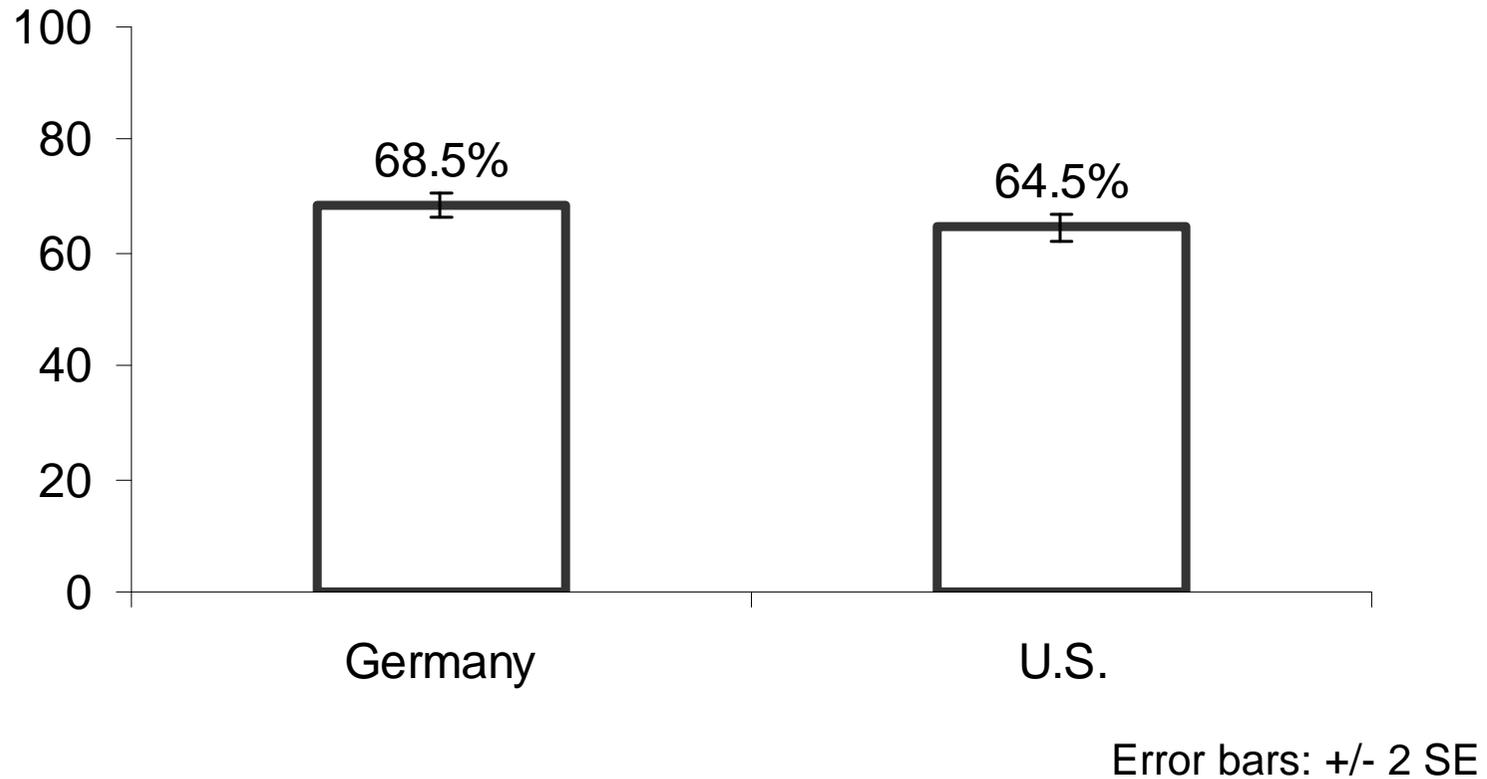
- Which of the following numbers represents the biggest risk of getting a disease: 1 in 100, 1 in 1000, or 1 in 10?

**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.

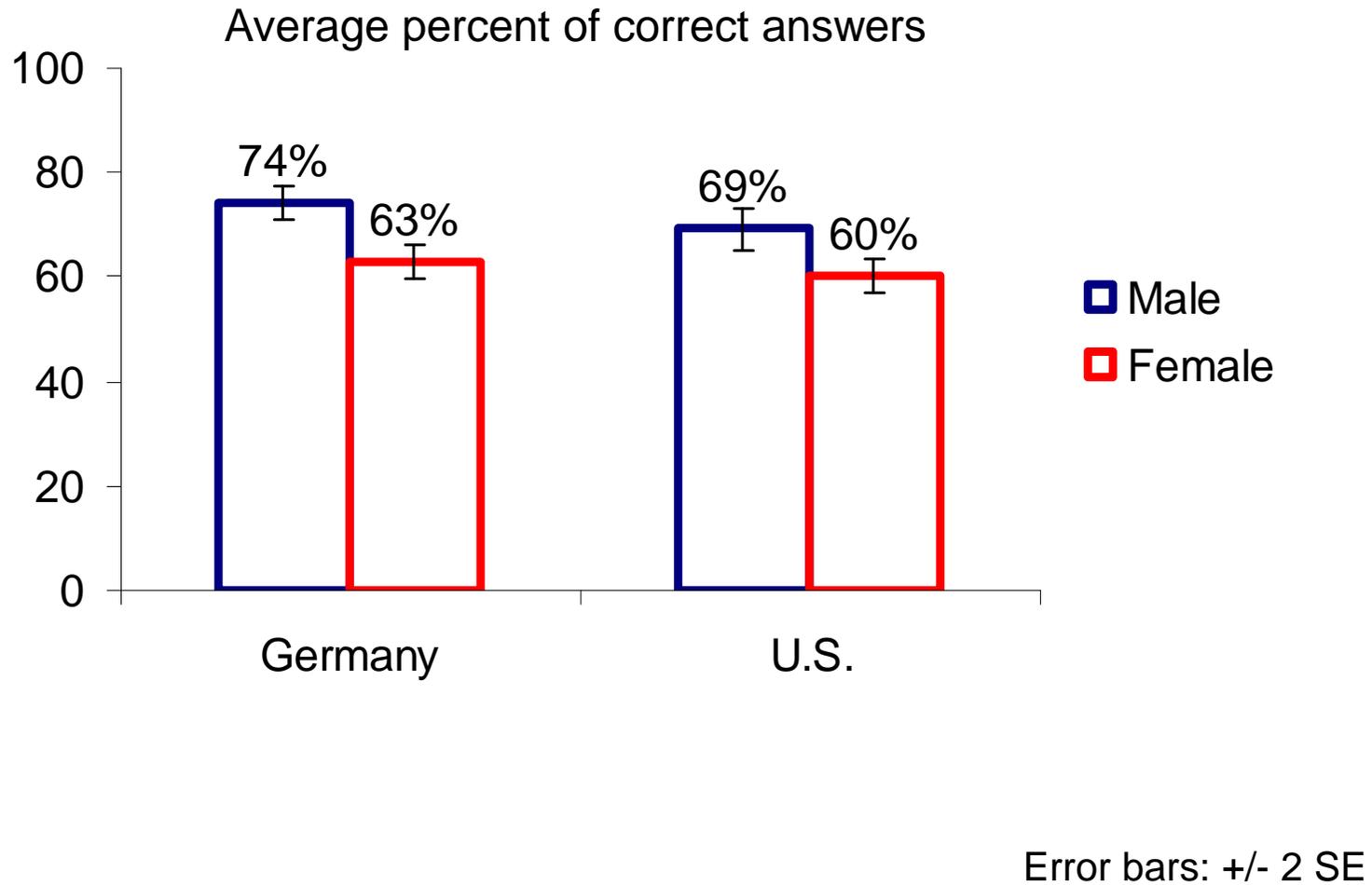
**Incorrect: 27% in Germany, 30% in US**

