Understanding Risk

Steve Gilbert

- Confounding Factors
- Probability
- Risk
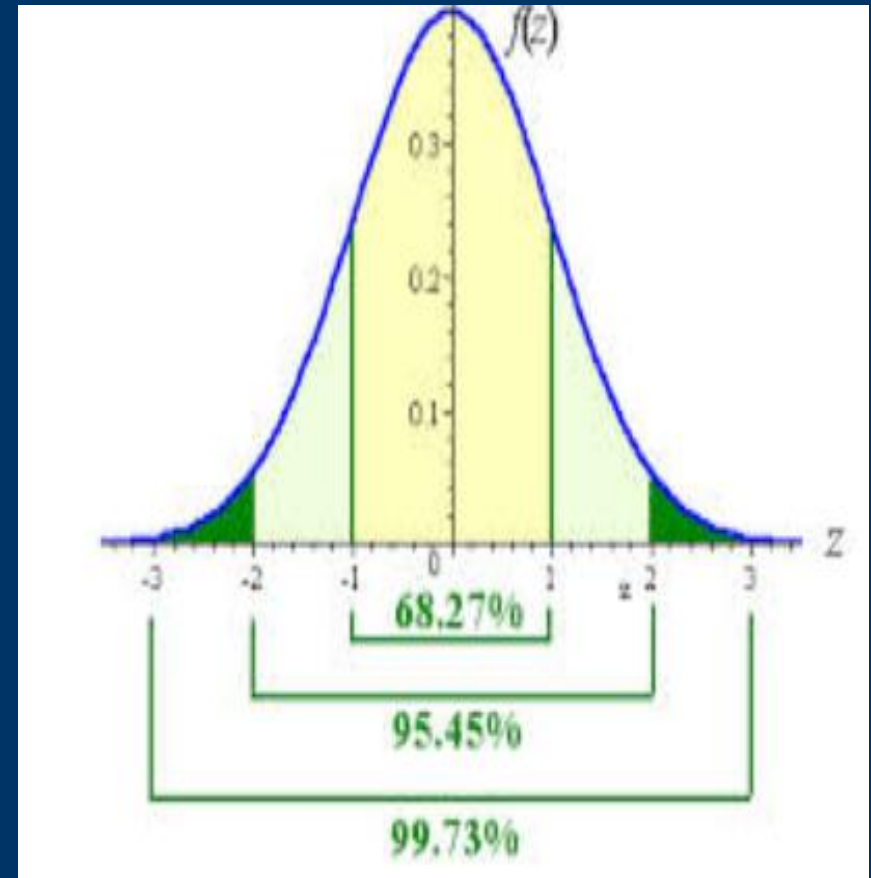- Psychology
- The Power of the Irrational
- Chaos

Confounding Factors

The SIC Syndrome

Defensive decision making
(Self Interest)

Don't understand health statistics
(Innumerate)

Pursue profit / bias instead of truth
(Conflict of Interest)

Relative versus Absolute

1995 UK Committee on Safety of Medicines. The committee warned that third-generation oral contraceptive pills doubled the risk of thrombosis. The risk associated with the second-generation Pill, 1 in 7,000, was increased to 2 in 7,000 in the new Pill. Distressed women stopped taking the Pill. Unwanted pregnancies and abortions – with all their associated risks – resulted.

Although the relative risk of thrombosis did indeed double, the absolute risk, the real risk, increased by only 1 in 7,000. In added irony, the risk of thrombosis is greater with pregnancy or abortion than with the third-generation Pill.

First statistics lesson: always ask, what is the increase in absolute risk?

Medical understanding of Risk

Which of the following proves that a screening test saves lives from cancer?

1, More cancers are detected in screened population rather than unscreened

2, Cancers detected by screening have a better 5 year survival rate than those detected by symptoms.

3, Mortality rates are lower in screened persons than unscreened persons in a randomised controlled trial

Medical understanding of Risk

Survey of 412 American physicians with 10 – 20 years practice

Which of the following proves that a screening test saves lives from cancer?

