“*In this world there is nothing certain but death and taxes.*“
Benjamin Franklin

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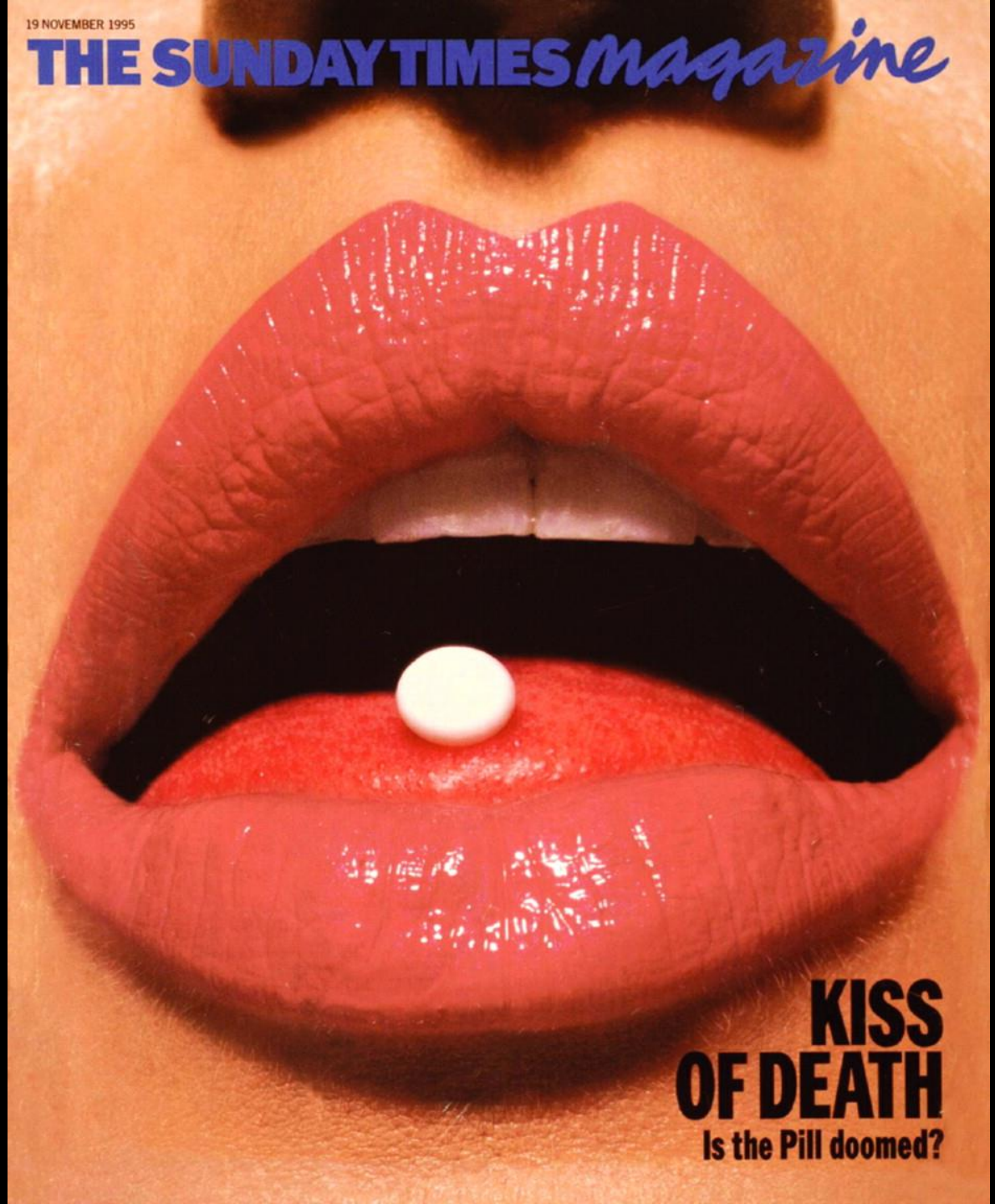
Helping Doctors and Patients Make Sense of Health Statistics

Wolfgang Gaissmaier, PhD
Department of Psychology
Social Psychology and Decision Sciences