## Average percent of correct answers (of total 9 questions)



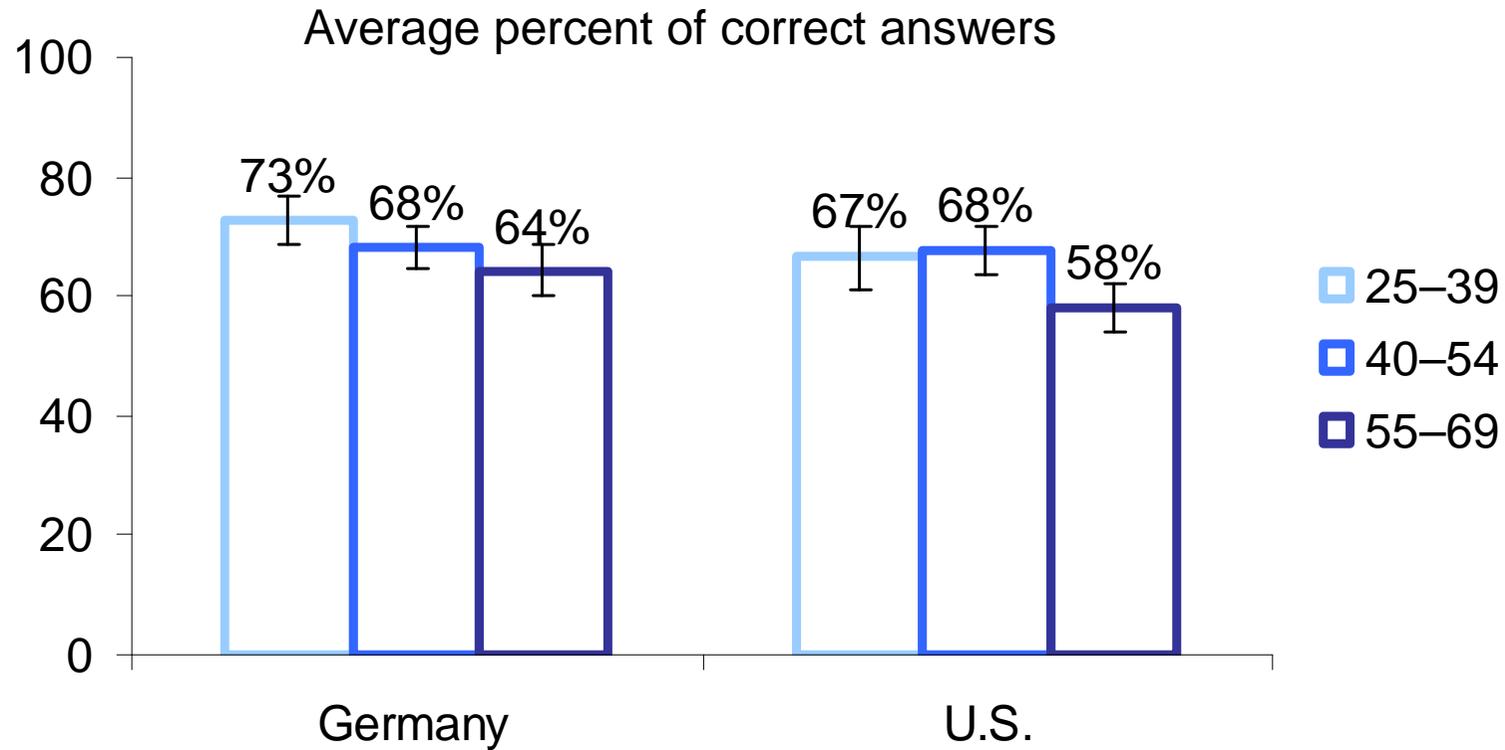
Galesic, M. & Garcia-Retamero, R. (2010). Statistical numeracy for health: A cross-cultural comparison with probabilistic national samples. *Archives of Internal Medicine*, 170, 462-468.

## Numeracy and gender



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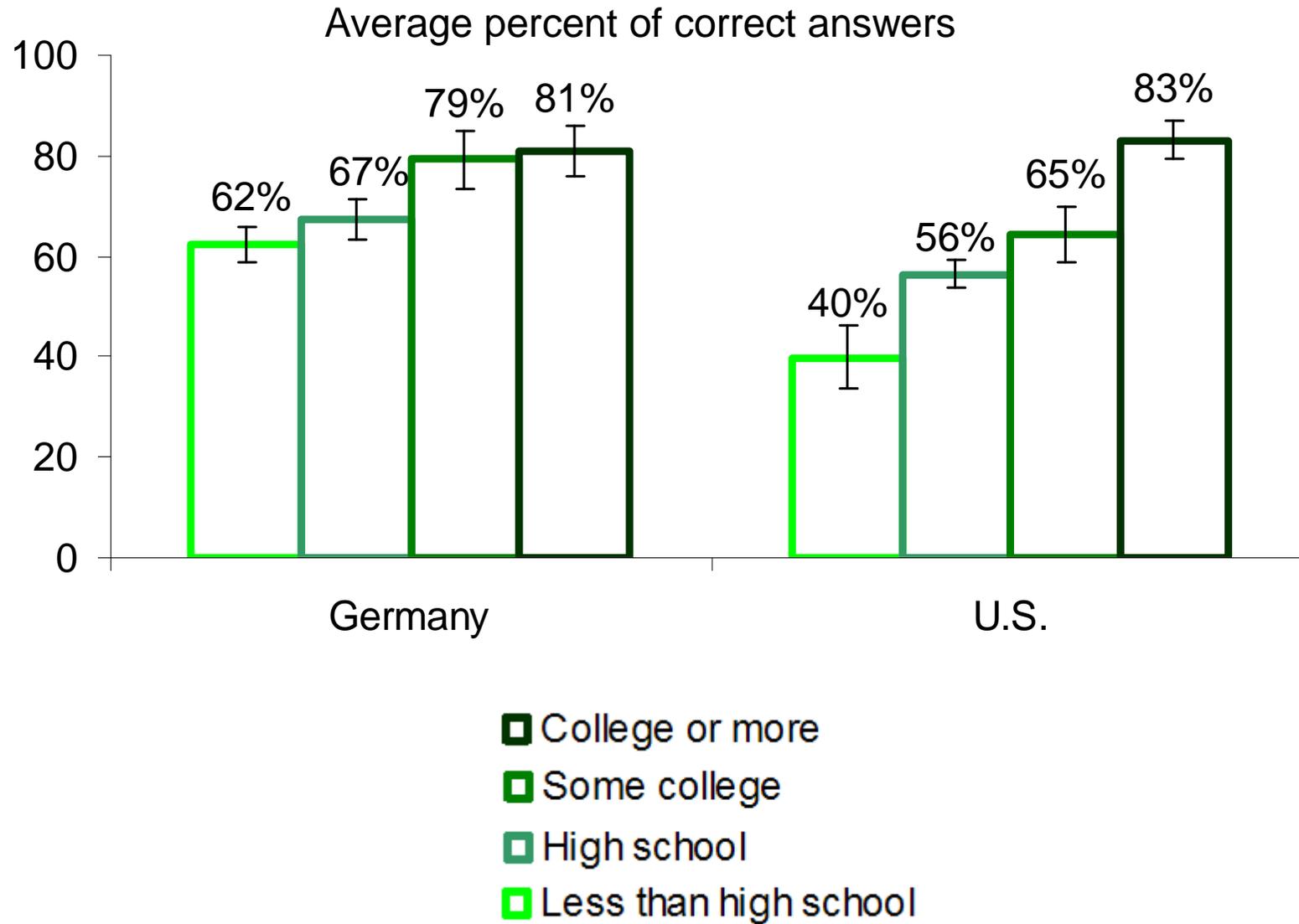
## Numeracy and age



Error bars: +/- 2 SE

Galesic, M. & Garcia-Retamero, R. (2010). Statistical numeracy for health: A cross-cultural comparison with probabilistic national samples. *Archives of Internal Medicine*, 170, 462-468.

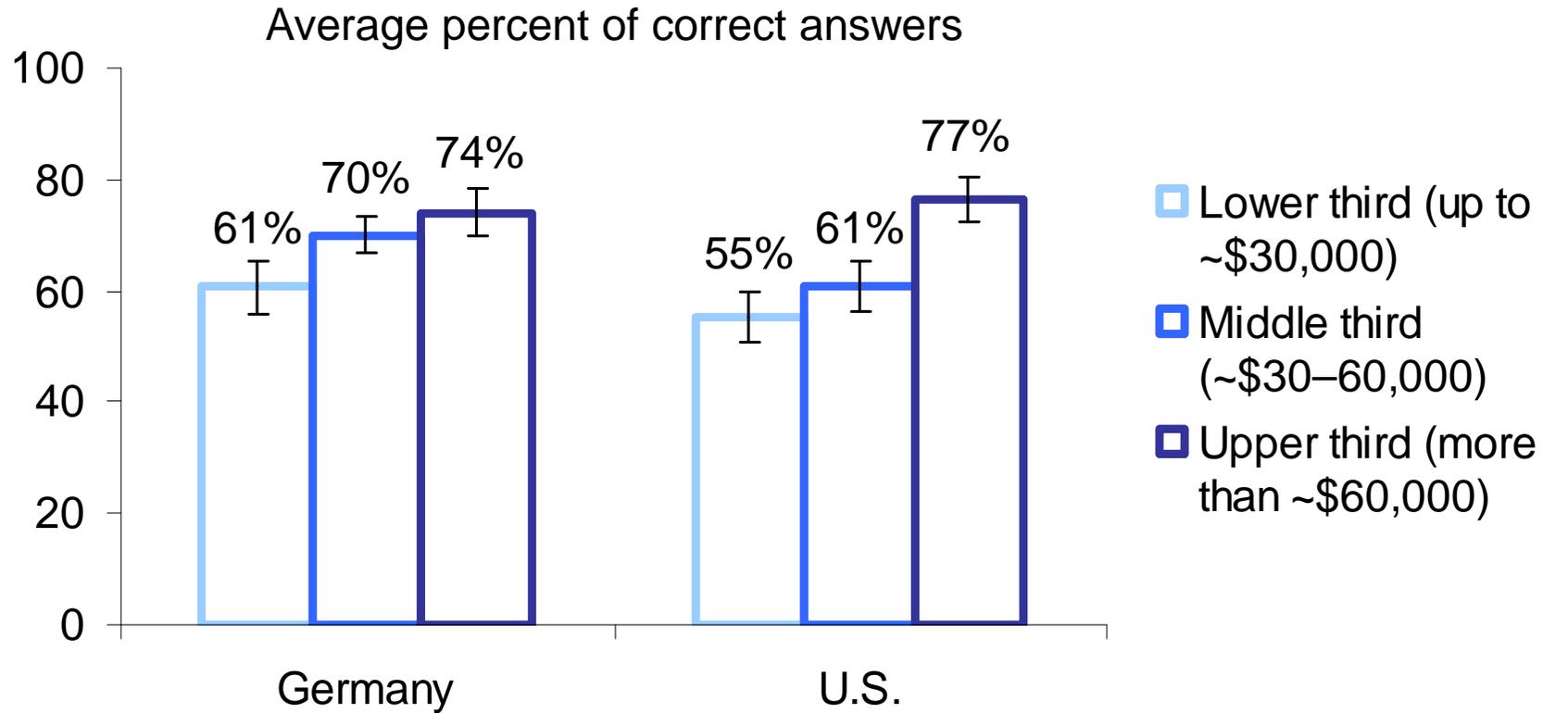
## Numeracy and education



Galesic, M. & Garcia-Retamero, R. (2010). Statistical numeracy for health: A cross-cultural comparison with probabilistic national samples. *Archives of Internal Medicine*, 170, 462-468.