1, More cancers are detected in screened population rather than unscreened **(47%)**

2, Cancers detected by screening have a better 5 year survival rate than those detected by symptoms. **(76%)**

3, Mortality rates are lower in screened persons than unscreened persons in a randomised controlled trial **(81%)**

Medical understanding of Risk

Imagine that a 55 year old healthy patient asks you about a screening test for cancer X
You have the following info from a large trial, of patients between 50 & 69 over 10 years

Five year survival –   Without screening – 69%
                        With screening   - 99%

Would you recommend screening?

Medical understanding of Risk

Imagine that a 55 year old healthy patient asks you about a screening test for cancer Y

You have the following info from a large trial, of patients between 50 & 69 over 10 years

Mortality rate –   Without screening – 2 deaths/1000

With screening   -   1.6 deaths/1000

Would you recommend screening?

Medical understanding of Risk
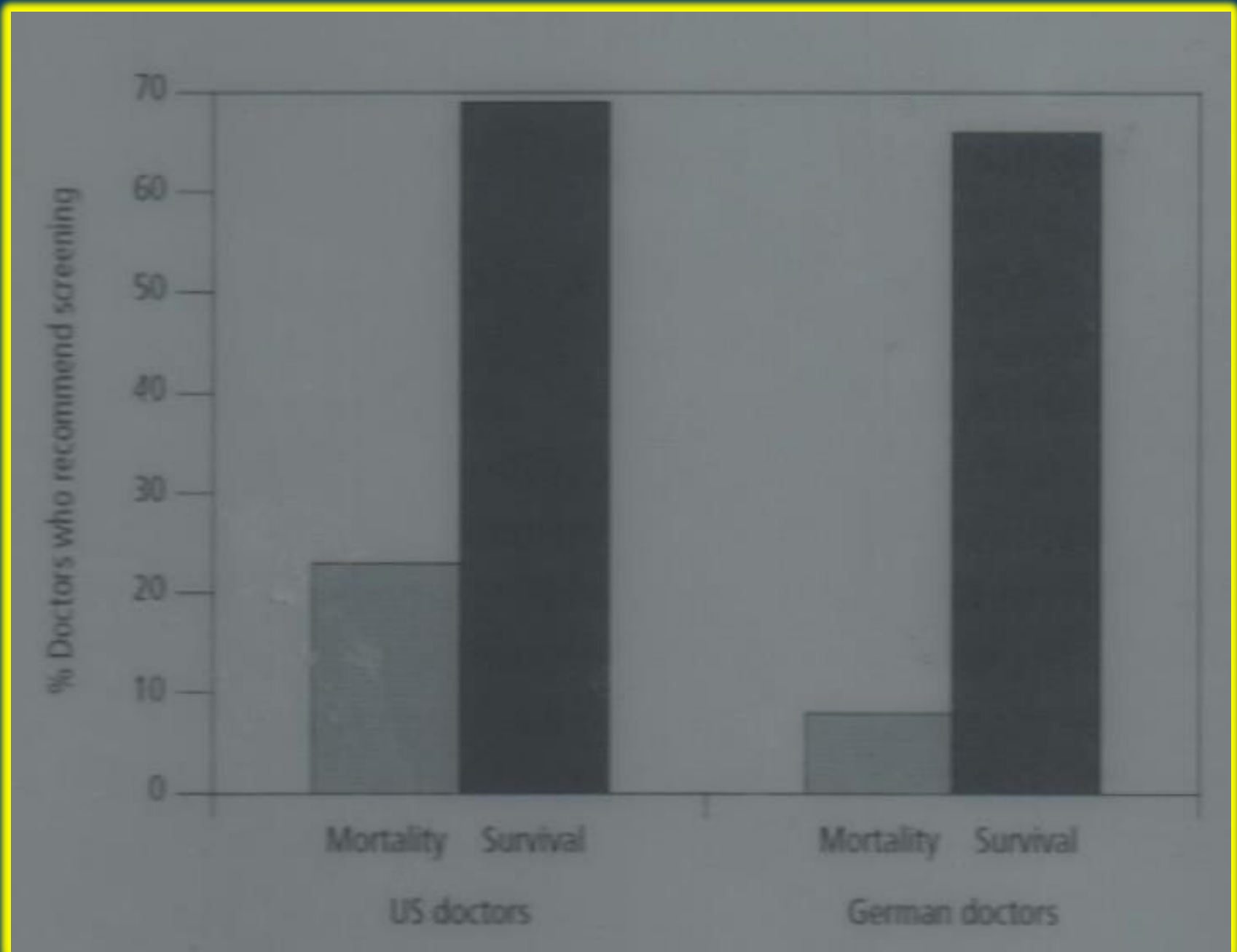
NAP3: Brief summary of major results