19 NOVEMBER 1995
THE SUNDAY TIMES magazine

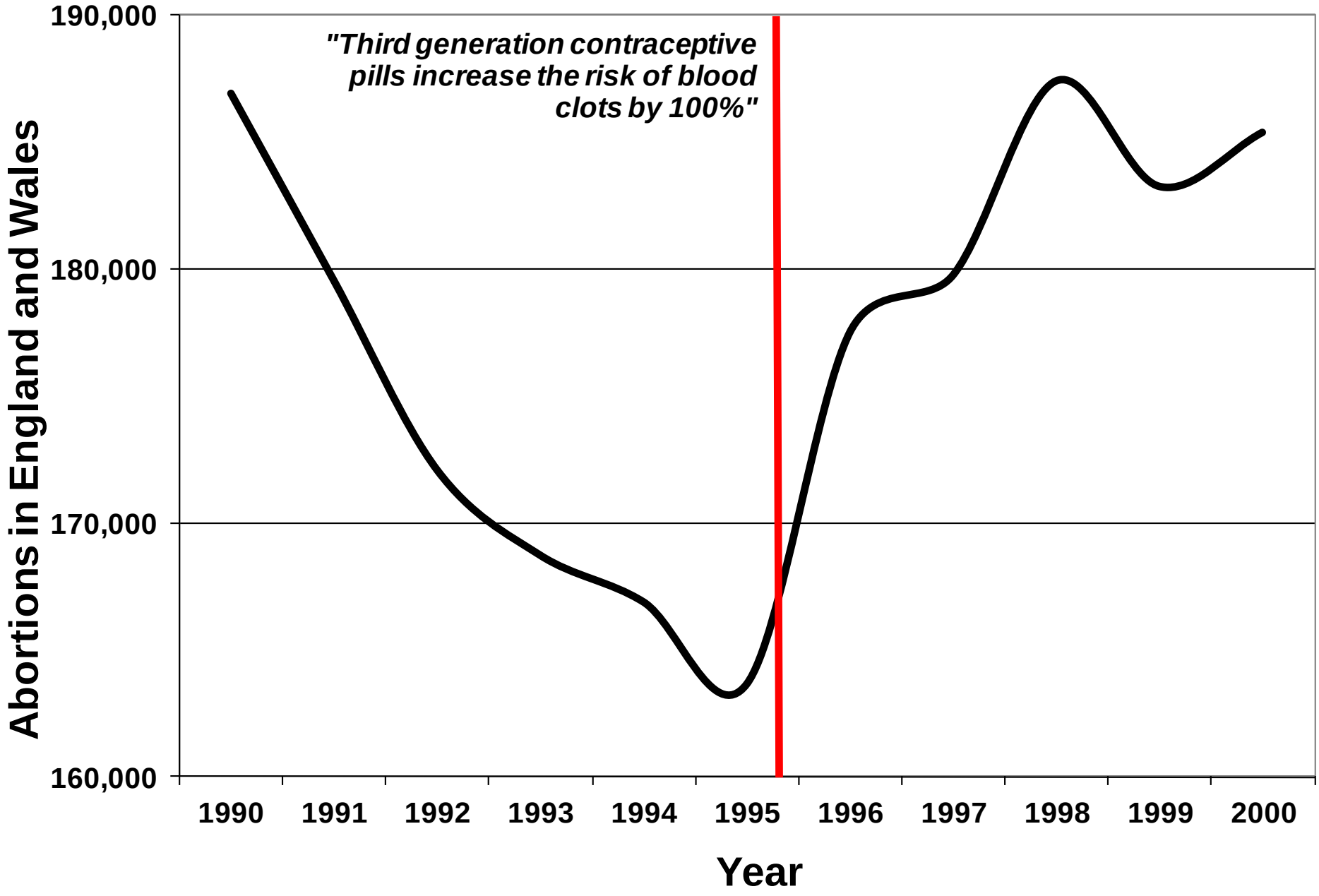


KISS OF DEATH

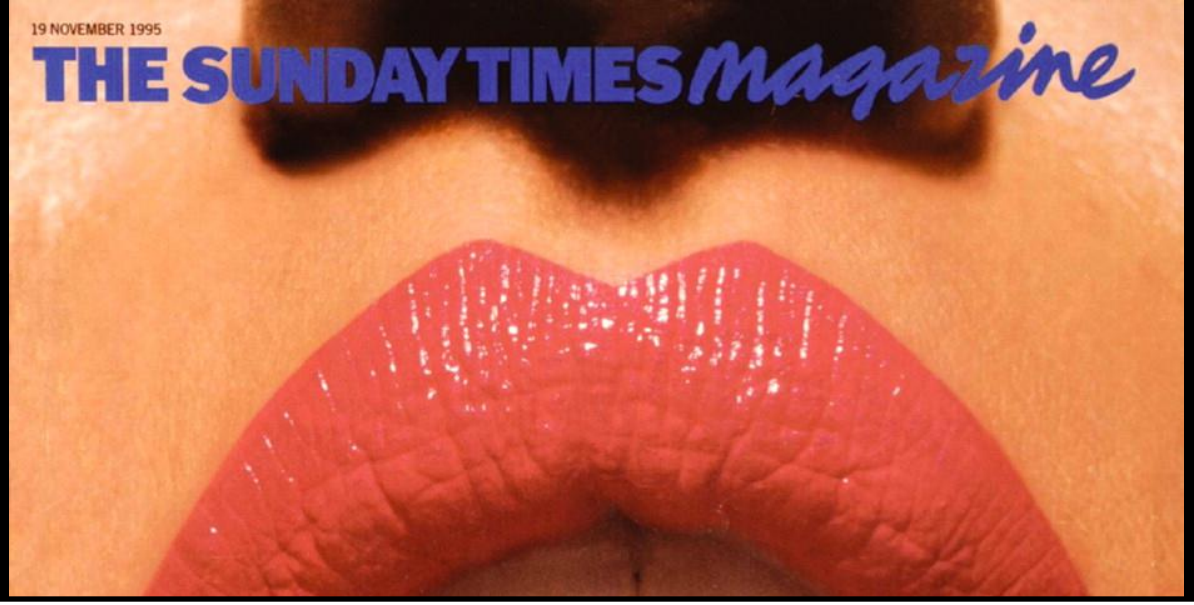
Is the Pill doomed?

Official announcement:
“Contraceptive pills double the risk of venous thromboembolism!”

(UK Committee on the Safety of Medicines, 1995)



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



Transparent format:

“Contraceptive pills increase the risk of venous thromboembolism from 1 to 2 women out of every 7,000 women.”

THE LANCET

LONDON: SATURDAY, JANUARY 2, 1937

MATHEMATICS AND MEDICINE

STATISTICS are curious things. They afford one of the few examples in which the use, or abuse, of mathematical methods tends to induce a strong emotional reaction in non-mathematical minds. This is because statisticians apply, to problems in which we are interested, a technique which we do not understand. It is exasperating, when we have

Outline of Challenges and Opportunities

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- Clinical evidence is often not reasonably considered
  - Statistics are an educational blind spot of many people
  - The representation of the evidence can bias the perception of effectiveness and risks
  - There is a lack of evidence culture
- Yet patients have to understand this evidence, because
  - physicians often also lack the understanding
  - physicians can have different preferences
- Methods have been developed to turn confusion about clinical evidence into insight

Gaissmaier (2011). *Way Ahead*

Representation biases perception

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- Relative risks vs. absolute risks:

  100% increase of thromboembolism is more threatening than an increase from 1 in 7,000 to 2 in 7,000

  Gigerenzer, Gaissmaier, et al (2007). *Psychological Science in the Public Interest*

- Framing:

  80% chance of survival looks more promising than a 20% chance of dying

  Garcia-Retamero & Galesic (2010). *Journal of General Internal Medicine*

- Denominator neglect:

  1 in 10 is sometimes perceived as lower than 9 in 100

  Garcia-Retamero ,Galesic ,& Gigerenzer (2010). *Medical Decision Making*

Lack of evidence culture

ÖSTERREICHISCHE
ÄRZTEKAMMER

“Meta-analyses are an interesting instrument for theoretical science but of little relevance to clinical practice”

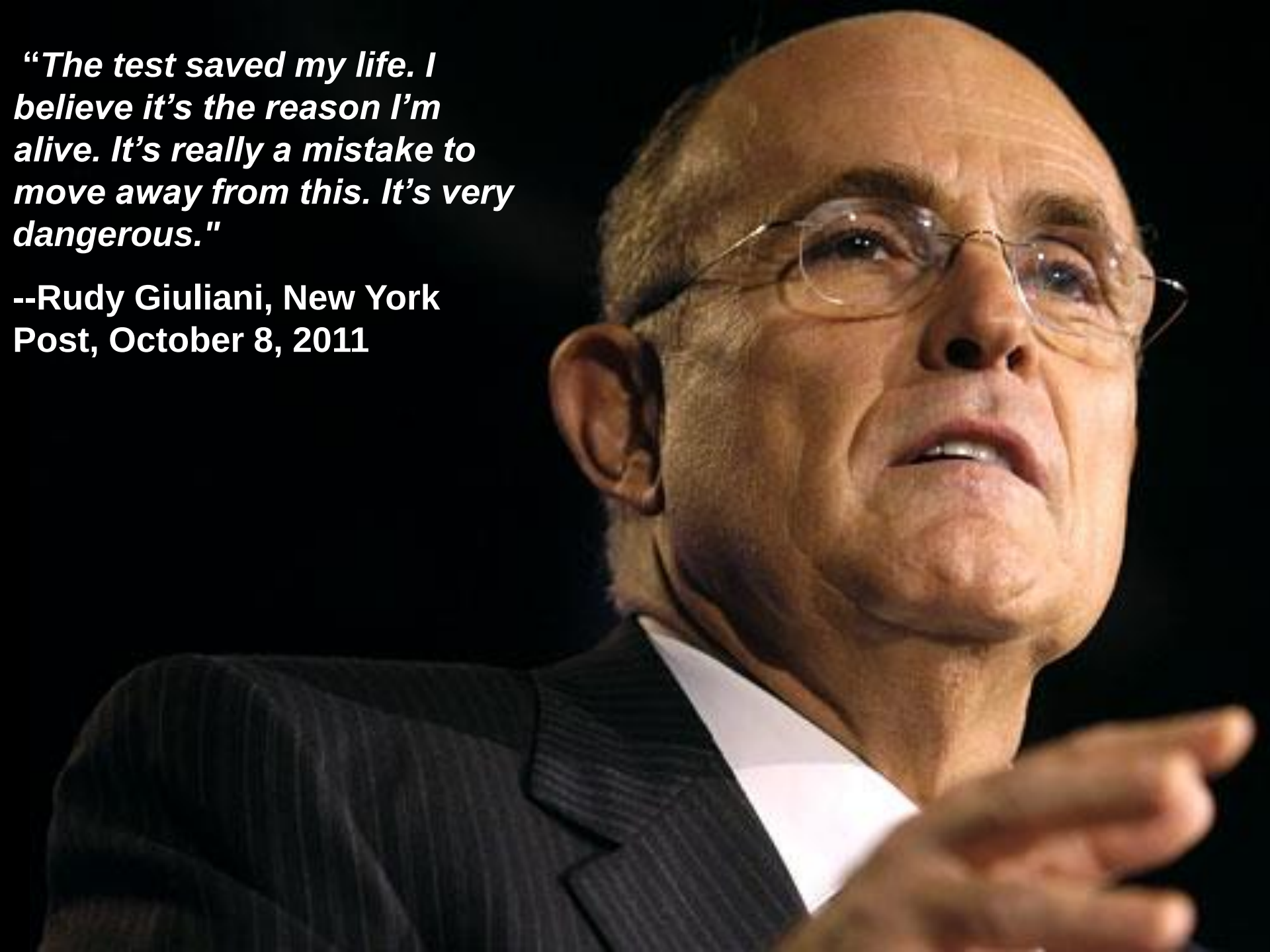
(Austrian chamber of physicians in response to a 2005 meta-analysis in *The Lancet* finding homeopathy to have no effect)

U.S. Preventive Services Task Force

The U.S. Preventive Services Task Force (USPSTF) recommends against prostatespecific antigen (PSA)-based screening for prostate cancer.