Error bars: +/- 2 SE

## Numeracy and income



Error bars: +/- 2 SE

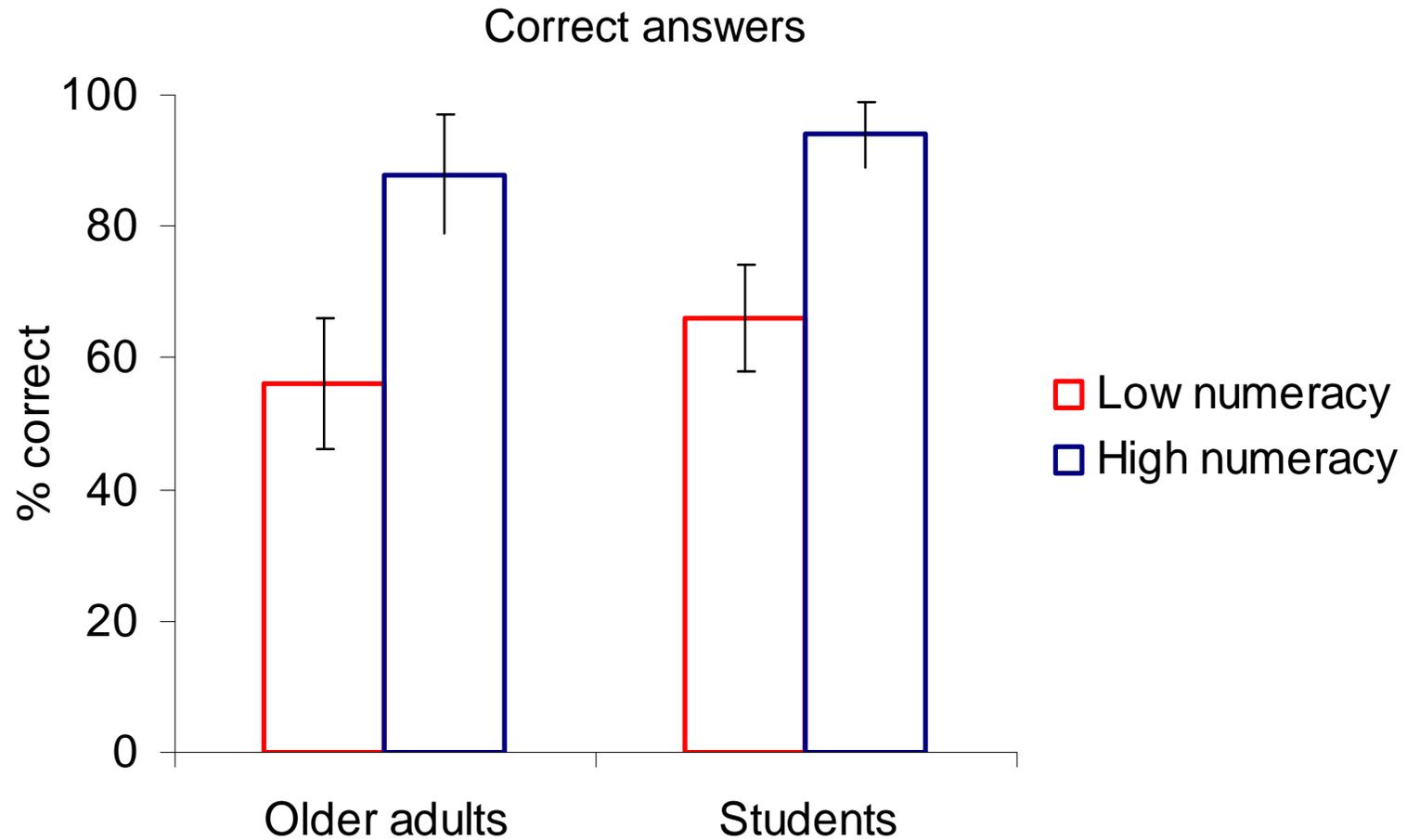
Galesic, M. & Garcia-Retamero, R. (2010). Statistical numeracy for health: A cross-cultural comparison with probabilistic national samples. *Archives of Internal Medicine*, 170, 462-468.

## **Effects of low numeracy**

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## Impaired understanding of benefits of treatments and screenings

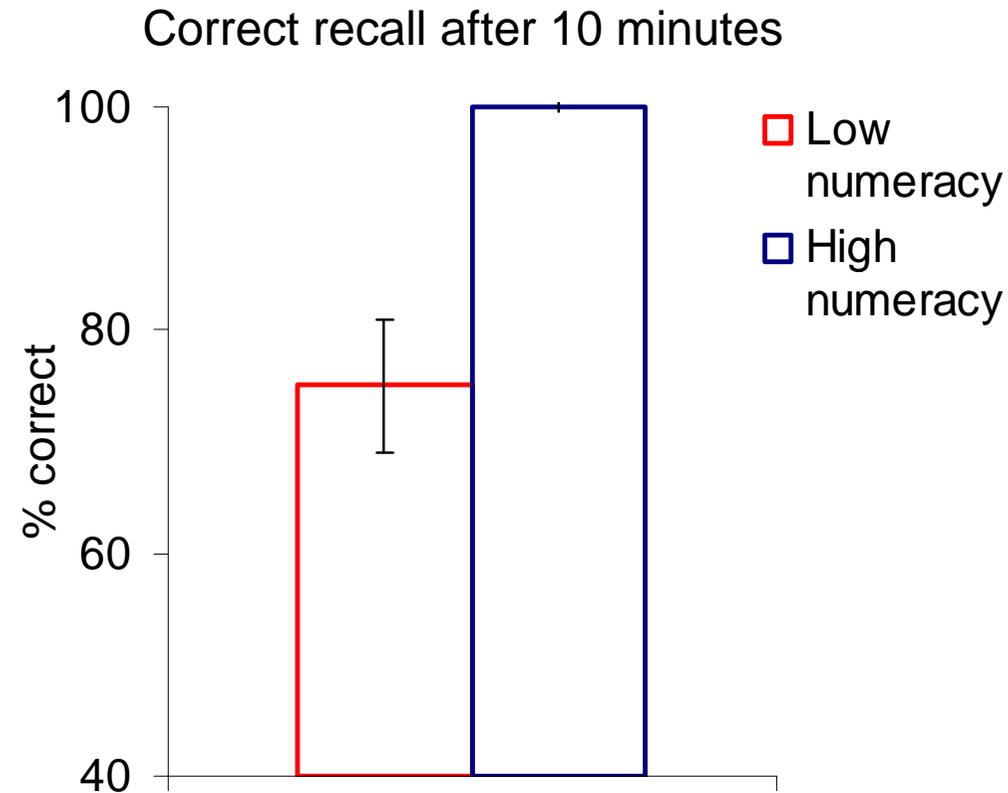
“Of 1000 people, how many fewer people die from a heart attack after taking a drug that reduces risk from 8% to 5%?”



Galesic, M., Garcia-Retamero, R., & Gigerenzer, G. (2009). Using icon arrays to communicate medical risks to low-numeracy people. *Health Psychology, 28*, 210-216.