NAP 3: Point estimates of incidence (95% confidence intervals NOT stated).
These are presented as a summary: for more informative information 95% confidence intervals are represented: please see the

> NAP3 report and

> original paper in the BJA

Cases with Permanent Harm with CNB:

Indications	Pessimistic	Optimistic
Overall	1 in 23,500	1 in 50500
Paraplegia and death	1 in 54,500	1 in 141,500
Overall death	< 1 in 100,000	< 1 in 200,000
Peri-operative overall	1 in 12,500	1 in 24,000
Obstetric	1 in 80,000	1 in 320,000
Chronic Pain	1 in 40,000	Had full recovery
Paediatrics	No permanent Harm	No permanent Harm

Cases with Permanent Harm with Peri-operative Epidural:

Indications	Pessimistic	Optimistic
Overall	1 in 5,800	1 in 12,000
Paraplegia and death	1 in 16,000	1 in 98,000

Probability

What is the benefit of breast screening?

Breast screening finds cancers early

In women who have breast screening, most cancers are found at an early stage when there is a good chance that treatment will be successful. In the UK more than half of the breast cancers found through screening are discovered very early: when they are very small and haven't spread to the lymph nodes close to the breast.

Breast screening saves lives

Over 19 million women have had breast screening in the UK since the Breast Screening Programme was set up in 1988. In this time, it has found more than 117,000 cancers.

A report in 2006, by the Advisory Committee on Breast Cancer Screening, indicated that screening saved 1,400 lives a year in England. Research by the International Association for Cancer Research has shown that for every 500 women who have breast screening one life will be saved.

Women who take part in breast screening reduce their risk of dying from breast cancer.

Breast conserving surgery is possible

In women who have breast screening, cancer is more likely to be found early. This means that the cancer is likely to be small and there is more chance that it can be removed by a lumpectomy (removal of the lump) rather than needing a mastectomy (removal of the whole breast).

Approximately 7 out of 10 (70%) women whose breast cancer is diagnosed by screening have breast conserving therapy, compared with 55% of women diagnosed outside the screening programme.

Breast Cancer Early Detection

by mammography screening

Numbers for women aged 50 years or older who participated in screening for 10 years

	1,000 women without screening	1,000 women with screening
Benefits		
How many women died from breast cancer?	5	4*
How many women died from all types of cancer?	21	21
Harms		
How frequent were false diagnoses, often associated with months of waiting for all-clear?	–	100
How many women were additionally diagnosed and operated** for breast cancer?	–	5

* This means that about 4 out of 1,000 women (50+ years of age) with screening died from breast cancer within 10 years – one less than without screening.

