Helping Doctors and Patients Make Sense of Health Statistics

Towards an Evidence-based Society

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HARDING CENTER FOR RISK LITERACY

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Collective Statistical Illiteracy in Health Care

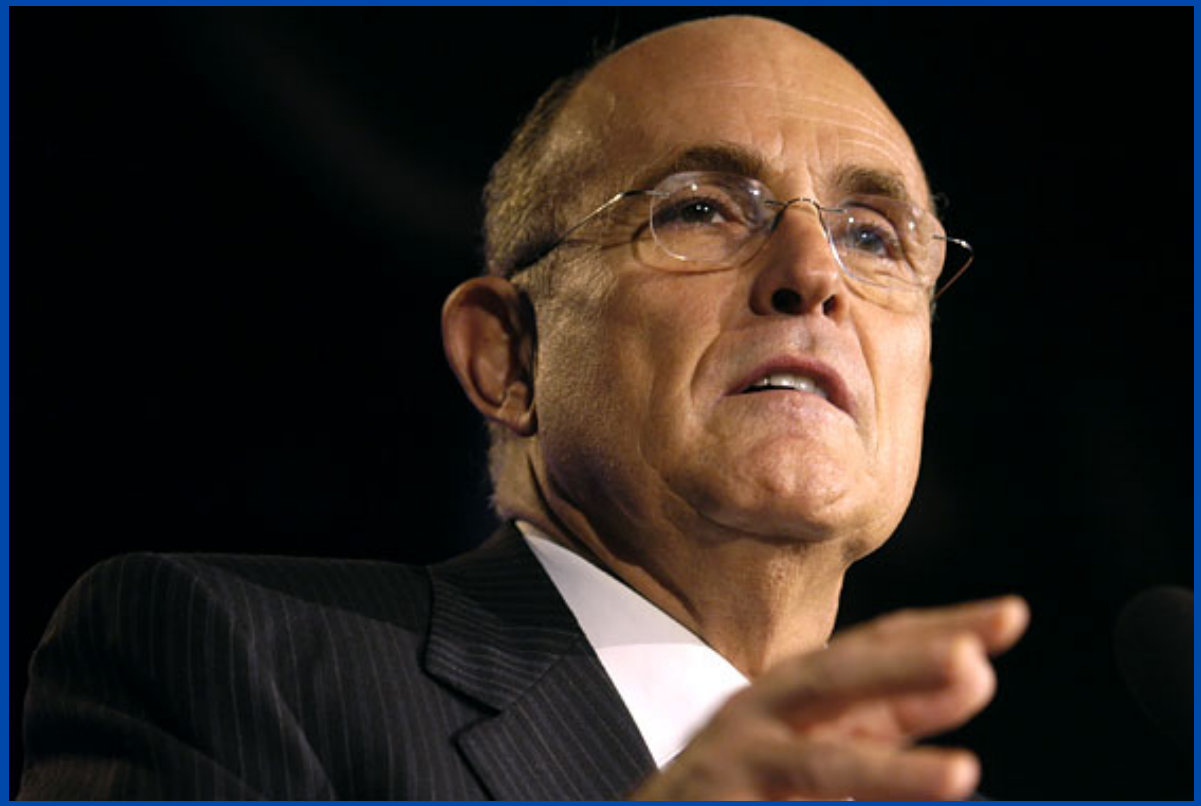
1. Few physicians, patients, and politicians understand health statistics.
2. Causes:

   - non-transparent framing of information, and

   - lack of training in risk communication in medical schools and the educational system in general.
3. There would be a simple solution: teach and implement transparent risk communication.

Collective Statistical Illiteracy

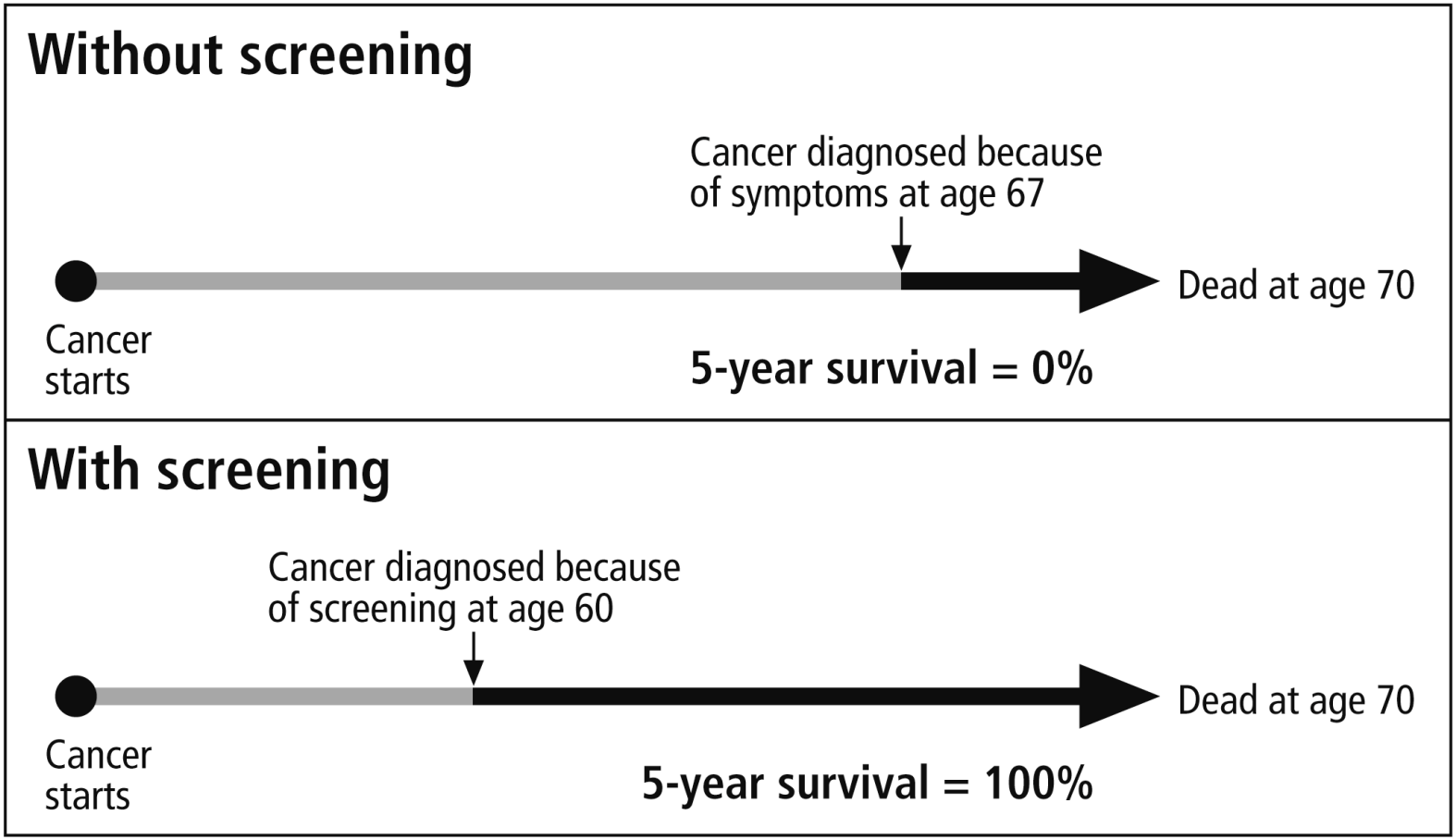
I
5-Year Survival Rates



"I had prostate cancer, five, six years ago. My chances of surviving prostate cancer and thank God I was cured of it, in the United States, 82 percent. My chances of surviving prostate cancer in England, only 44 percent under socialized medicine."