## Impaired recall of health related information

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



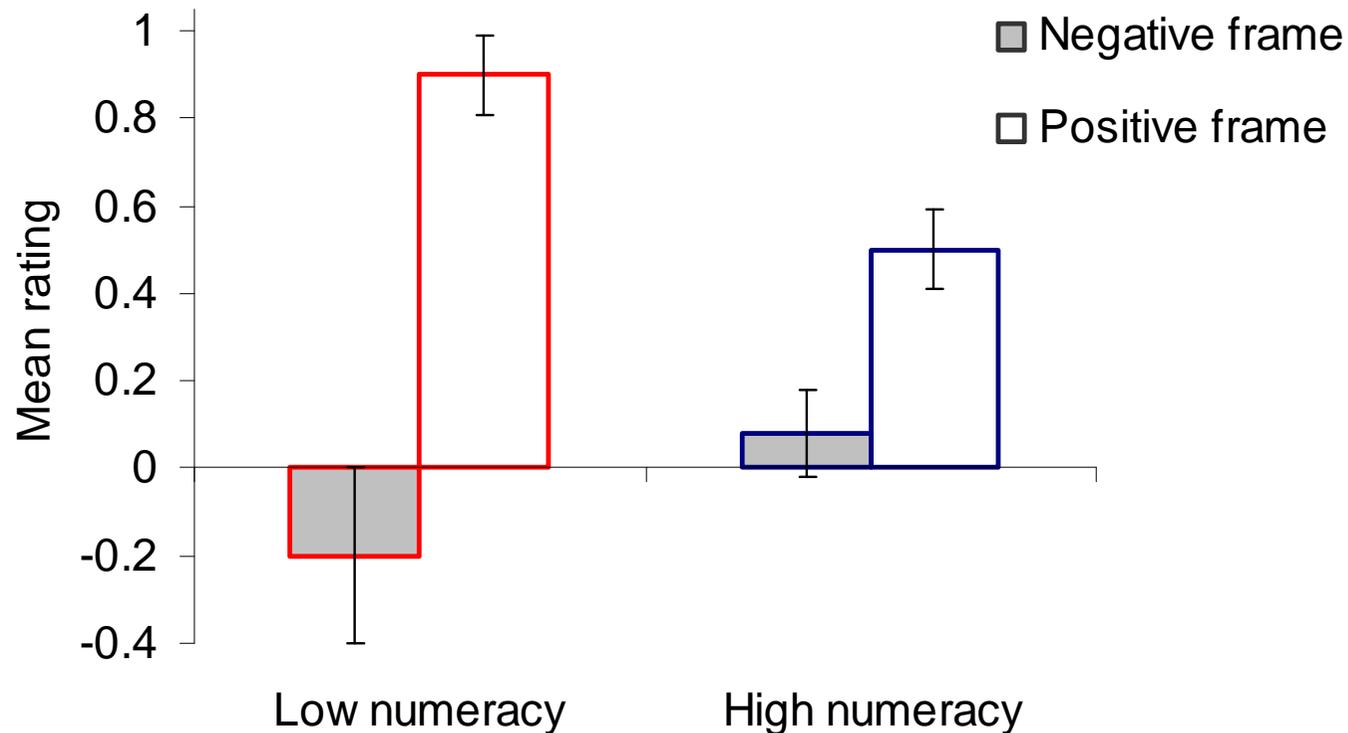
Galesic, M. & Garcia-Retamero, R. (2011). Communicating consequences of risky behaviors: Life expectancy versus risk of disease. *Patient Education and Counseling*. 82, 30-35.

## 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)

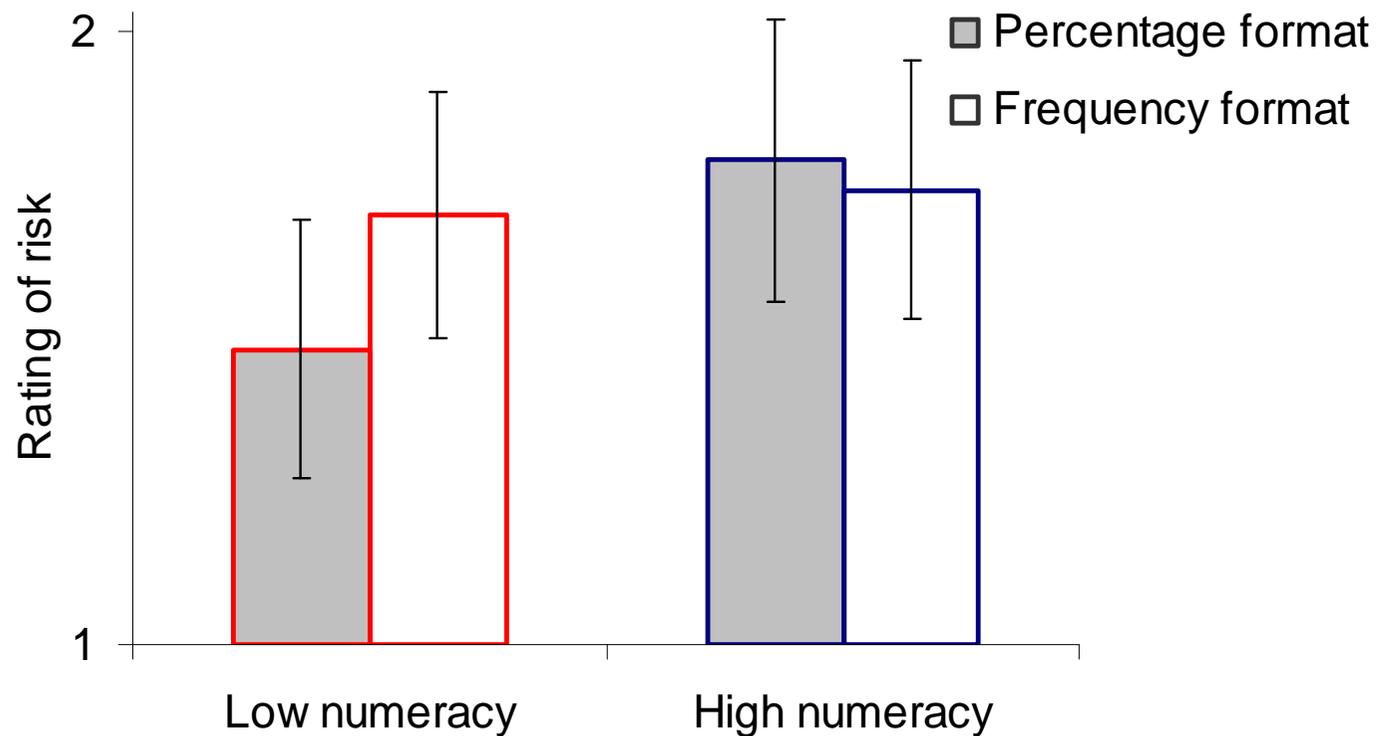


## Stronger effects of irrelevant factors on decision making

### Percentage vs. Frequency format

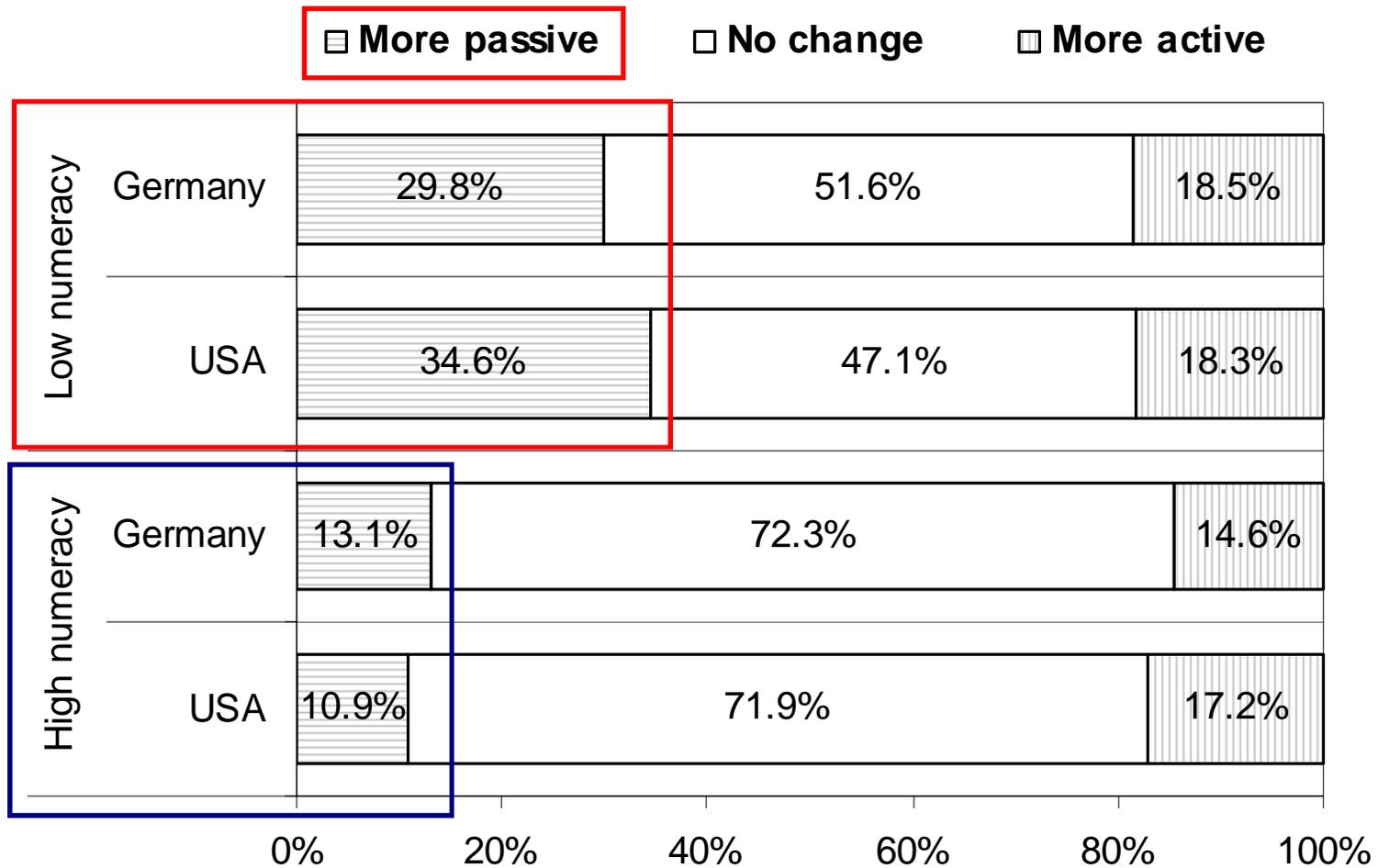
- 10% of patients get a bad blistering rash (Percentage format)
- 10 out of every 100 patients get a bad blistering rash (Frequency format)

How risky is a medication with this side-effect?