** Complete or partial breast removal

Source: Gøtzsche, PC, Nielsen, M (2011). *Cochrane database of systematic reviews* (1): CD001877.
Where no data for women above 50 years of age are available, numbers refer to women above 40 years of age.
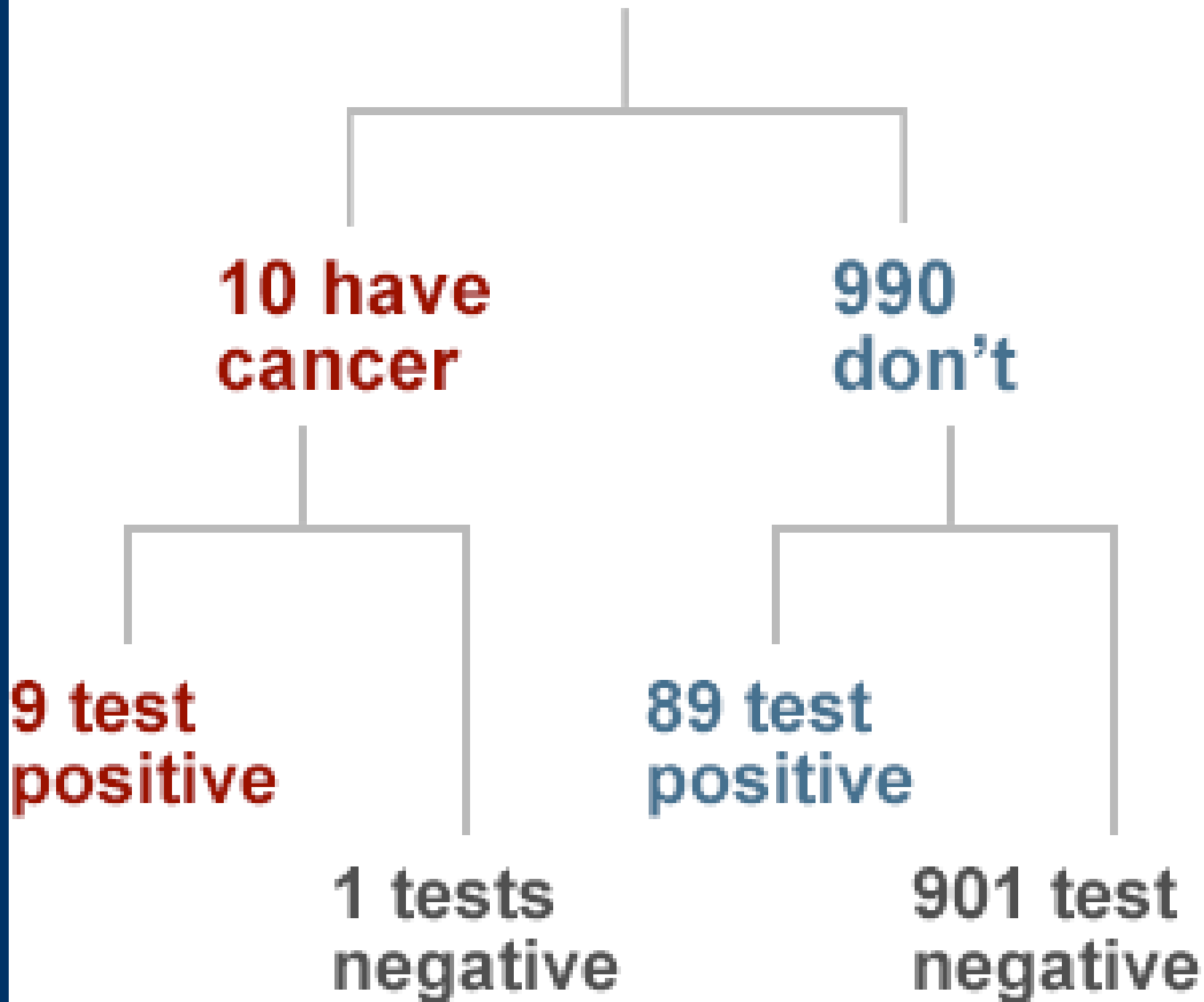
Lead Time