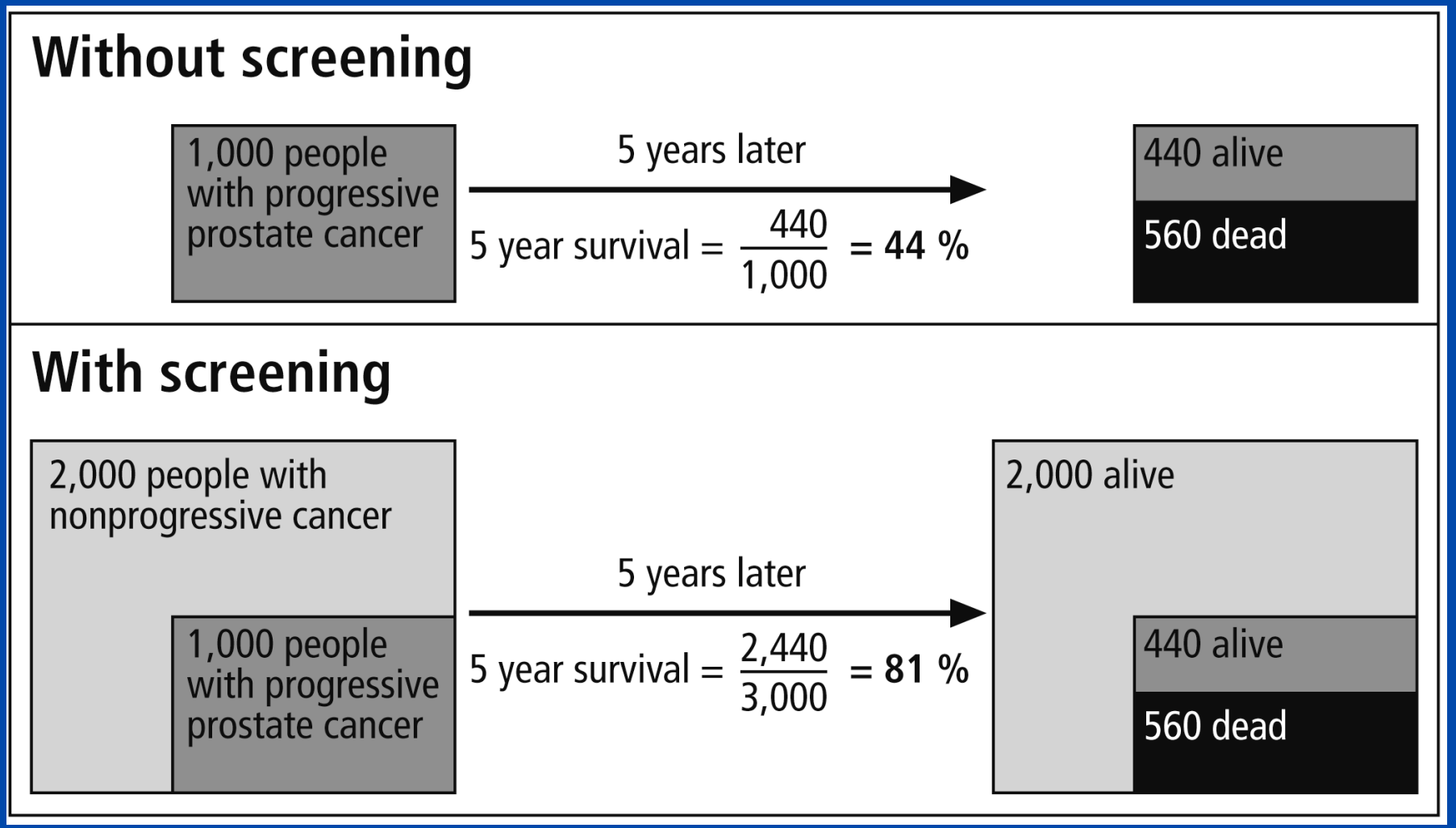
Rudy Giuliani, New Hampshire radio advertisement, October 2007

Lead Time Bias



Gigerenzer, Gaissmaier, Kurz-Milcke, Schwartz, & Woloshin 2007. *Psychological Science in the Public Interest*.

Overdiagnosis



Gigerenzer, Gaissmaier, Kurz-Milcke, Schwartz, & Woloshin 2007. *Psychological Science in the Public Interest*.

Do Physicians Understand 5-Year Survival Rates?

65 German physicians (internal medicine)

When the (same) information about PSA tests was framed as

Survival rates: **79%** judged screening as effective

Mortality rates: **5%** judged screening as effective

Lead-time-bias? **2** out of 65 knew

Overdiagnosis? **0** out of 65 knew

➔ Costs of PSA mass screening: first year $12 – 28 billion (US)

Wegwarth, Gaissmaier & Gigerenzer 2010

Deception by Medical Institutions
One of the most prestigious cancer centers in the US: M. D. Anderson

Prostate Cancer

Over four decades, the overall survival rate has more than doubled for men with prostate cancer treated at M. D. Anderson.

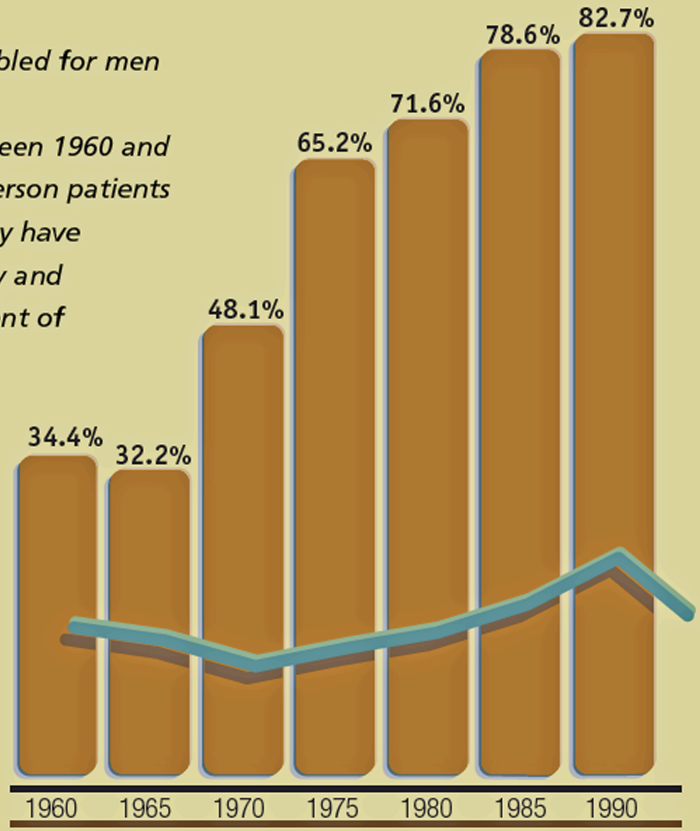
As national mortality rates for prostate cancer fluctuated between 1960 and 1990, five-year survival rates for prostate cancer among M. D. Anderson patients continued to improve. More effective radiation therapy and surgery have contributed to the overall increase in longevity, with chemotherapy and hormone treatments now playing an increasing role in the treatment of prostate cancer.

What makes these survival statistics even more remarkable is that the M. D. Anderson patient population includes more advanced patients. If the cancer center's case mix was more like that seen nationally, its survival rates would likely be even higher.