Peters, E., Hart, S., & Fraenkel, L. (2011). Informing patients: The influence of numeracy, framing, and format of side-effect information on risk perceptions. *Medical Decision Making*, 31, 432–436.

## Lower desire to engage in shared decision making



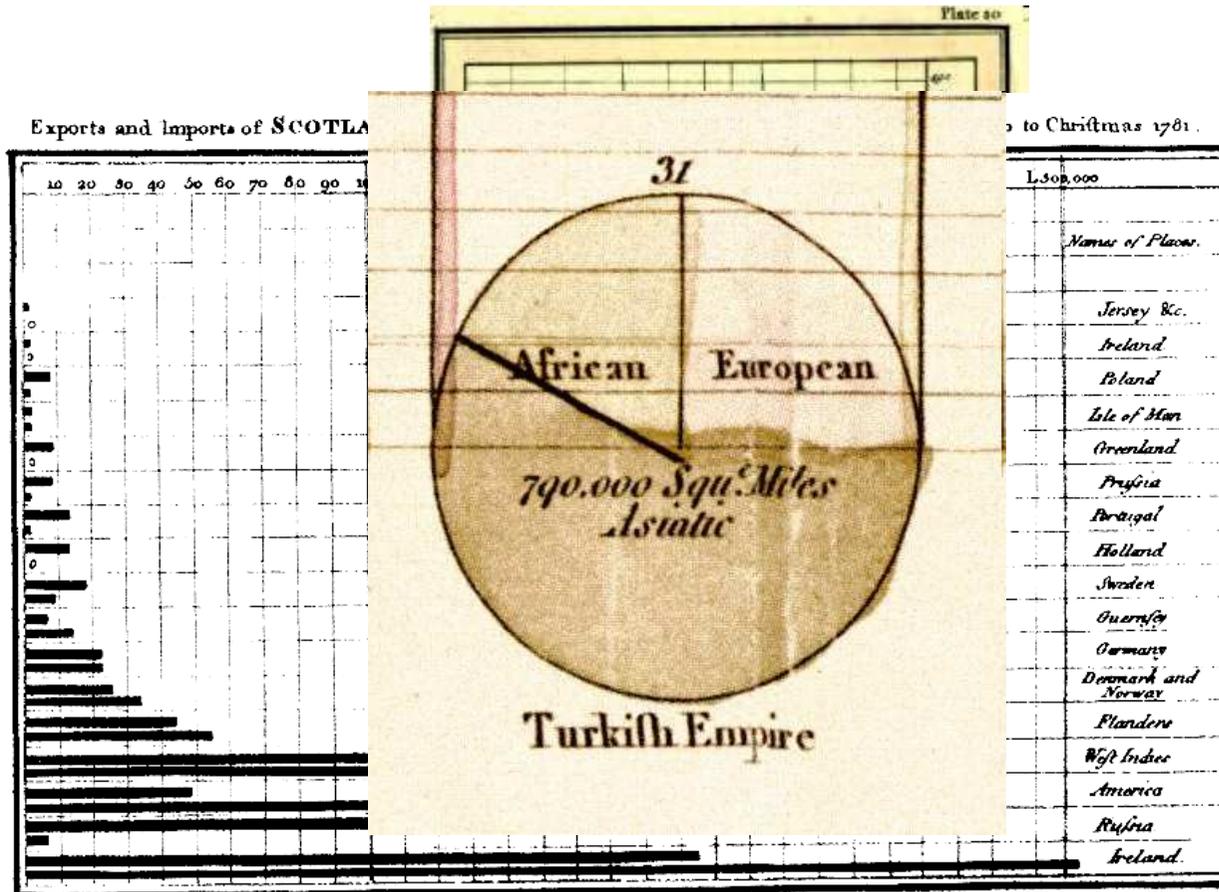
Galesic, M. & Garcia-Retamero, R. (2011). Do low numeracy people avoid shared decision making? *Health Psychology, 30*, 336-341.

**Can graphical representations help?**

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# Graphs are a recent invention

- William Playfair first used bar, line, and pie charts  
*Commercial and Political Atlas* (1786), *Statistical Breviary* (1801)

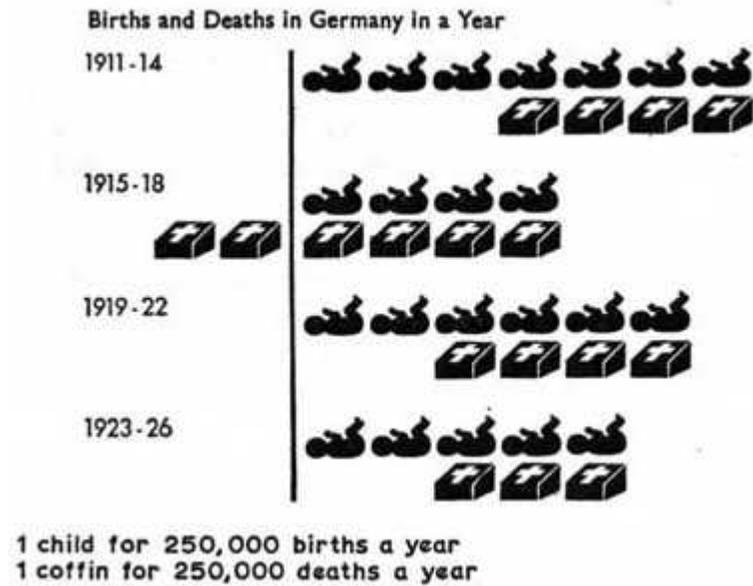


The Upright divisions are Ten Thousand Pounds each. The Black Lines are Exports the Ribbed lines Imports.  
 Published in the *Atlas* Series June 7<sup>th</sup> 1786 by W<sup>m</sup> Playfair  
 Made comp<sup>d</sup> 1532 Strand. London.



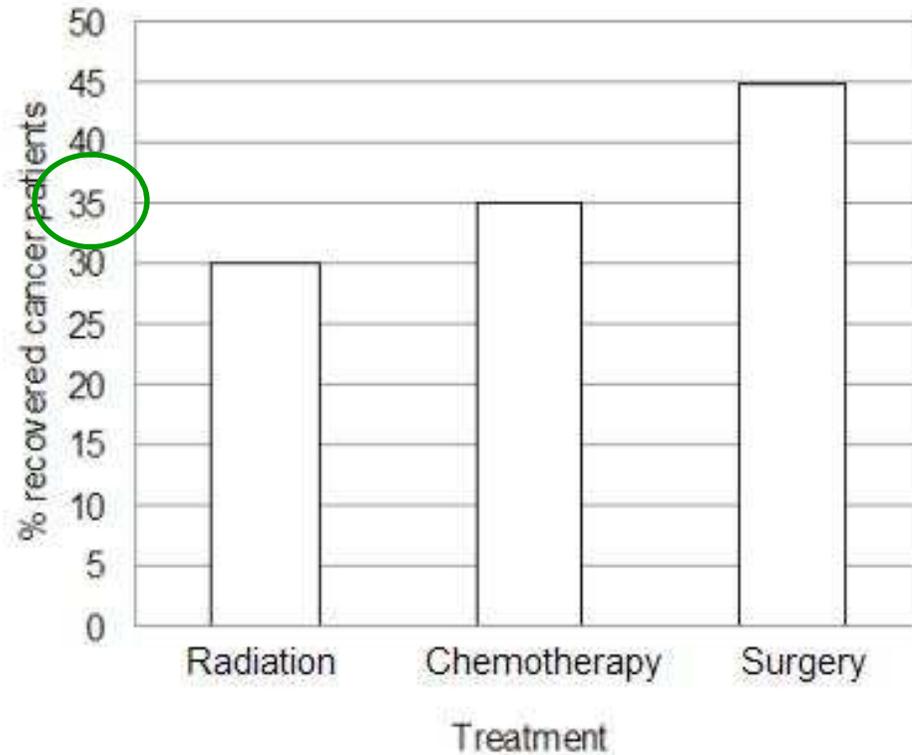
## Graphs are a recent invention

- Otto Neurath used icons to educate public in 1920s



## Measuring graph literacy

Here is some information about cancer treatments:

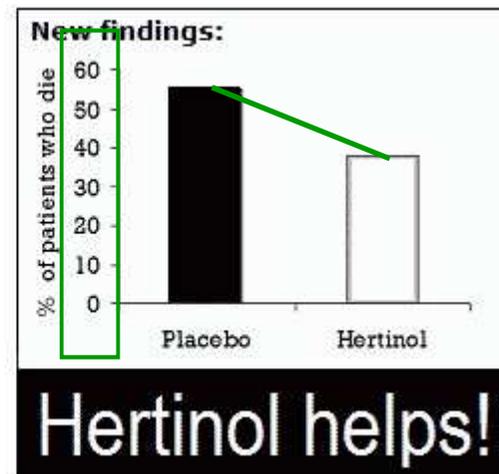
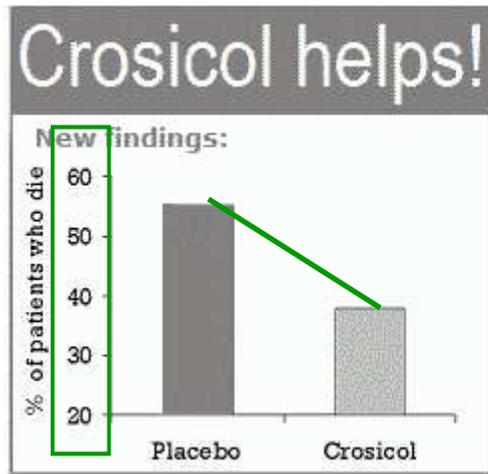


What percentage of patients recovered after chemotherapy?