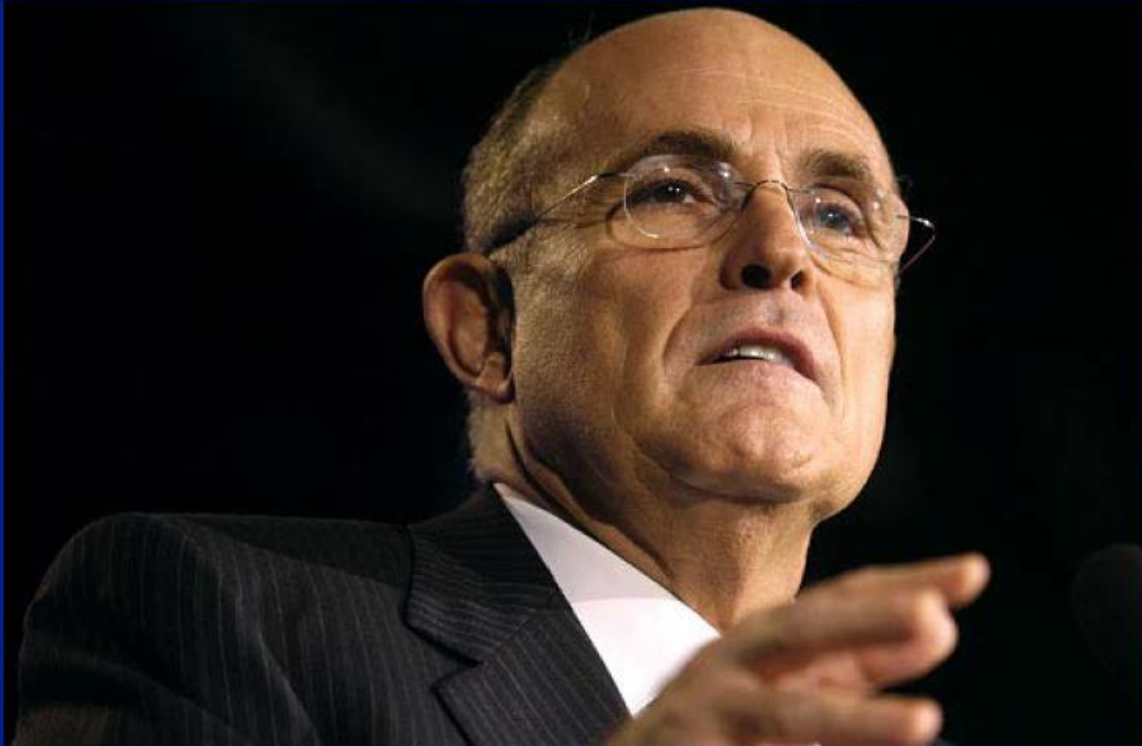
"I had prostate cancer, five, six years ago. My chances of surviving prostate cancer and thank God I was cured of it, in the United States, 82 percent. My chances of surviving prostate cancer in England, only 44 percent under socialized medicine."