M. D. Anderson Overall Survival*

Average Annual U.S. Mortality Rate**

1960 - 64	21.5
1965 - 69	21.0
1970 - 74	20.0
1975 - 79	20.7
1980 - 84	21.3
1985 - 89	22.4
1990 - 94	24.2
1995 - 98	21.2



* Medical Informatics, The University of Texas M. D. Anderson Cancer Center

** National Center for Health Statistics public use tapes provided to the National Cancer Institute. The rates are per 100,000 and are age-adjusted to the 1970 U.S. standard population.

Confusion about progress against cancer.
Unwarranted enthusiasm for medical center.

PSA Tests

Annual Costs: $6 – 8 billion (US)

	1.000 men 55+ No Screening	Screening (9 years)
Benefit?		
cancer mortality [1]	23.8	23.9
prostate cancer mortality [2]	3.7	3.0
Harm?		
unnecessary biopsies	-	50 – 200
unnecessary treatments	-	10 – 30
incontinence / impotence	-	3 – 20

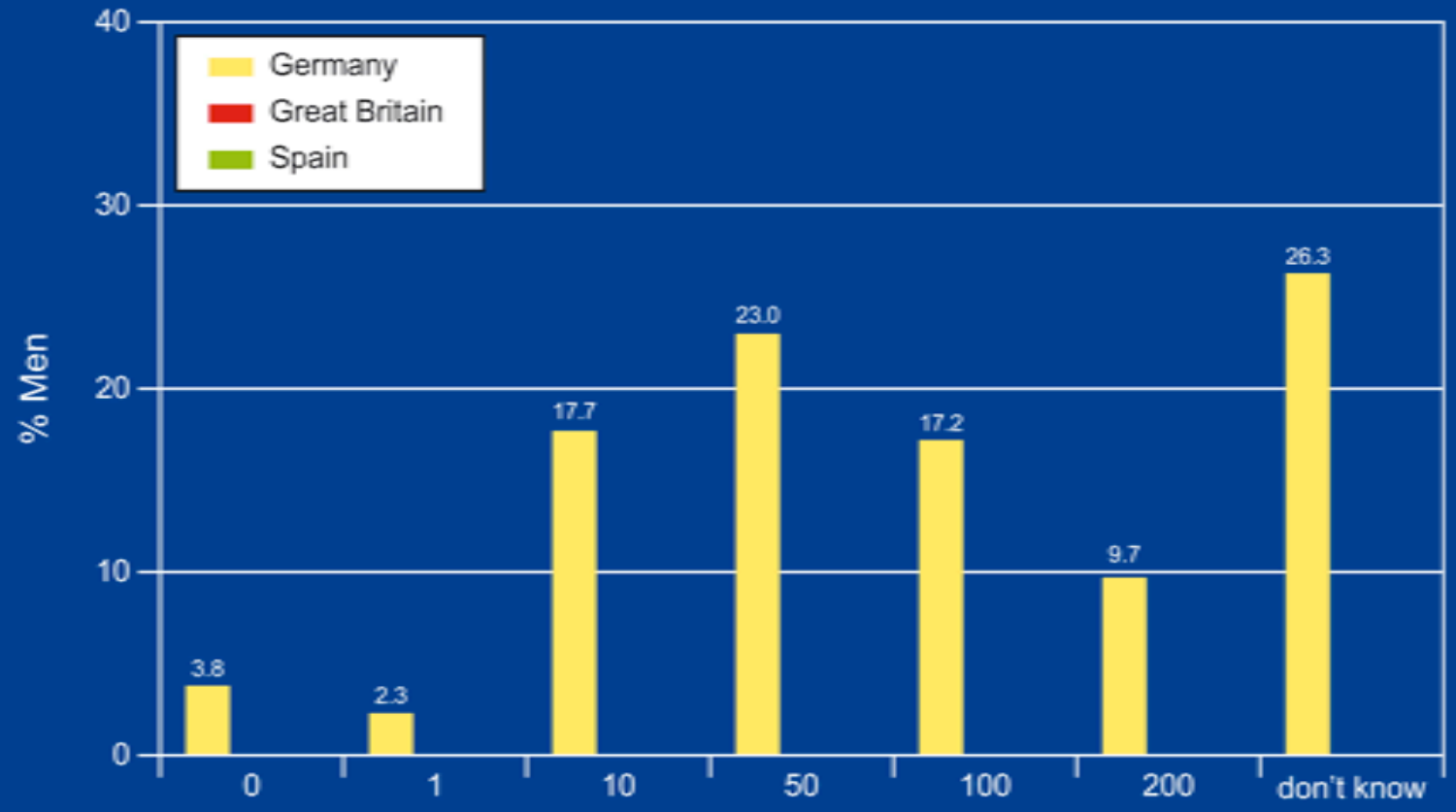
[1] Andriole GL, Grubb RL, Buys SS, et al. Mortality results from a randomized prostate cancer screening trial. N Engl J Med 2009.

[2] Schröder FH, Hugosson J, Roobol MJ, et al. Screening and prostate-cancer mortality in a randomized European study. N Engl J Med 2009.

Woloshin & Schwarz 2009. *Journal of the National Cancer Institute.*

PERCEIVED BENEFITS OF PSA SCREENING

Out of 1000 men who regularly participate in screening, how many fewer will die of prostate cancer in comparison to those who do not participate?



Gigerenzer, Mata, & Frank *JNCI* 2009

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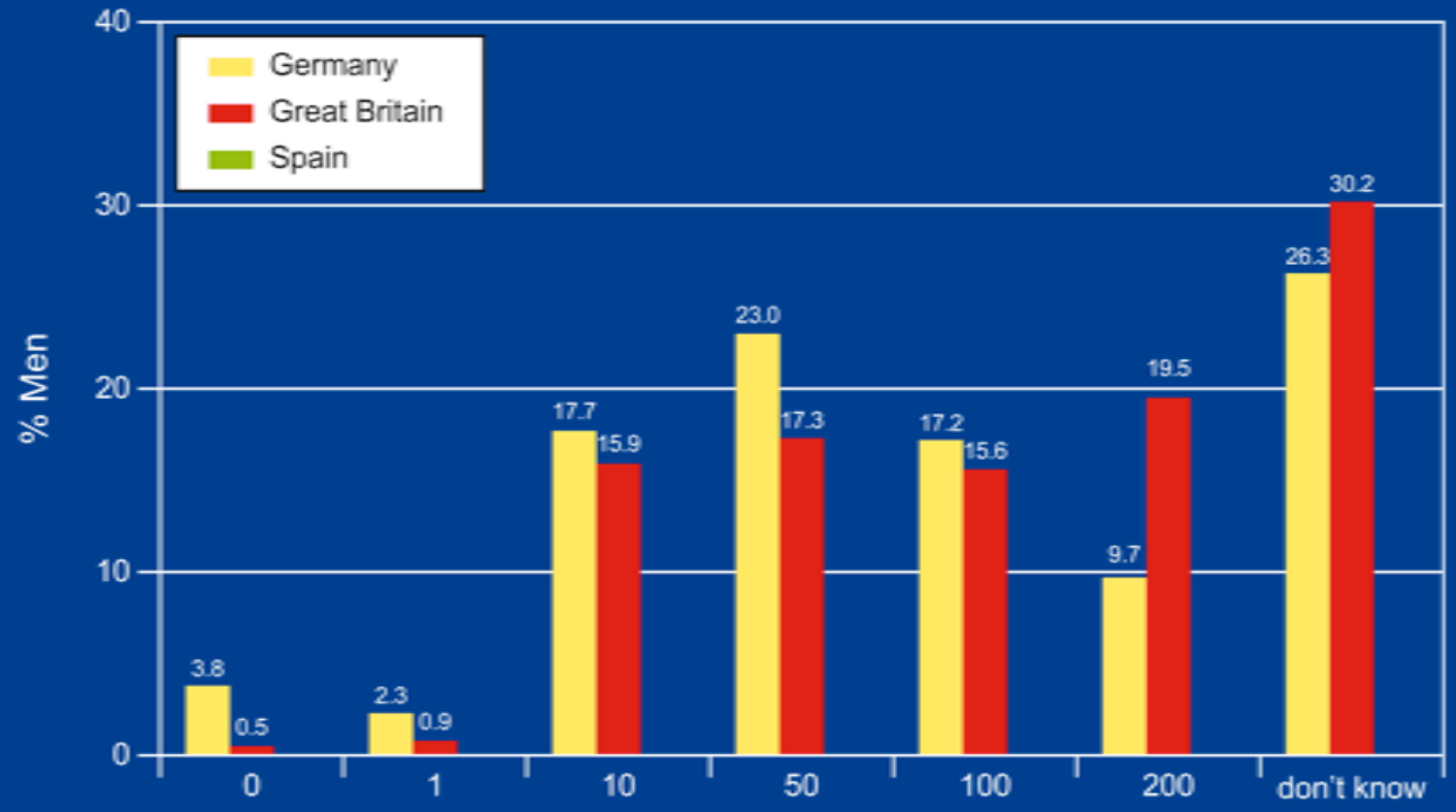