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

## Measuring graph literacy

*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).*

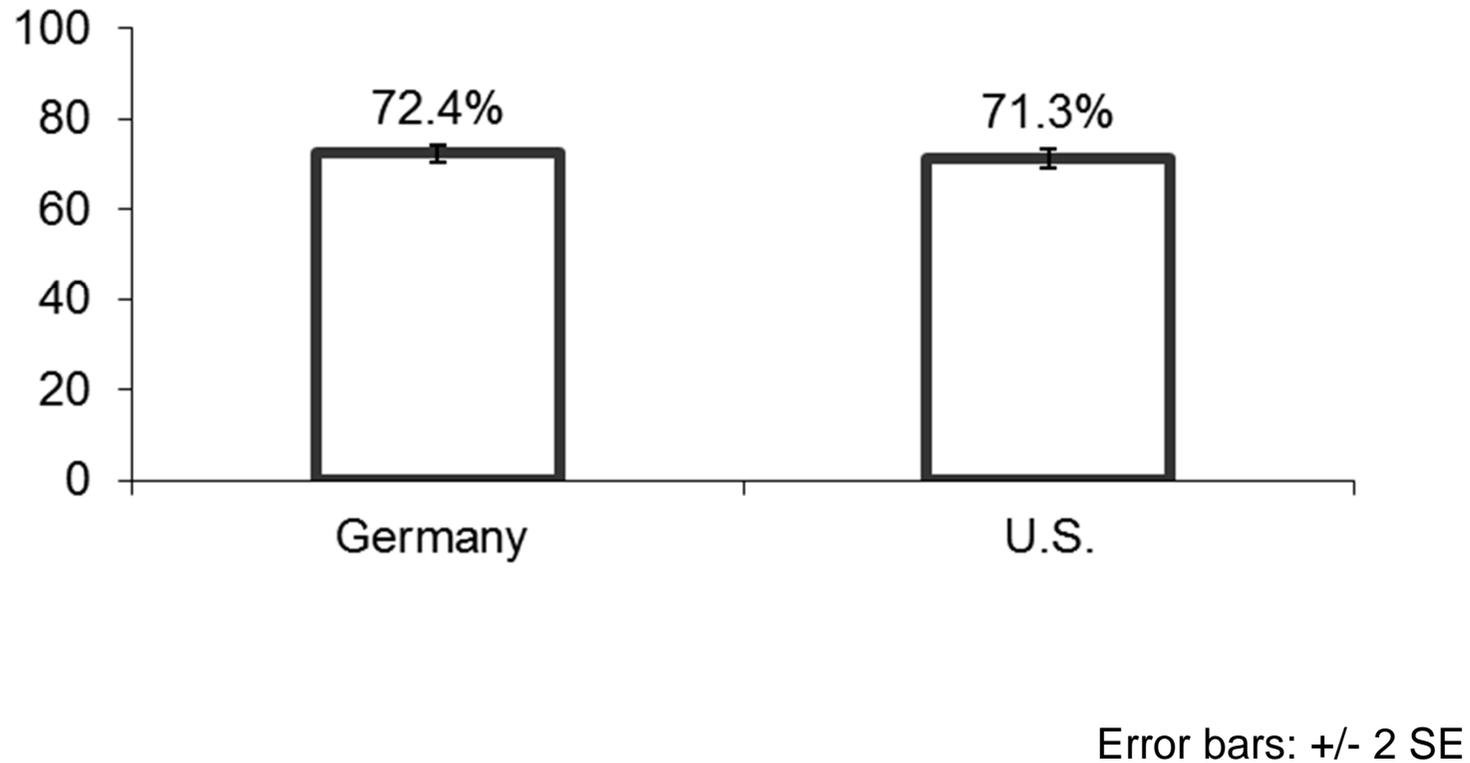


*Compared to the placebo, which treatment leads to a larger decrease in the percentage of patients who die?*

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

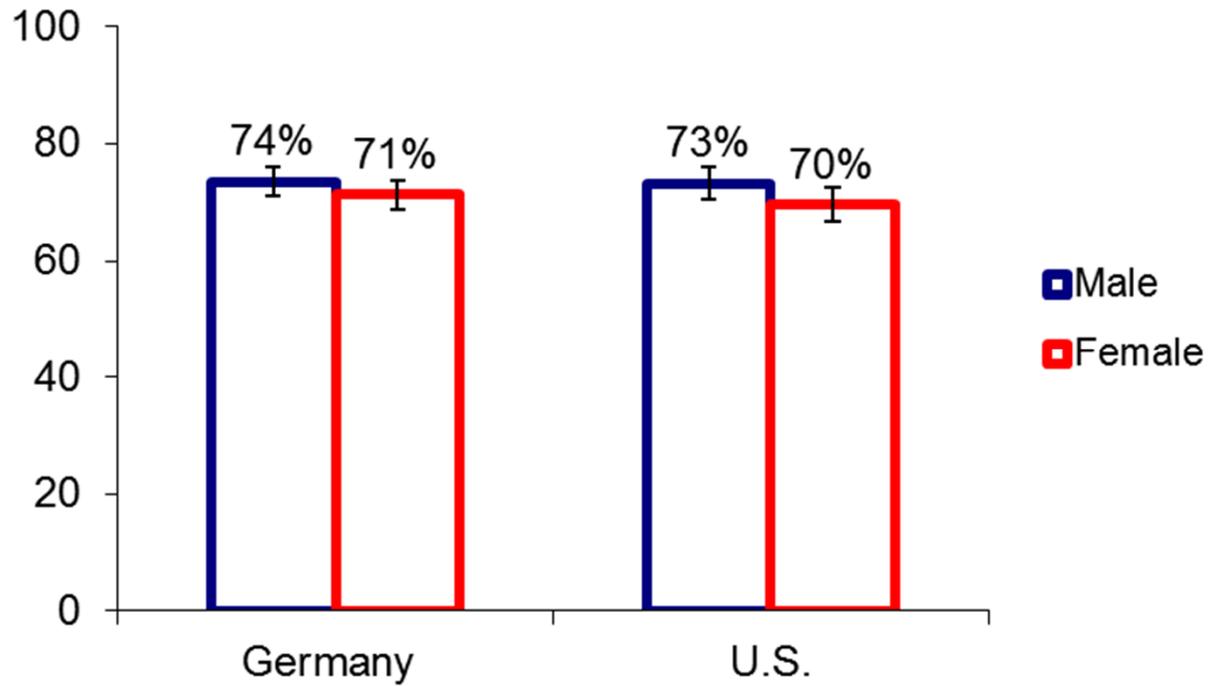
**Incorrect: 63% in Germany, 66% in the US**