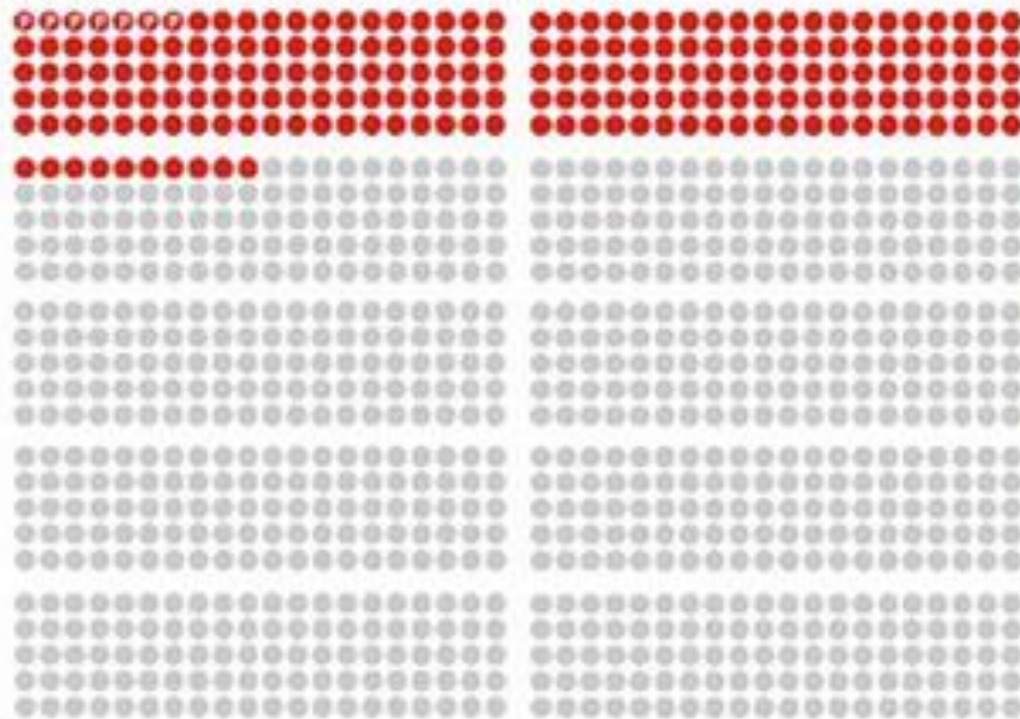Rudy Giuliani, New Hampshire radio advertisement, October 2007
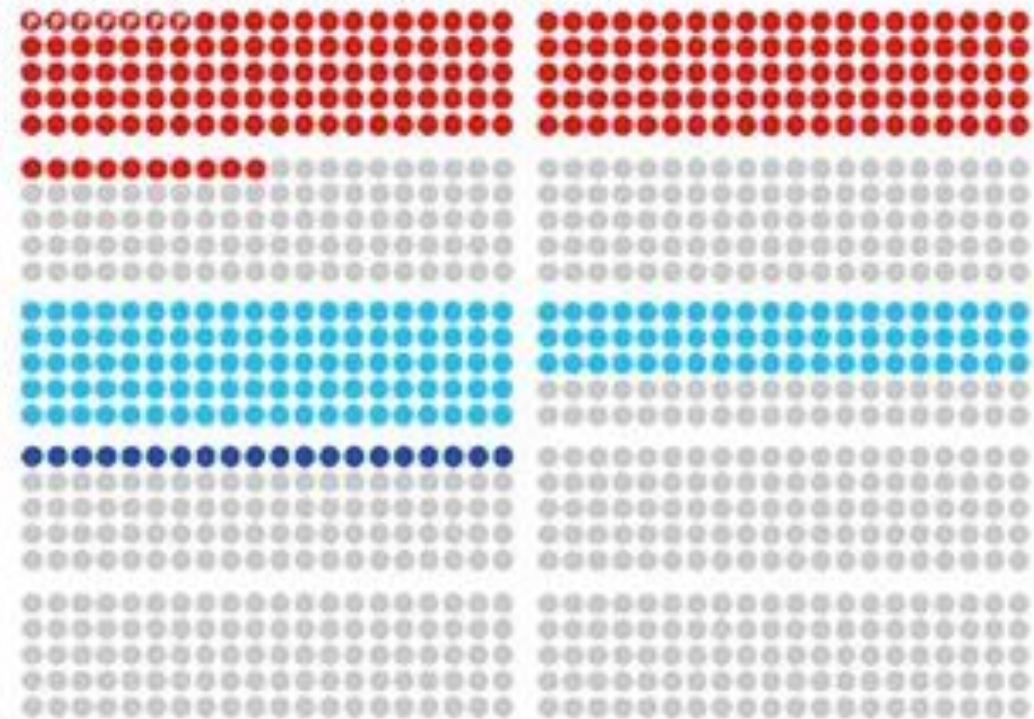
Prostate Cancer Early Detection