The USPSTF concludes that there is moderate certainty that the harms of PSA-based screening for prostate cancer outweigh the benefits.

Arkes & Gaissmaier (2012). *Psychological Science*


“The test saved my life. I believe it’s the reason I’m alive. It’s really a mistake to move away from this. It’s very dangerous."
--Rudy Giuliani, New York Post, October 8, 2011

Cell A bias

Outcome

PSA Screened?	Alive	Dead
Yes	A	B
No	C	D

Arkes & Gaissmaier (2012). *Psychological Science*
Gaissmaier, Anderson, & Schulkin (2014). *Medical Decision Making*

Prostate Cancer Early Detection

HARDING CENTER FOR RISK LITERACY

by PSA screening and digital-rectal examination.
Numbers are for men aged 50 years or older, not participating vs. participating in screening for 10 years.

	1,000 men without screening	1,000 men with screening
Benefits		
How many men died from prostate cancer?	8*	8
How many men died from any cause?	200	200
Harms		
How many men were diagnosed and treated** for prostate cancer unnecessarily?	–	20
How many men without cancer got a false alarm and a biopsy?	–	180

* This means that about 8 out of 1,000 men (50+ years of age) without screening died from prostate cancer within 10 years.

** With prostate removal or radiation therapy, which can lead to incontinence or impotence.

Source: Djulbegovic M, Beyth RJ, Neuberger MM, et al. (2010). *British Medical Journal,* 341:c4543.

Physicians sometimes lack accurate understanding

AIDS-Counseling
at German health offices

Client: ***"If one is not infected with HIV, is it possible to have a positive test result?"***

Gigerenzer, Hoffrage & Ebert (1998). *Aids Care*

AIDS-Counseling
at German health offices

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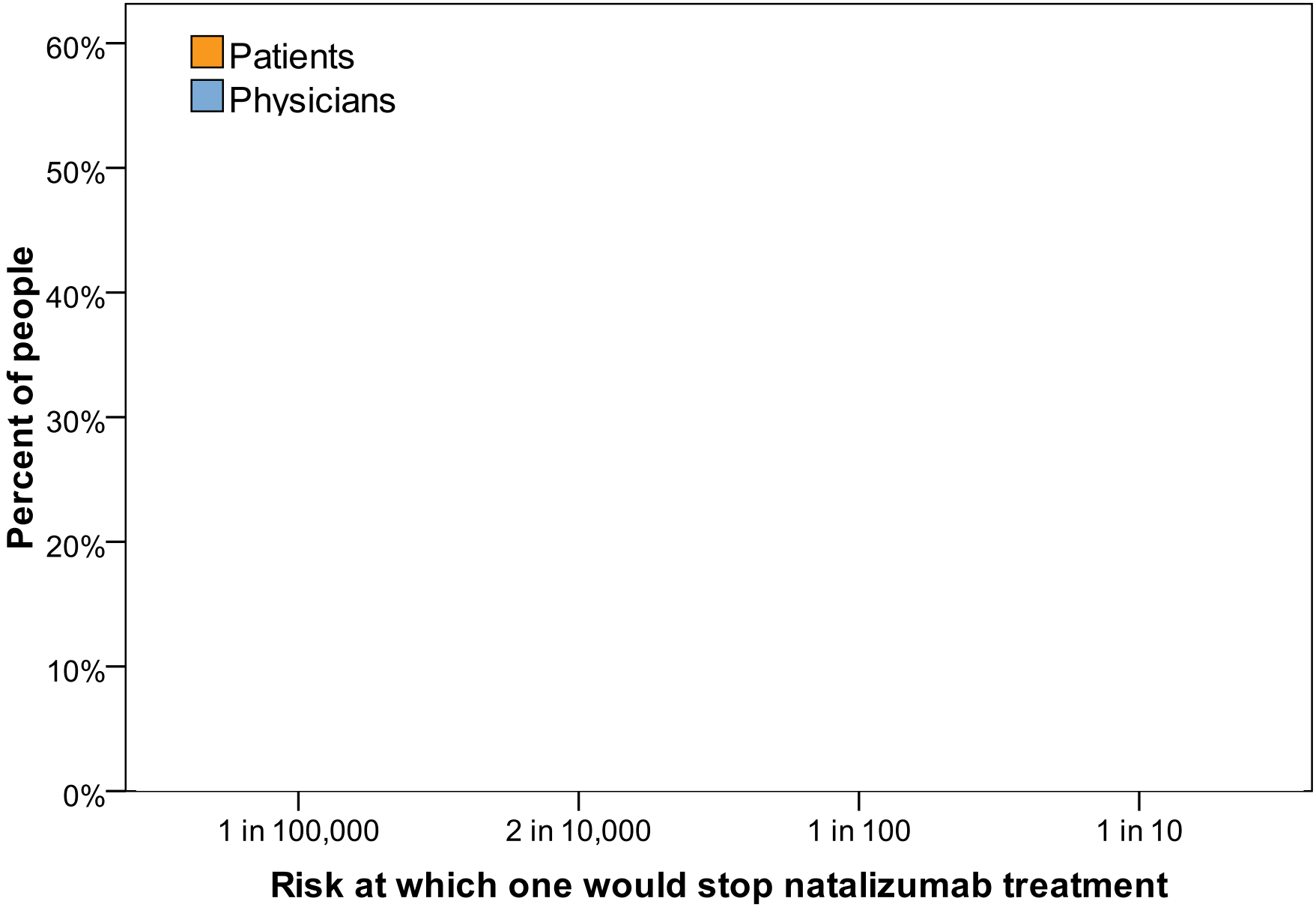
Client: ***"If one is not infected with HIV, is it possible to have a positive test result?"***

Counselors:

1 *"No, certainly not"*
2 *"Absolutely impossible"*
3 *"With absolute certainty, no"*
4 *"No, absolutely not"*
5 *"Never"*
6 *"Absolutely impossible"*
7 *"Absolutely impossible"*
8 *"With absolute certainty, no"*
9 *"The test is absolutely certain"*
10 *"No, only in France, not here"*
11 *"False positives never happen"*
12 *"With absolute certainty, no"*
13 *"With absolute certainty, no"*
14 *"Definitely not" … "extremely rare"*
15 *"Absolutely not" … "99.7% specificity"*
16 *"Absolutely not" … "99.9% specificity"*
17 *"More than 99% specificity"*
18 *"More than 99.9% specificity"*
19 *"99.9% specificity"*
20 *"Don't worry, trust me"*

Gigerenzer, Hoffrage & Ebert (1998). *Aids Care*

Physicians have different preferences than patients



Heesen, Kleiter, Nguyen, Schäffler, Kasper, Köpke, & Gaissmaier (2010). *Multiple Sclerosis*