## Average percent of correct answers (of total 13 questions)



# Graph literacy and gender

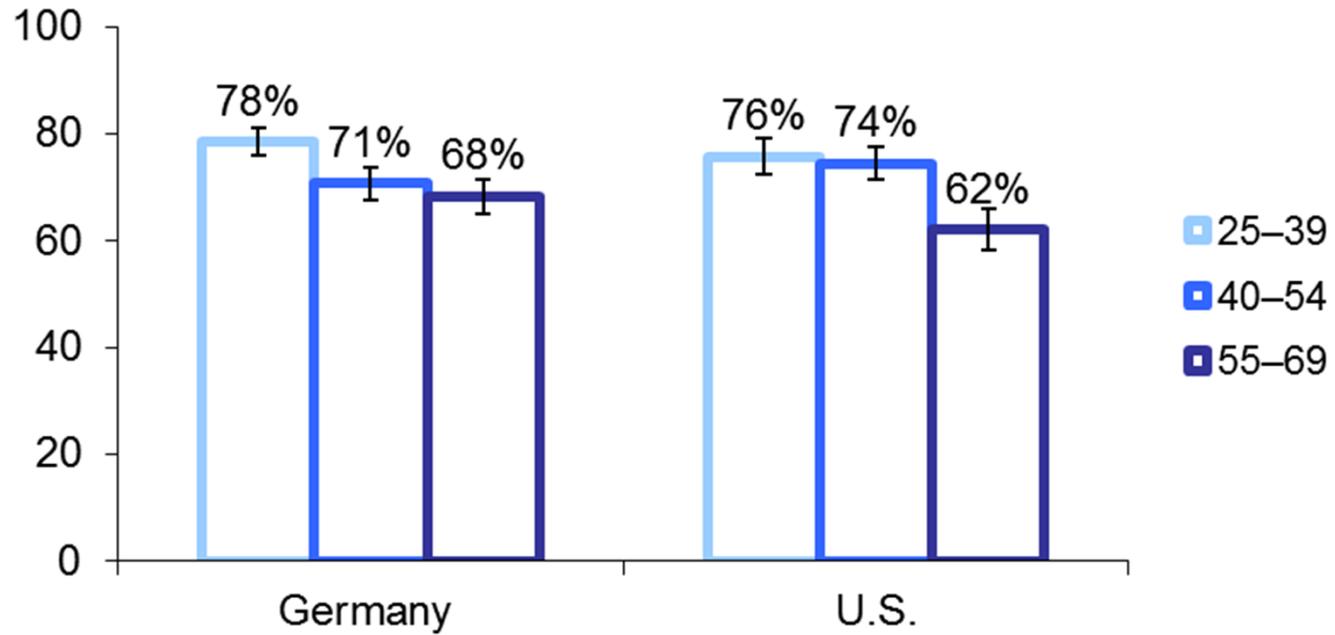
Average percent of correct answers



Error bars: +/- 2 SE

# Graph literacy and age

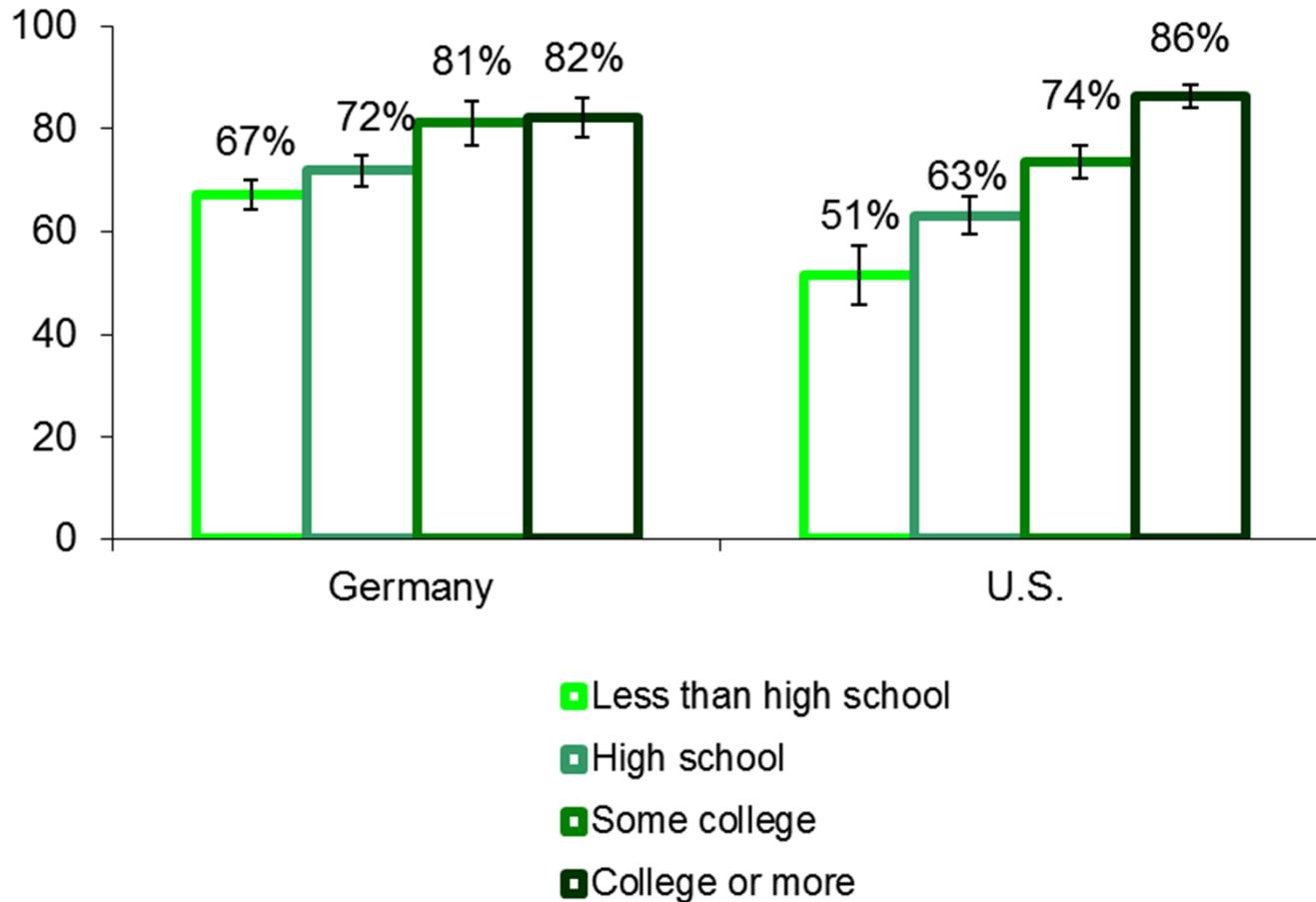
Average percent of correct answers



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# Graph literacy and education