by PSA testing and palpation of the prostate gland

Numbers are for men aged 50 years and older, not participating vs. participating in early detection for 11 years

1000 men without early detection:

1000 men with early detection:

○ Men who died from prostate cancer:	7	7
● Men who died from any cause:	210	210
● Men who learned after a biopsy that their diagnosis was a false-positive:	–	160
● Men who were diagnosed and treated for prostate cancer unnecessarily:	–	20
○ Remaining men:	783	603

Source:
Ilic et al. (2013) Cochrane Database of Systematic Reviews, Art. No.:CD004720.

Lead Time Bias

Without screening

Cancer diagnosed because of symptoms at age 67

Cancer starts

Dead at age 70

5-year survival = 0%

With screening

Cancer diagnosed because of screening at age 60

Cancer starts

Dead at age 70

5-year survival = 100%
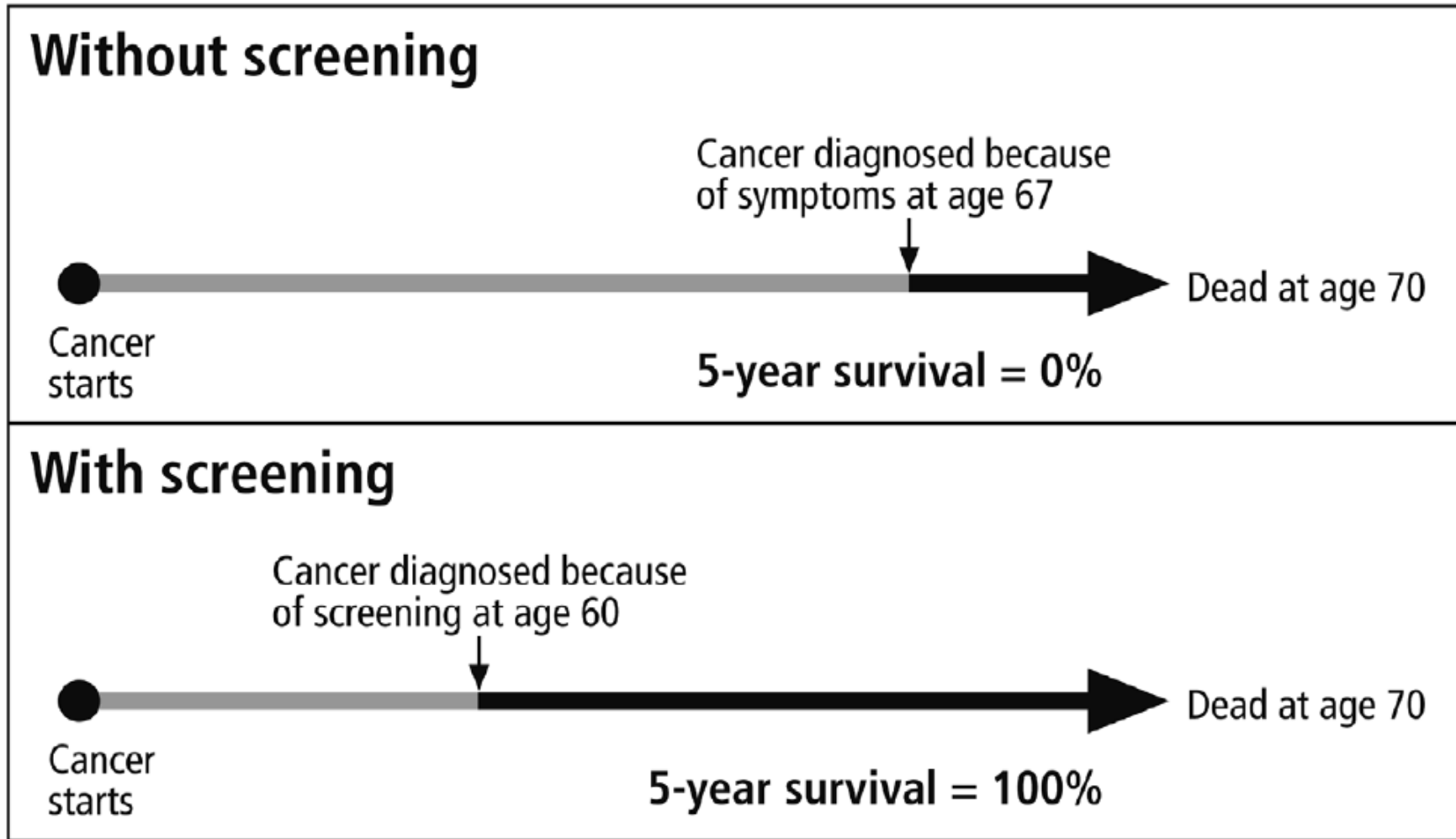
"Double Tonguing"

cherry-pick the sample groups and/or statistical methods to "prove" the efficacy of their product

Often using a mixture of absolute & relative risks

For instance – a drug reduces mortality from stroke from 2 to 1 in 100 patients - & increases mortality due to cancer from 1 to 2 – obviously there is no survival benefit, but the risk may be expressed as