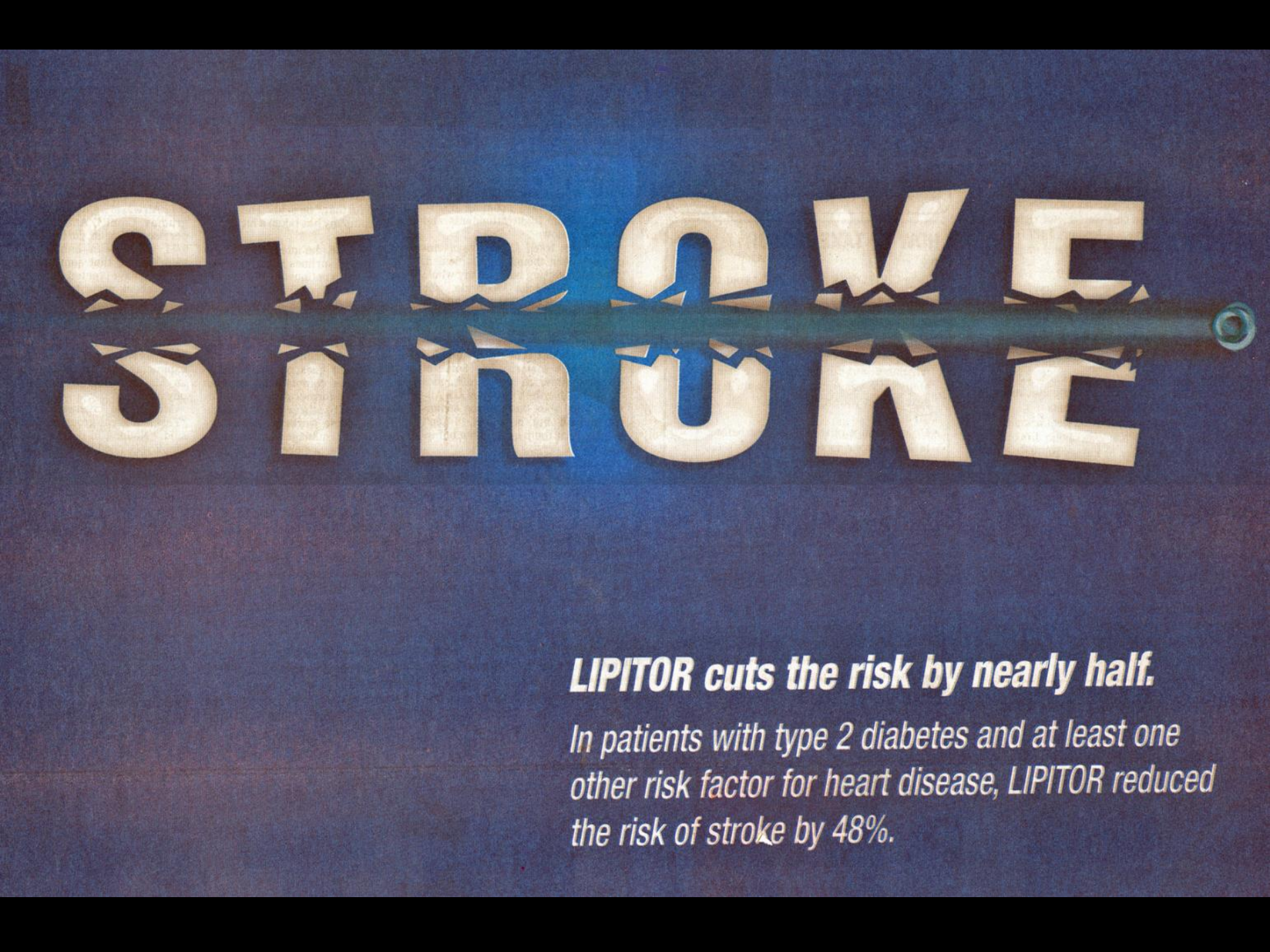
From confusing representations to insight

Relative risks

Single event probabilities

Conditional probabilities

Survival rates


STROKE
STROKE
LIPITOR cuts the risk by nearly half.
In patients with type 2 diabetes and at least one other risk factor for heart disease, LIPITOR reduced the risk of stroke by 48%.


STROKE
This means: 2.8% vs. 1.5% after 4 years
LIPITOR cuts the risk by nearly half.
In patients with type 2 diabetes and at least one other risk factor for heart disease, LIPITOR reduced the risk of stroke by 48%.

Risk communication

~~Relative risks~~

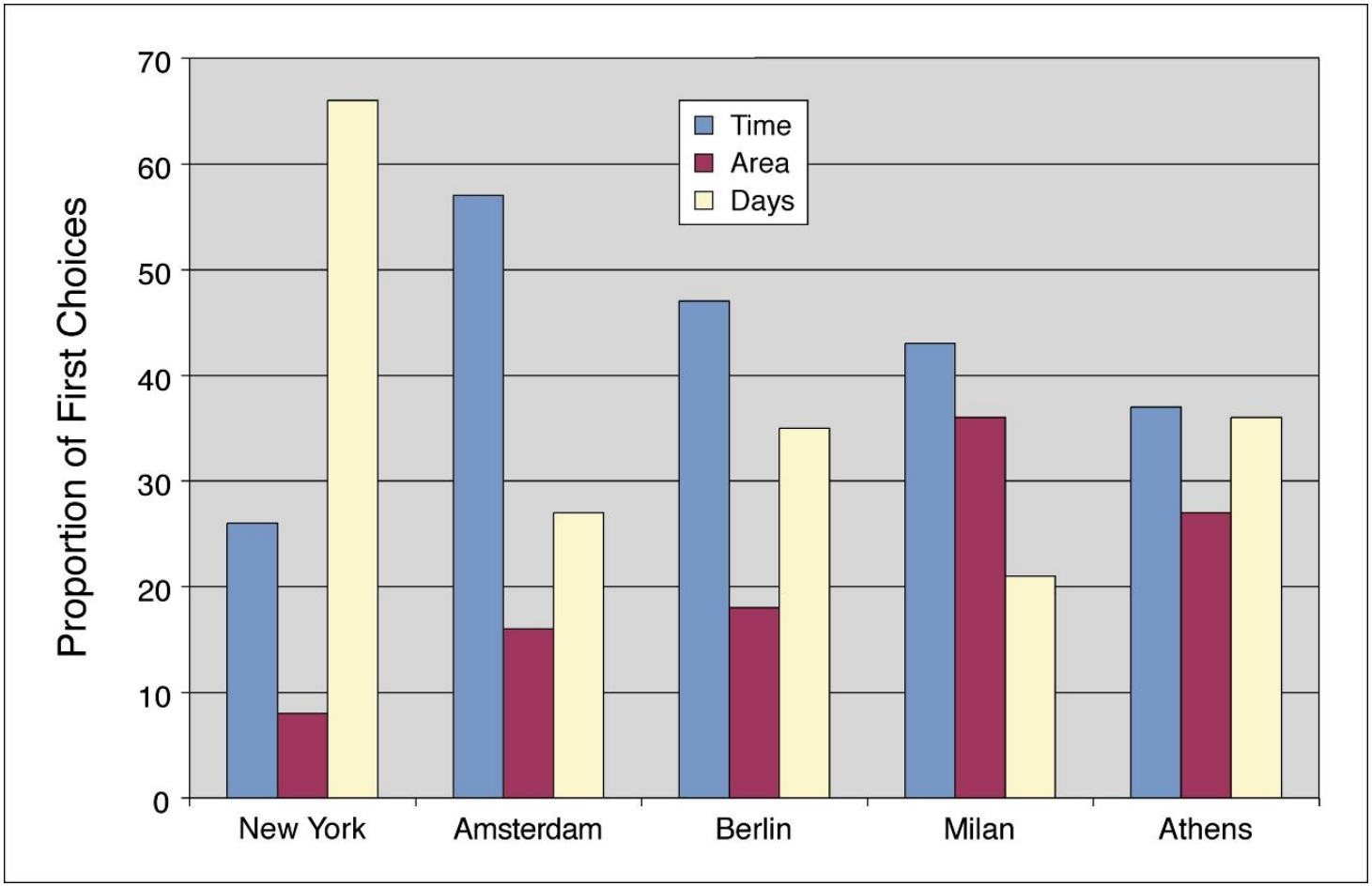
Single event probabilities

Absolute risks

Conditional probabilities

Survival rates

The Probability of Rain is 30%



Gigerenzer, Hertwig, van den Broek, Fasolo, & Katsikopoulos (2005). *Risk Analysis*

Side Effects: Prozac

„The probability that you encounter sexual problems is 30% to 50%."