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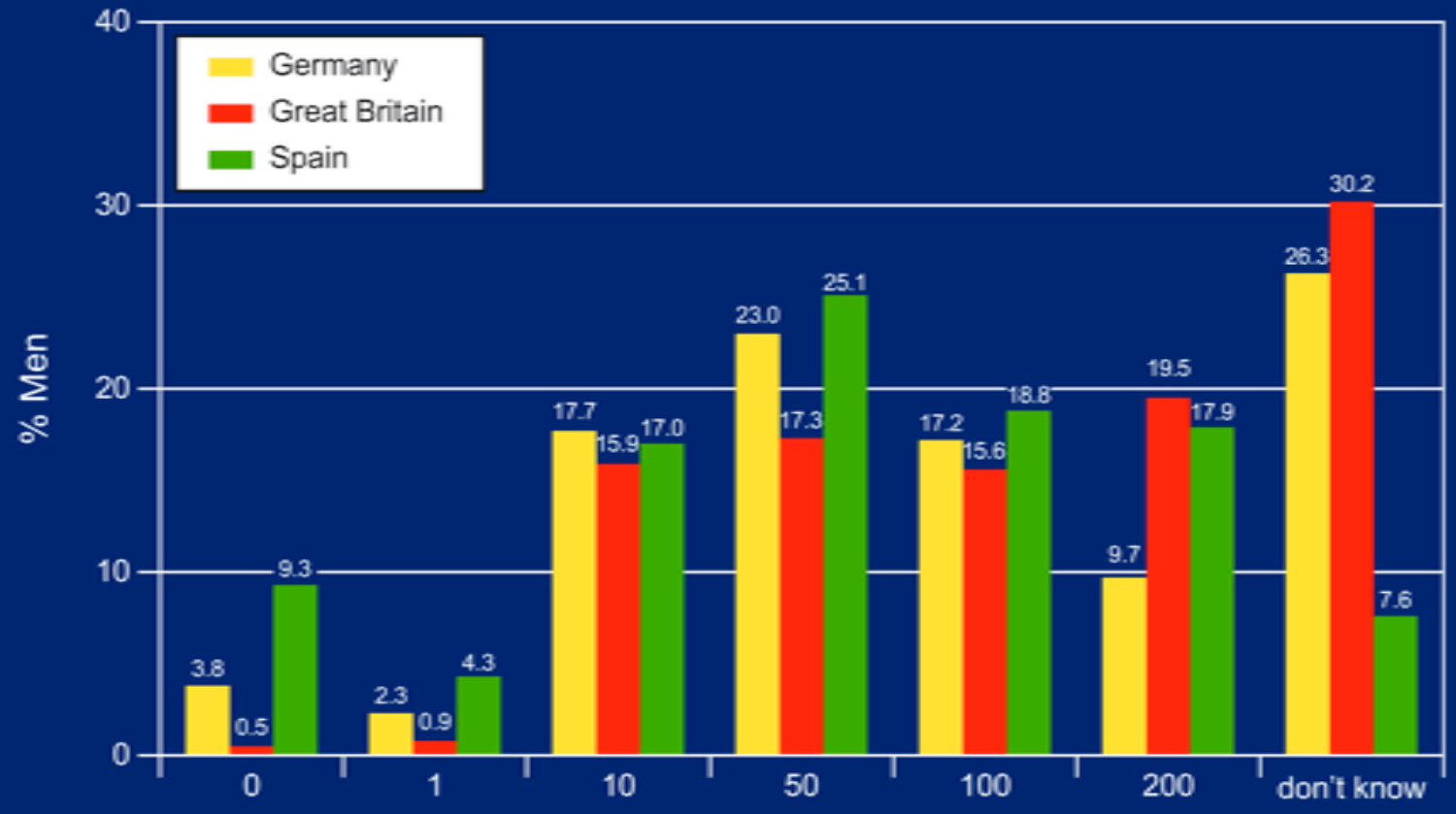