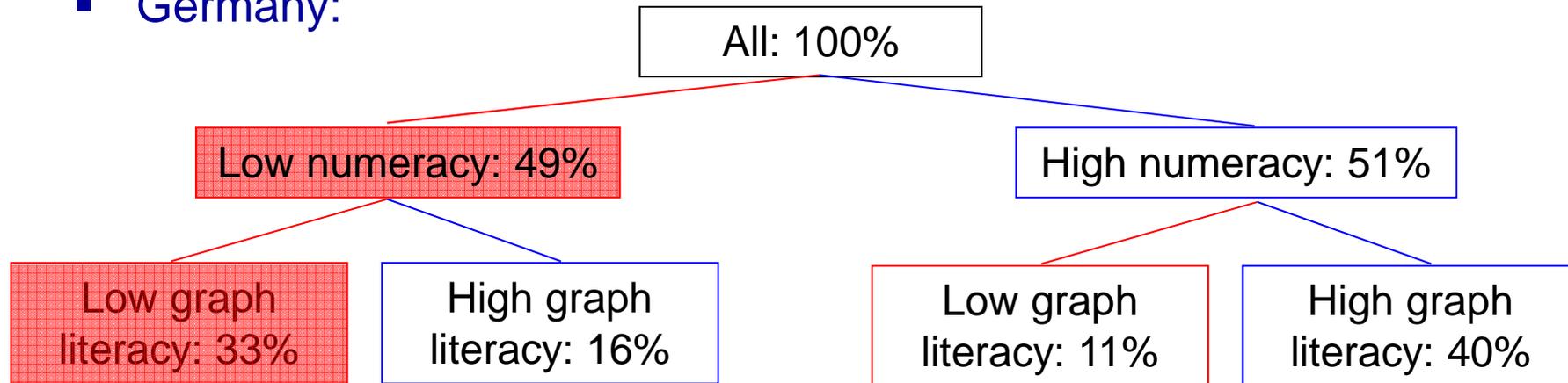
Average percent of correct answers



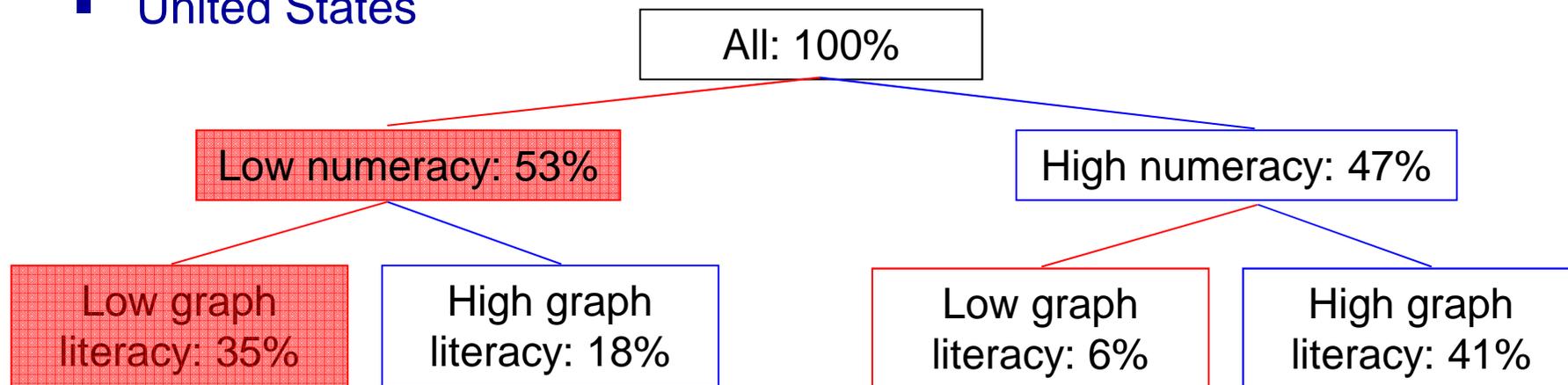
Error bars: +/- 2 SE

## Low graph literacy AND low numeracy?

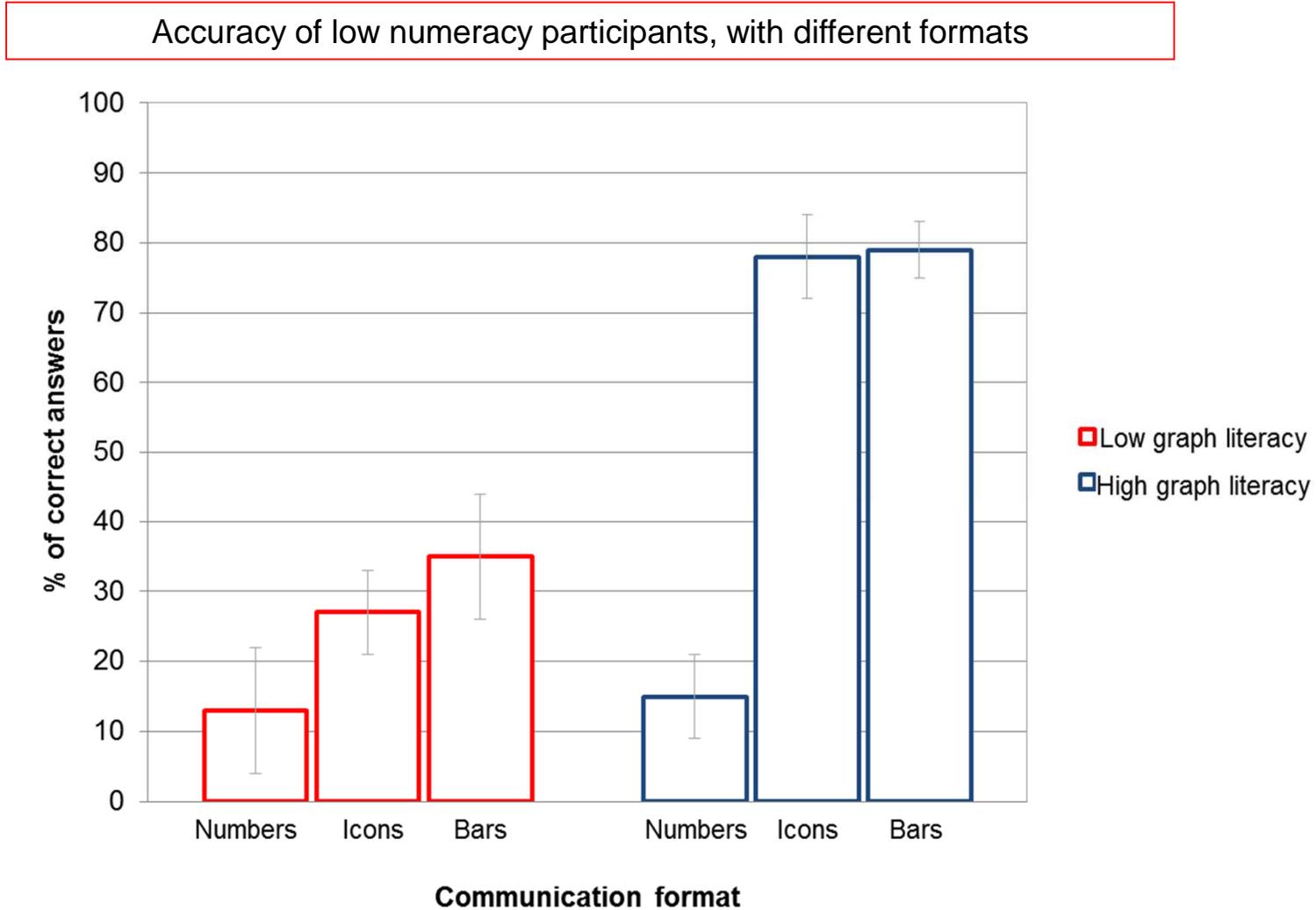
- Germany:



- United States



# Who profits from visual aids?



Garcia-Retamero, R., & Galesic, M. (2010). Who profits from visual aids: Overcoming challenges in people's understanding of risks. *Social Science & Medicine*, 70, 1019-1025.

## **Some remedies**

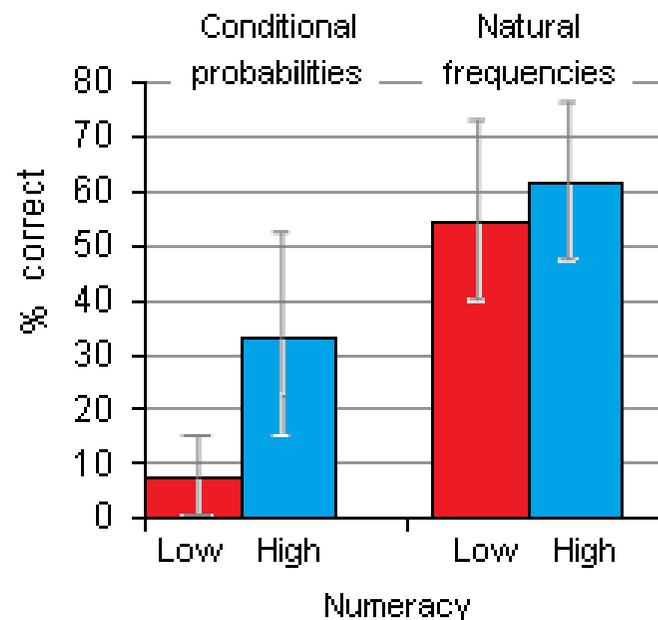
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## Intuitive visual and numerical representations

- Using natural correspondences between spatial and quantitative relationships

→ Yasmina Okan's work

- Natural frequencies instead of conditional probabilities



Galesic, M., Gigerenzer, G., & Straubinger, N. (2009). Natural frequencies help older adults and people with low numeracy to evaluate medical screening tests. *Medical Decision Making*, 29, 368-371.

# 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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# 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 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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# Analogies

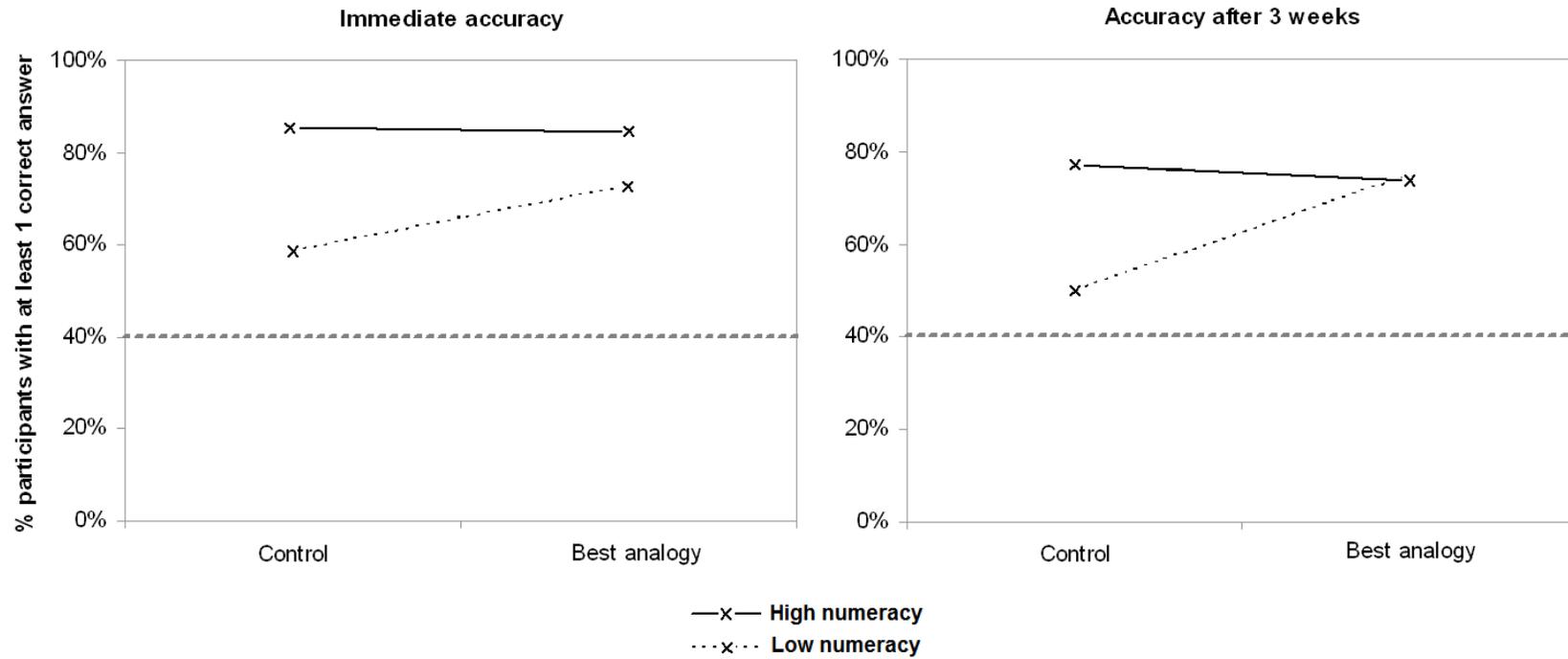
One often hears that medical screenings can help in the early detection of diseases. However, getting a positive result from a screening test does not always mean you have the disease.

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

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# Analogies



Galesic, M. & Garcia-Retamero, R. (2013). Using analogies to communicate information about health risks. *Applied Cognitive Psychology*, 27, 33-42.

## 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