- ***"Out of 10 patients, 3 to 5 will experience sexual problems."***
- ***"In 30% to 50% of your sexual activities, there will be a problem."***

Risk communication

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~~Relative risks~~

Absolute risks

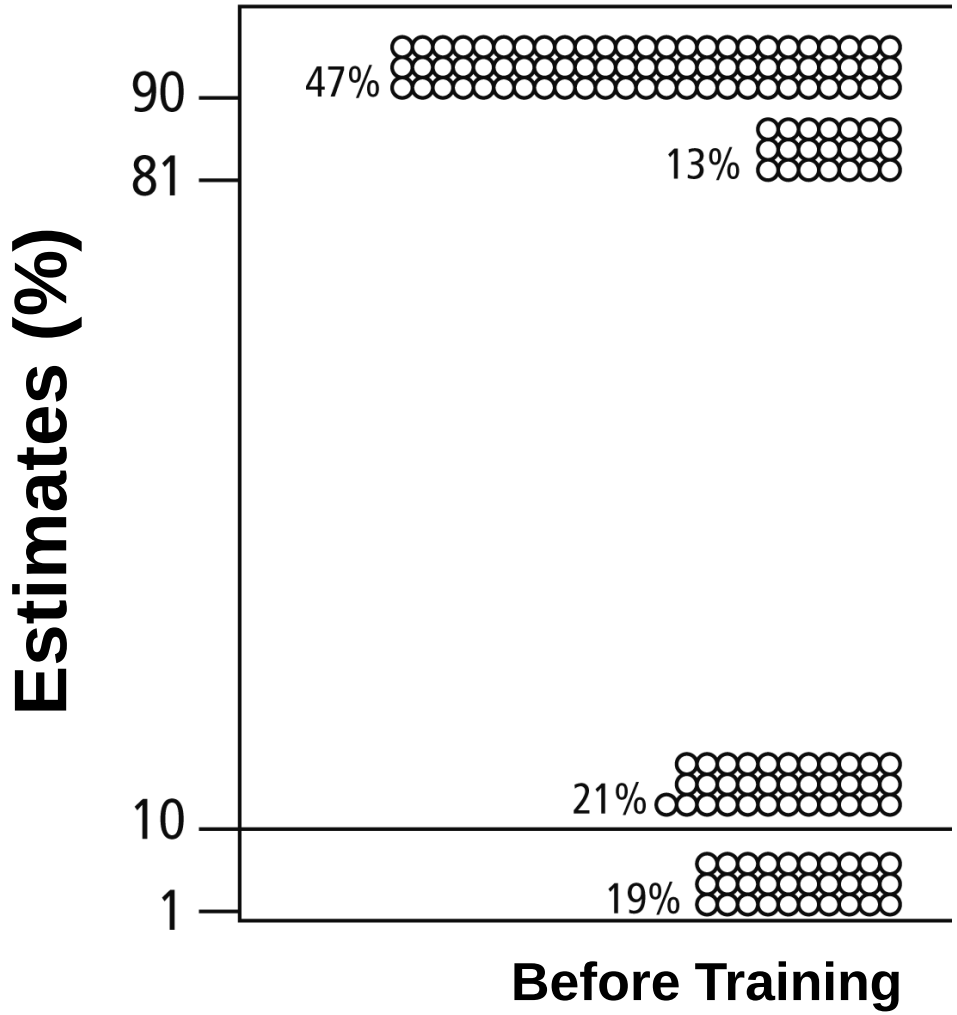
Conditional probabilities

~~Single event probabilities~~

Reference class

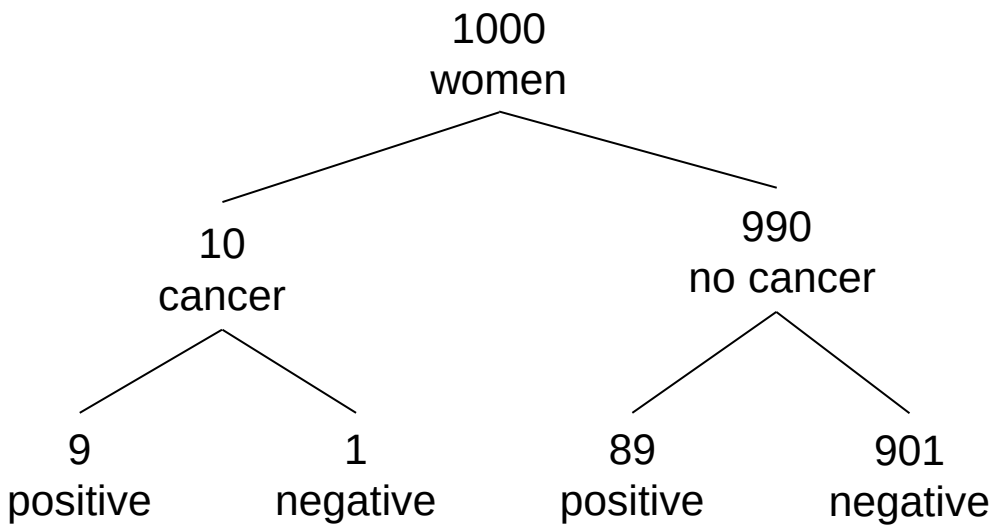
Survival rates

160 Gynecologists estimate: Probability of breast cancer | positive mammogram



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

Natural Frequencies



Conditional Probabilities

p(breast cancer) = 1%

p(positive|cancer) = 90%

p(positive|no cancer) = 9%

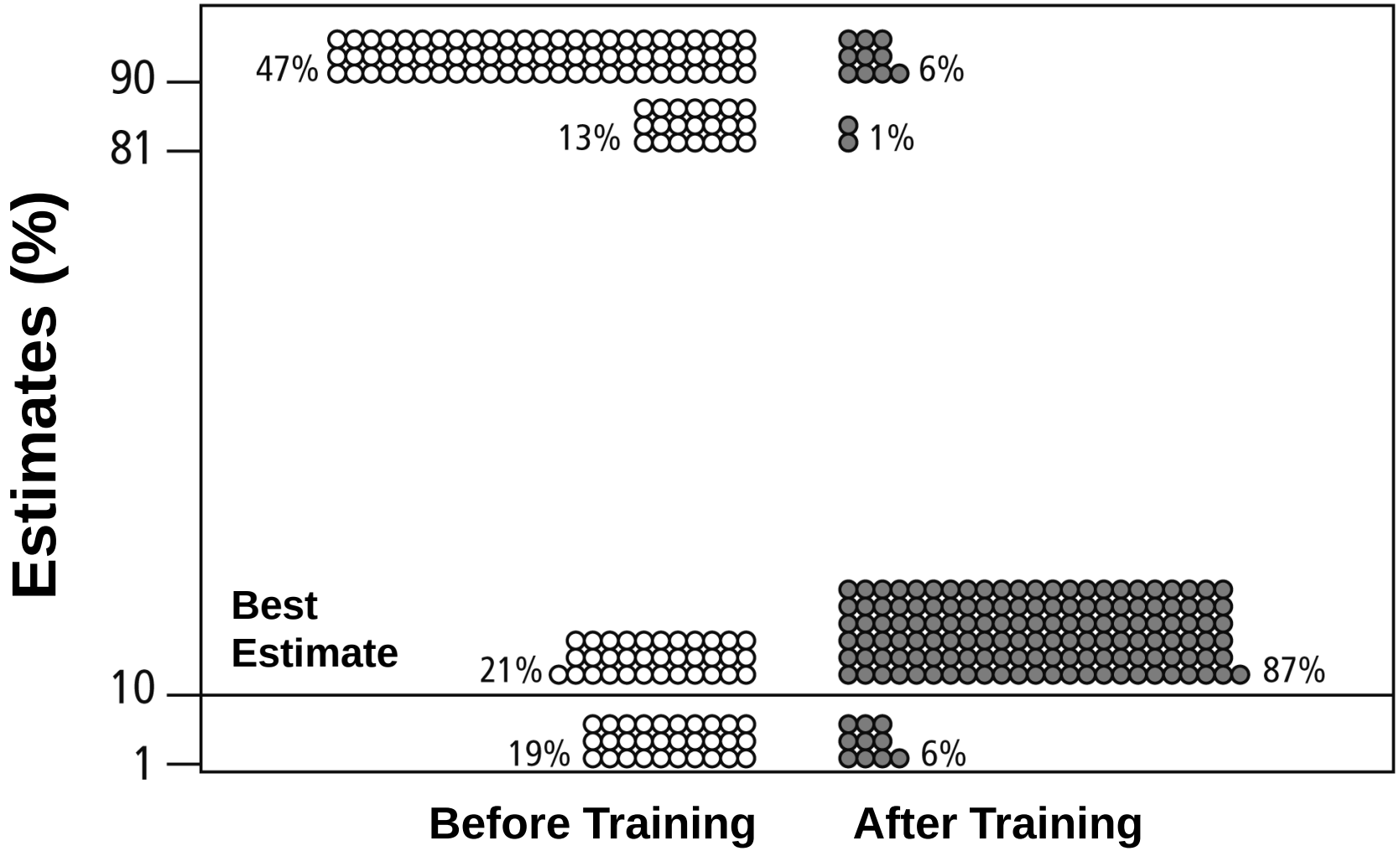
$$p(\text{cancer}|\text{positive}) = \frac{9}{9 + 89}$$

$$p(\text{cancer}|\text{positive}) = \frac{.01 \times .90}{.01 \times .90 + .99 \times .09}$$