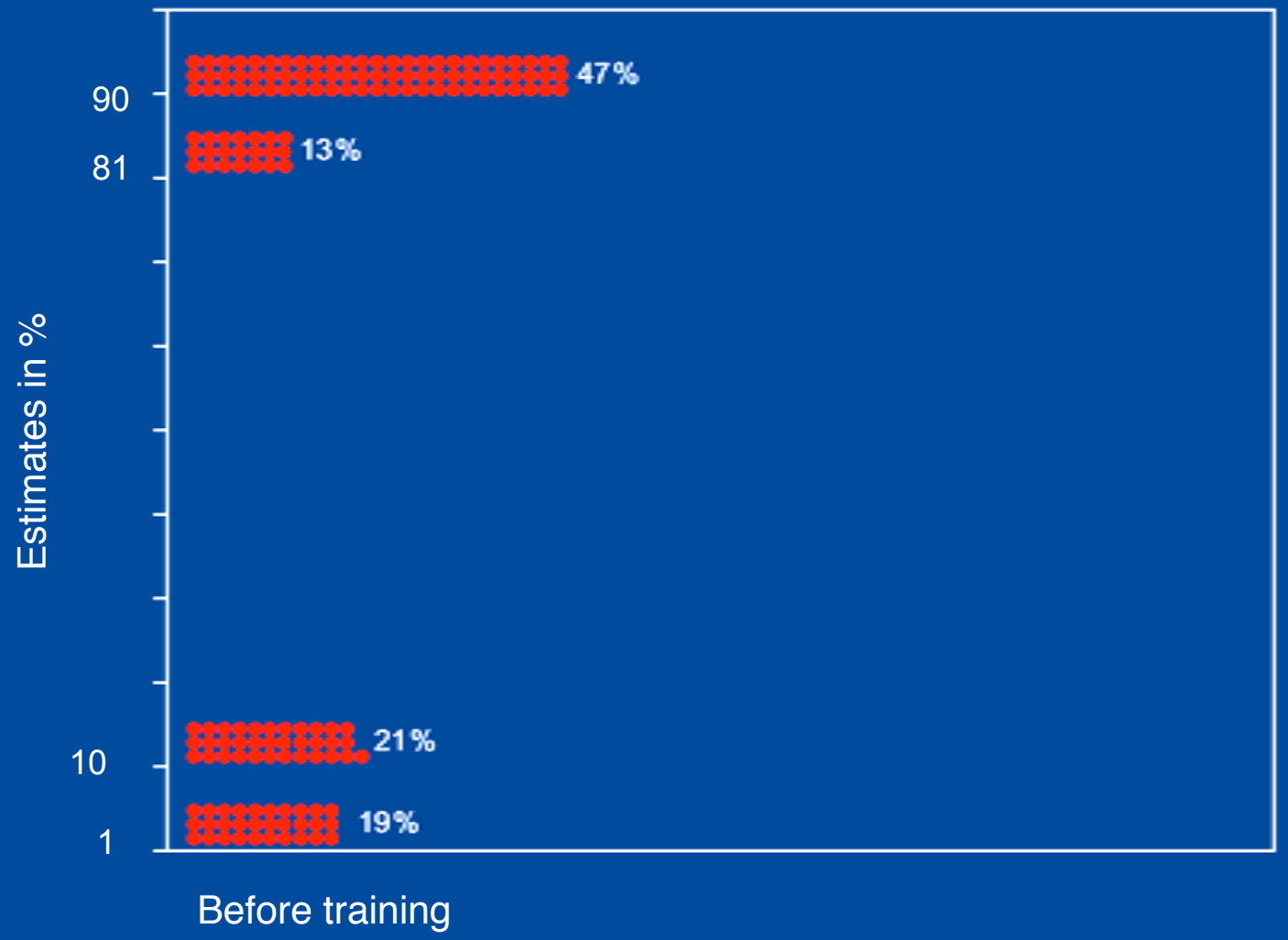
Gigerenzer, Mata, & Frank *JNCI* 2009

Collective Statistical Illiteracy

II
Conditional Probabilities

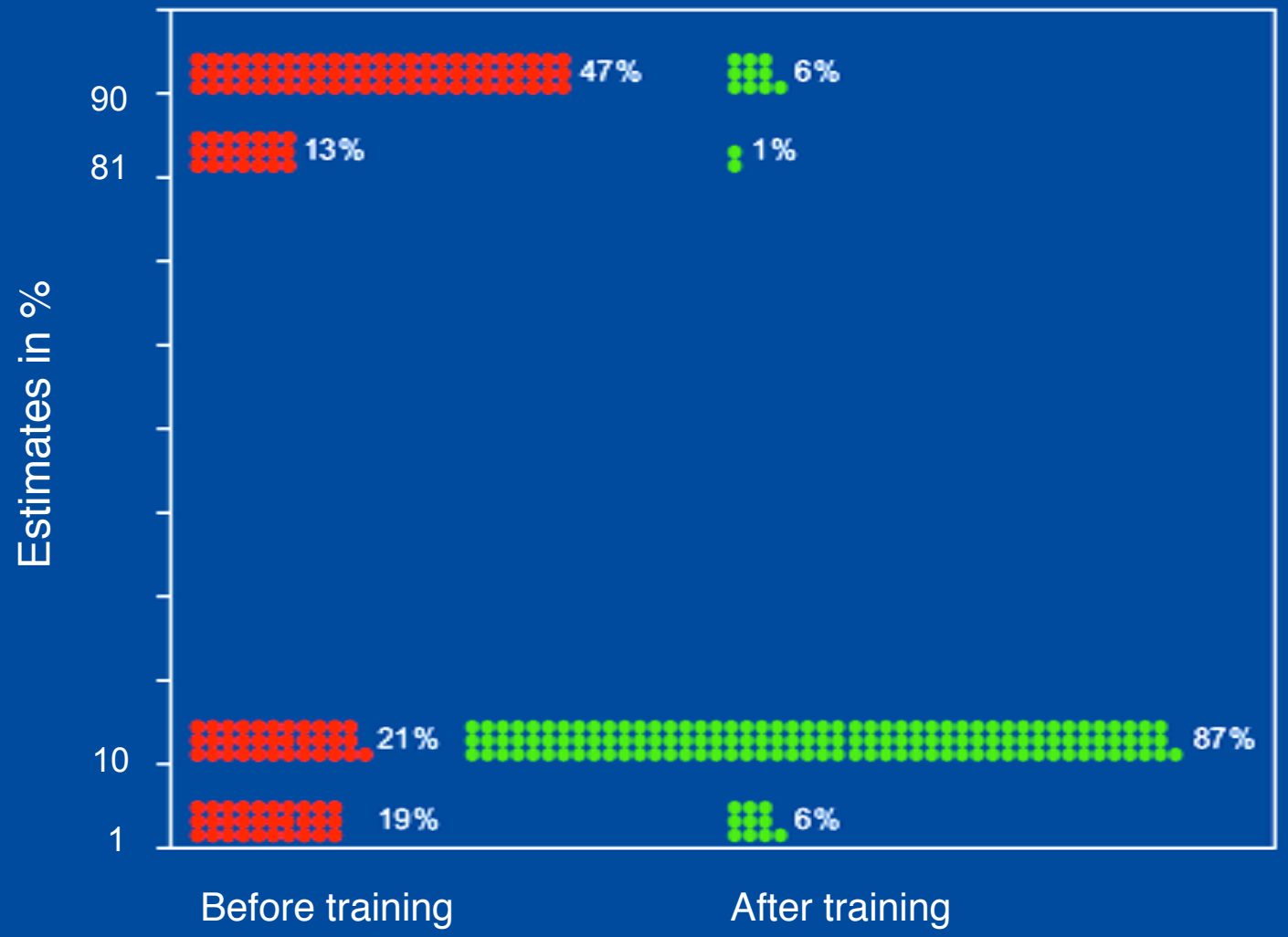

alpha RT

Gynecologists' (n = 160) estimates of p(breast cancer I positive mammogram)



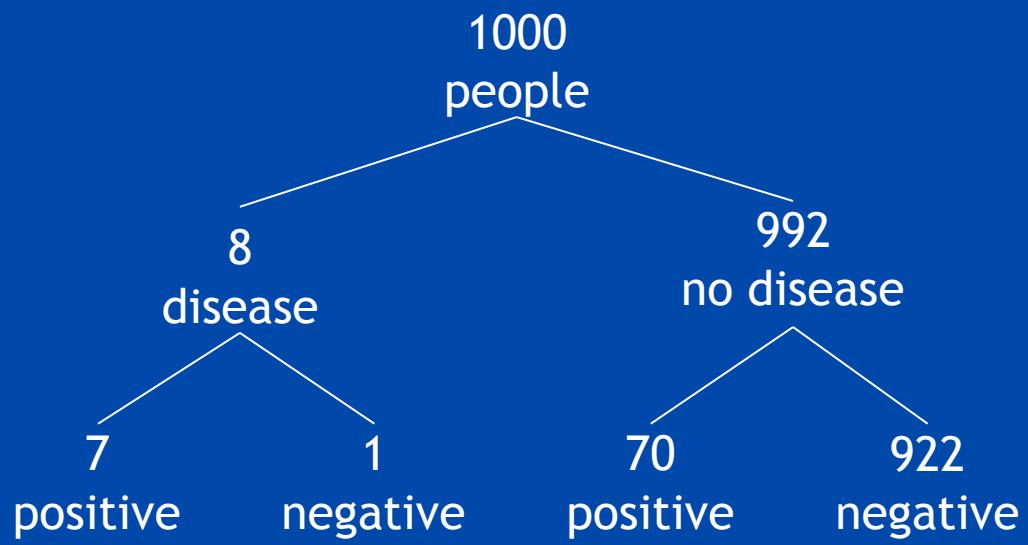
Gigerenzer, Gaissmaier, Kurz-Milcke, Schwartz, & Woloshin 2007. *Psychological Science in the Public Interest*.