~10 %

Mammography

160 Gynecologists estimate: Probability of breast cancer | positive mammogram



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

Risk communication

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~~Relative risks~~

Absolute risks

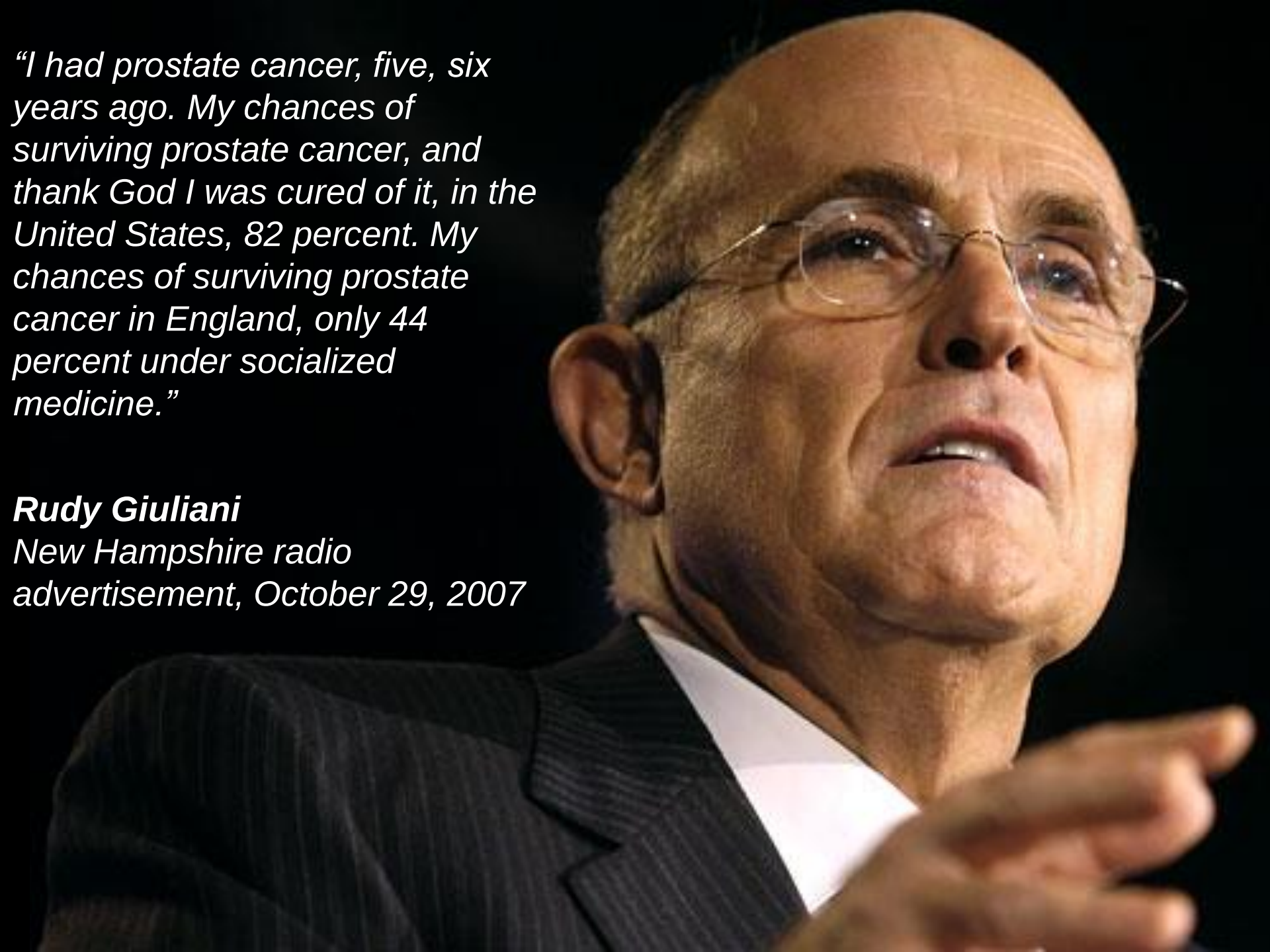
~~Single event probabilities~~

Reference class

~~Conditional probabilities~~

Natural frequencies

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 29, 2007

Lead time bias

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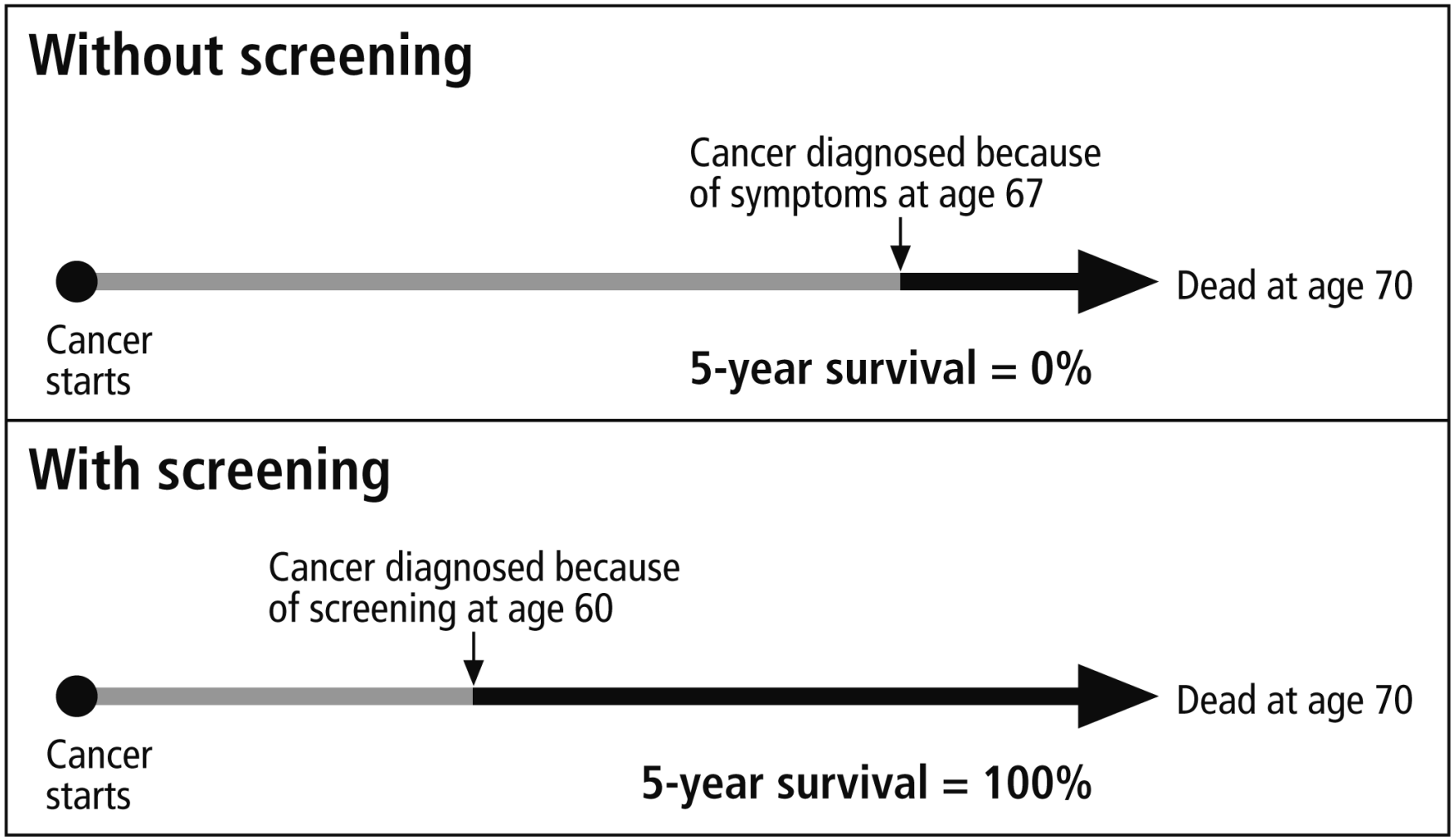

Overdiagnosis bias

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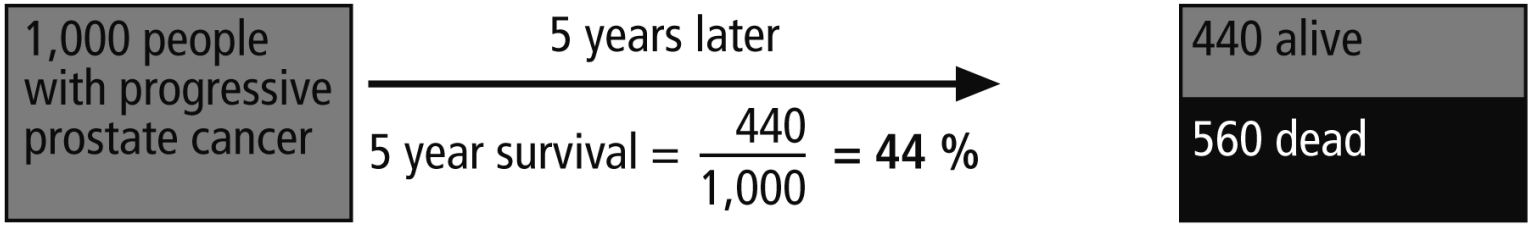
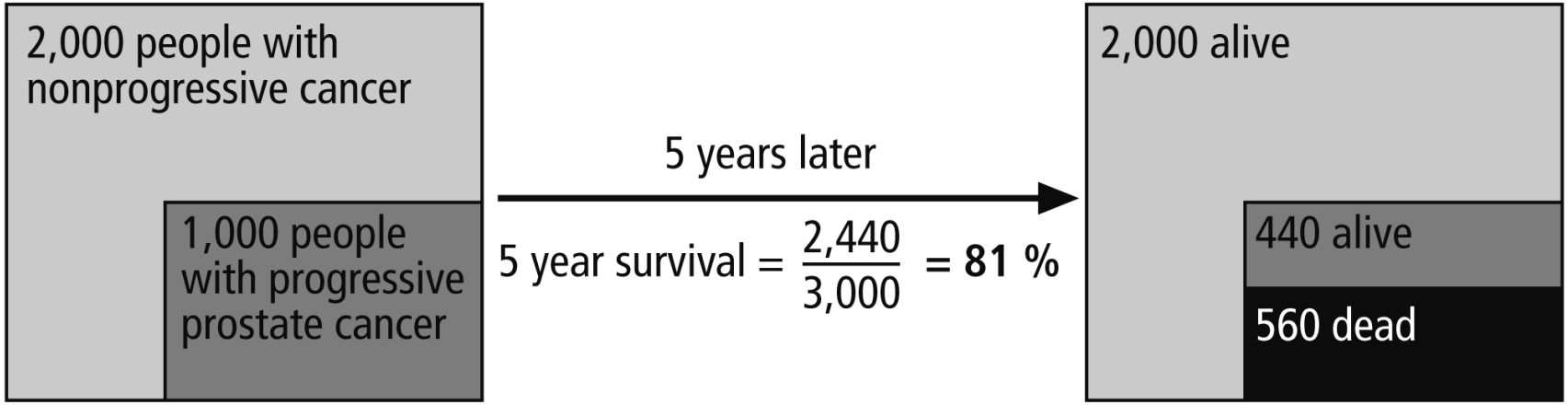
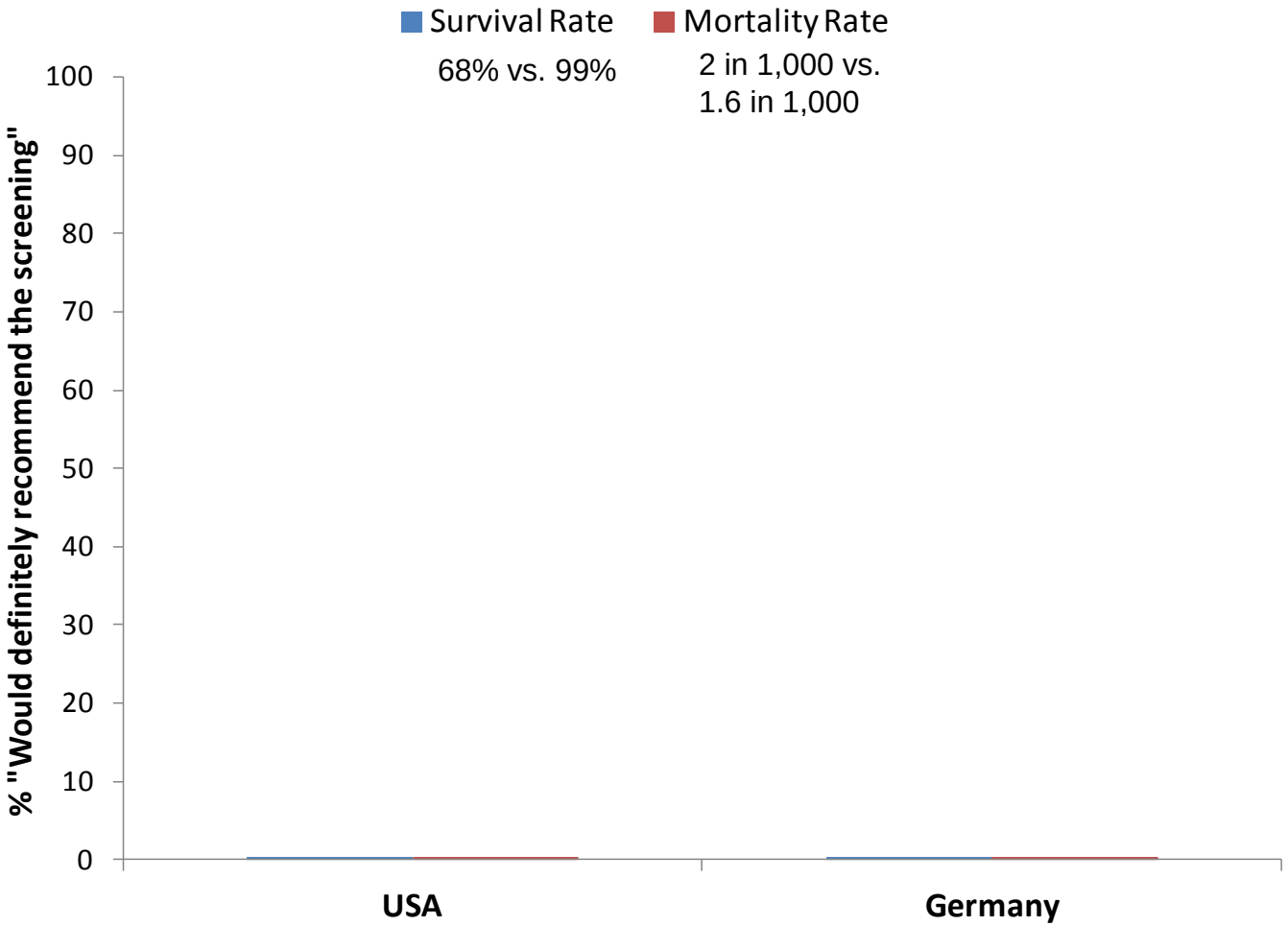
Without screening