Gynecologists can learn quickly:
Translate conditional probabilities into natural frequencies

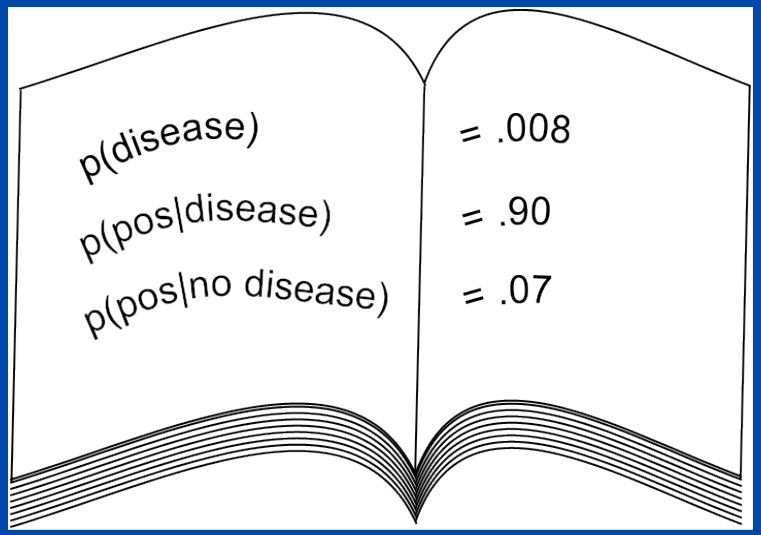


Gigerenzer, Gaissmaier, Kurz-Milcke, Schwartz, & Woloshin 2007. *Psychological Science in the Public Interest*.

Natural Frequencies



Conditional Probabilities
Relative Frequencies

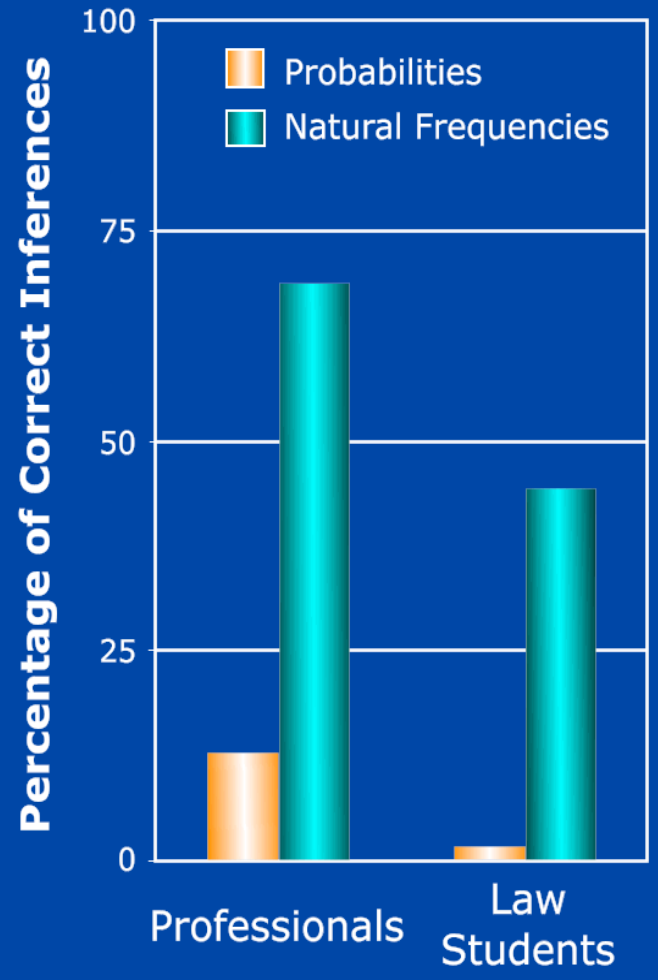


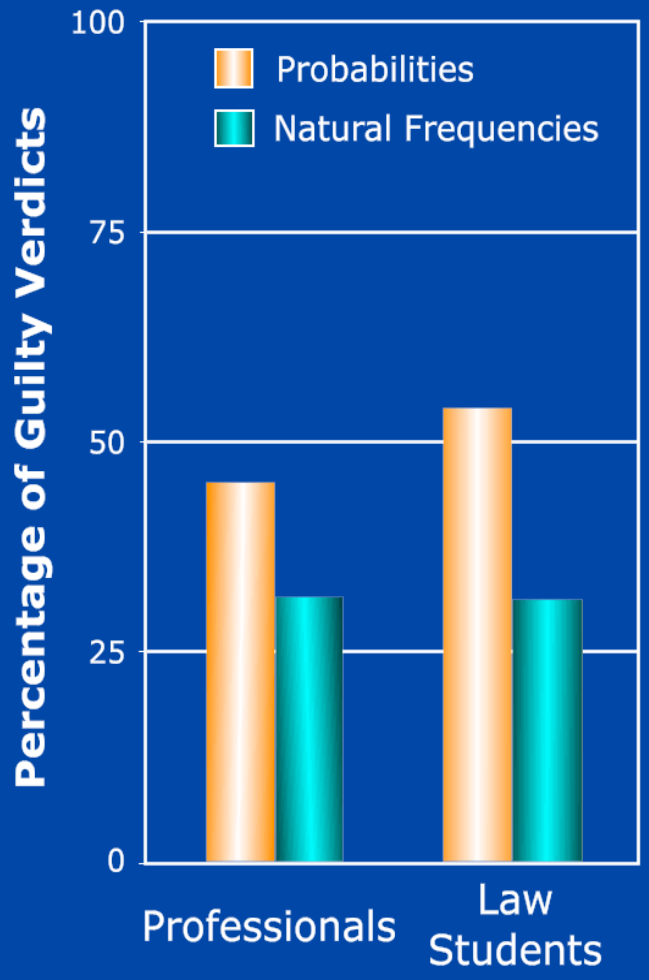
$$p(\text{disease}|\text{positive}) = \frac{7}{7 + 70}$$

$$p(\text{disease}|\text{positive}) = \frac{.008 \times .90}{.008 \times .90 + .992 \times .07}$$

Gigerenzer & Hoffrage *Psychological Review* 1995, 1999

DNA Evidence in the Courtroom





Hoffrage, Lindsey, Hertwig, & Gigerenzer (2000). *Science*.

German Bundestag, June 28, 2002: Mammography screening

p(cancer) = 0.4%; p(positive) = 5%; p(cancer|positive) = 20%

Source: Beilage zum Deutschen Ärzteblatt, January 23, 2004.