With screening





Wegwarth, Schwartz, Woloshin, Gaissmaier, & Gigerenzer (2012). *Annals of Internal Medicine*
Wegwarth, Gaissmaier, & Gigerenzer (2010). *Medical Decision Making*

Confusing representations…

and their transparent counterparts

~~Relative risks~~

Absolute risks

~~Single event probabilities~~

Reference class

~~Conditional probabilities~~

Natural frequencies

~~Survival rates~~

Mortality rates

Facts boxes

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- Simple tabular representation
- Balanced overview of benefits and harms
- Reducing the information to the most relevant pieces
- Simulatneous comparison between people
  - with different treatments
  - with treament vs. placebo
  - (pre- vs. post-treatment)

⇒ Are very well accepted by patients

⇒ Facilitate comprehension as well as the identification of superior options

Schwartz, Woloshin, & Welch (2007) *Medical Decision Making*
Schwartz, Woloshin, & Welch (2009) *Annals of Internal Medicine*

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** With prostate removal or radiation therapy, which can lead to incontinence or impotence.

Source: Djulbegovic M, Beyth RJ, Neuberger MM, et al. (2010). *British Medical Journal,* 341:c4543.

Graphical representations

- help people digest numbers
- are preferred
- reduce the influence of biases such as the ones presented earlier (framing, anecdotes, etc.)
- support healthy behaviors

Gaissmaier et al. (2012) *Health Psychology*
Garcia-Retamero & Cokely (2013) *Current Directions in Psychological Science*
Trevena et al. (2013) *BMC Medical Informatics and Decision Making*

Prostate Cancer Early Detection

HARDING CENTER FOR RISK LITERACY

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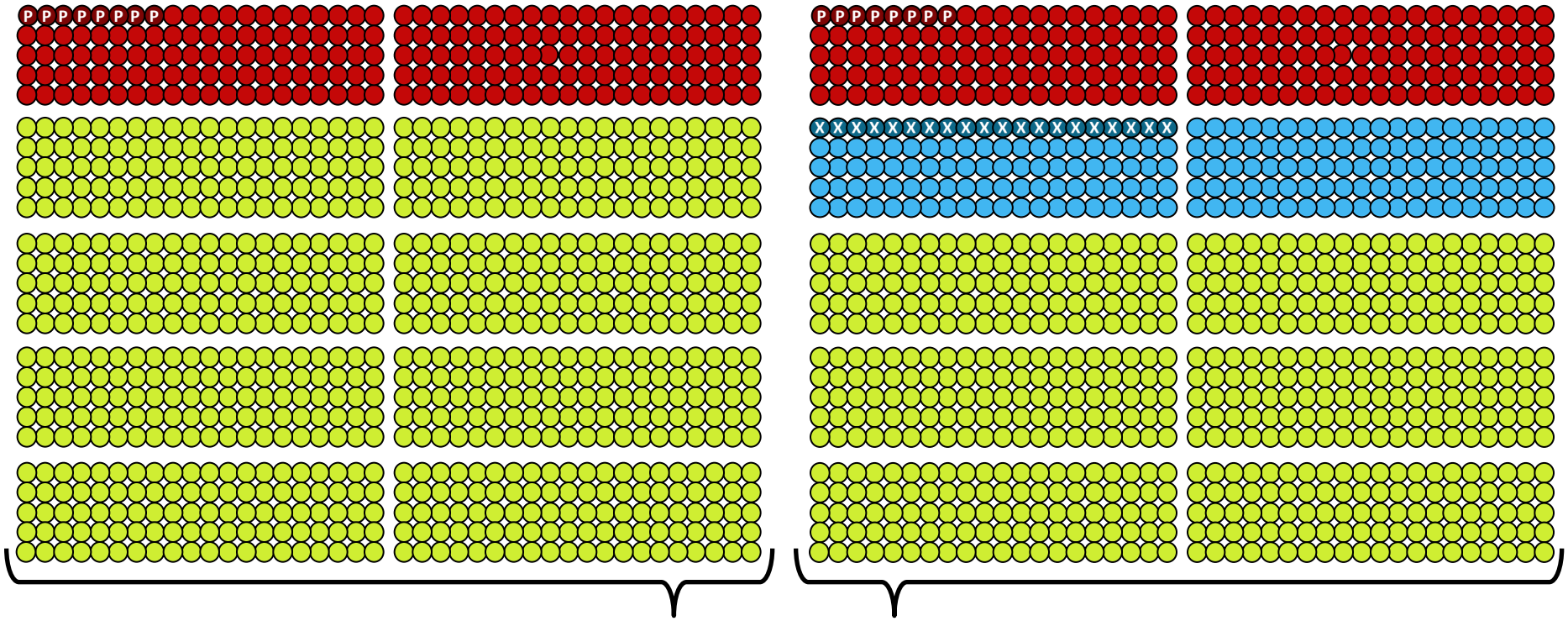

	1,000 men without screening:	1,000 men with screening:
Men dying from prostate cancer:	8	8
Men dying from any cause:	200	200
Men that were diagnosed and treated for prostate cancer unnecessarily:	–	20
Men without cancer that got a false alarm and a biopsy:	–	180
Men that are unharmed and alive:	800	600

Source:
Djulbegovic M, Beyth RJ, Neuberger MM, et al. (2010). *British Medical Journal,* 341:c4543.

Conclusions

- Patients need and want to be involved in decisions about their treatment
- This requires that both patients and physicians understand the benefits and harms of different treatment options
- Patients cannot delegate this decision to their physicians, because these might also lack understanding of the evidence and could have different preferences
- Simple transparent representations can help patients and doctors assess the benefits and harms of different treatment options to make decisions according to preferences and values