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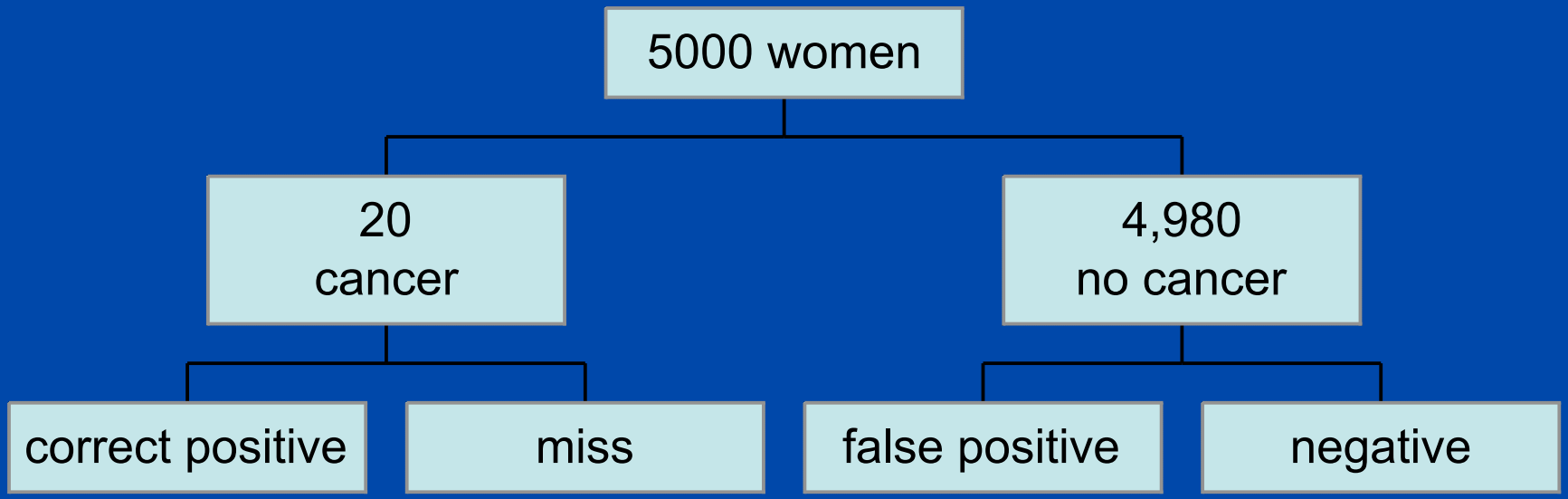
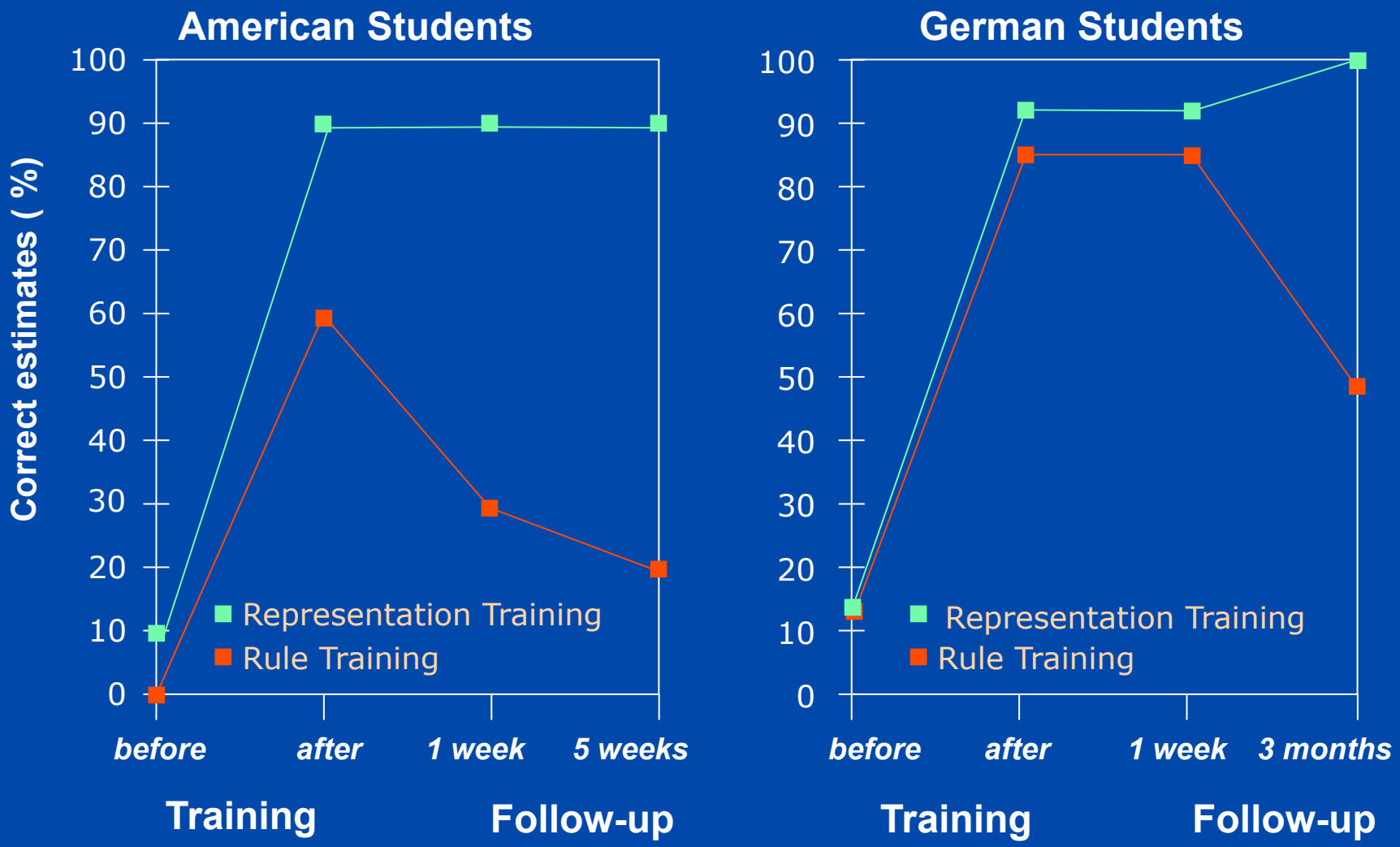


- ➡ 250 women test positive.
- ➡ 50 of these have cancer.
- ➡ ***There are 50 women with cancer among 20 women!***

How to learn Bayes in less than two hours

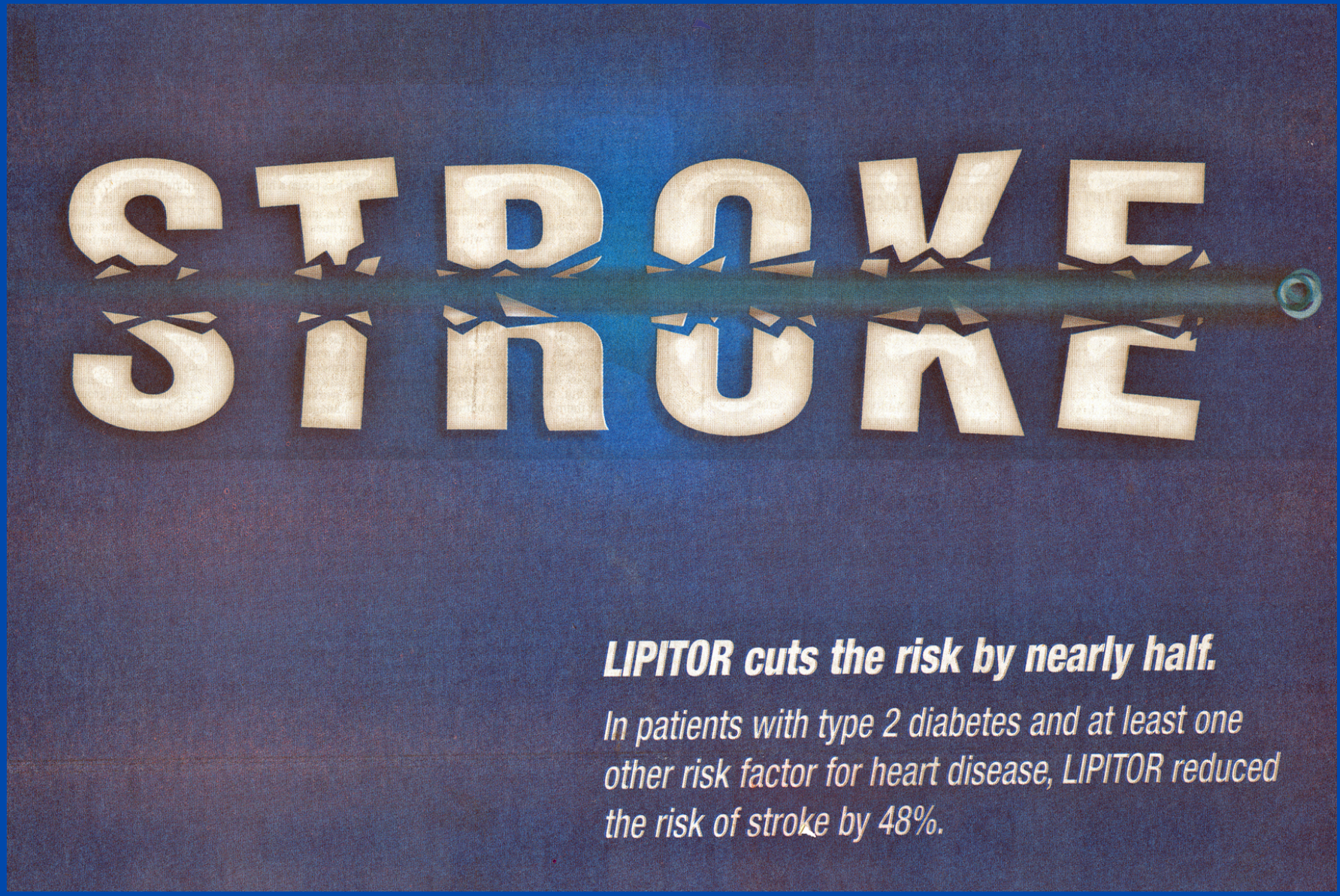


Sedlmeier & Gigerenzer 2001, *Journal of Experimental Psychology: General*

Collective Statistical Illiteracy

III
Relative Risks

Relative Risk Reductions in Advertising



Unwarranted enthusiasm for treatment: Reduction from 2.8 to 1.5 per 100

Mammography Screening

Breast cancer screening with mammography: per 1,000 women 50+

	No screening	Yearly screening over 10 years
Benefits?		
Cancer mortality	25	25
Breast cancer mortality	5	4
Risks?		
False positives with biopsies		50 – 200
Unnecessary treatments (e.g. lumpectomy)		2 - 10

Gøtzsche PC & Nielsen M 2006. *Cochrane Database Syst Re;*
Woloshin S & Schwarz LM 2009. *Journal of the National Cancer Institute 101(17)*

Gynecologists‘ understanding of a relative risk reduction

Participants: 150 German gynecologists

Setting: Continuing education session

“Mammography screening reduces mortality from breast cancer by about 25%. Assume that 1,000 women age 40 and over participate in mammography screening. How many fewer women are likely to die of breast cancer?”

- 1 [66%]
- 25 [16%]
- 100 [3%]
- 250 [15%]

Gigerenzer, Gaissmaier, Kurz-Milcke, Schwartz, & Woloshin 2007. *Psychological Science in the Public Interest*.

Brust-krebs

Die blauen Ratgeber 2

Deception Begins in Medical Journals

*Trick #1: Report benefits in **BIG** numbers and harms in **SMALL** numbers (e.g. relative risks for benefits of treatments, and absolute risks for harms).*

BMJ, JAMA, and *The Lancet*, 2004-2006: Mismatched framing used in 1 out of 3 articles.

Trick #2: Report neither benefits nor harms in a transparent way.

BMJ, JAMA, and *The Lancet*, 2004-2006: No absolute risks or other transparent frequency data reported in 1 out of 2 articles.

Sedrakyan & Shih 2007 *Medical Care*

Statistical Literacy

Representations that foster insight

~~*5-year survival rates*~~

Mortality rates

~~*Conditional probabilities*~~

Natural frequencies

~~*Relative risks*~~

Absolute risks

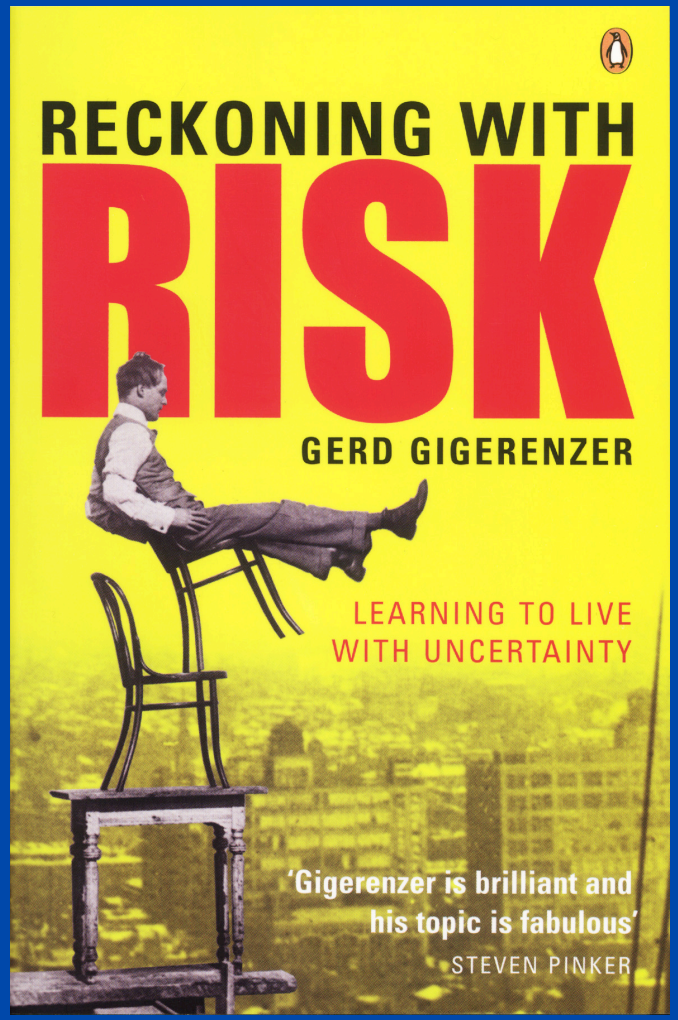
Risk Literacy

Few doctors and patients understand health statistics.

Collective Statistical Illiteracy is largely caused by

- lack of education in statistical thinking,
- lack of training in transparent risk communication.

Solution: Teach statistical thinking and risk communication in school.



Gigerenzer, Gaissmaier, Kurz-Milcke, Schwartz, Woloshin. Helping doctors and patients make sense of health statistics. *Psychological Science in the Public Interest* 2007

www.harding-center.de