50% reduction in Stroke mortality

1% increase in risk of cancer mortality

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
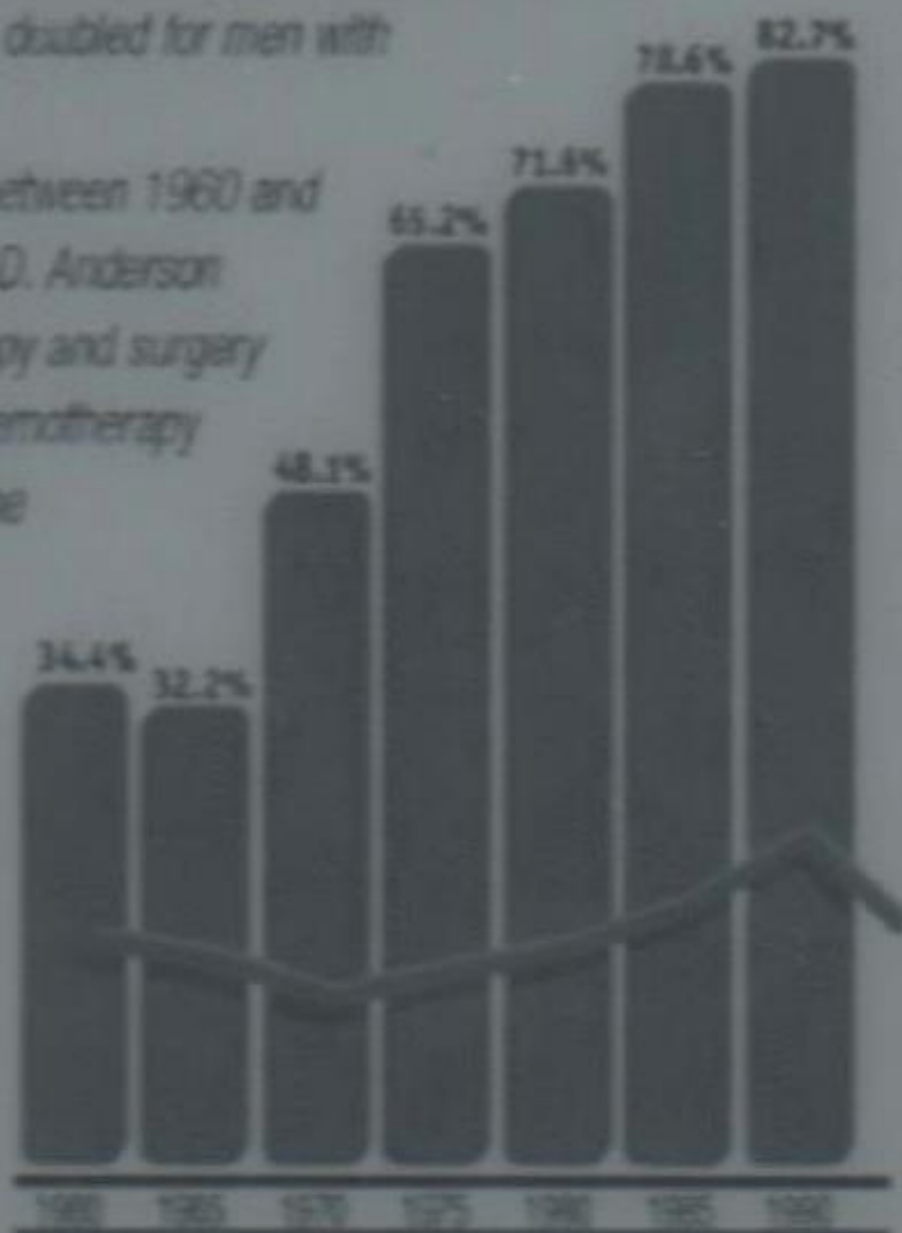
Bar chart values: 34.4%, 32.2%, 48.1%, 65.2%, 71.6%, 78.6%, 82.7% for years 1960, 1965, 1970, 1975, 1980, 1985, 1990

Known Risks and Uncertainty

Donald Rumsfeld – Unknown unknowns

"There are known knowns. These are things we know that we know. There are known unknowns. That is to say, there are things that we know we don't know. But there are also unknown unknowns. There are things we don't know we don't know."

Donald Rumsfeld

RISK VS UNCERTAINTY

RISK:

How should we make decisions when all relevant alternatives, consequences, and probabilities are known?

Statistical thinking, logic

UNCERTAINTY:

How should we make decisions when NOT all alternatives, consequences, and probabilities are known?

Heuristic thinking, intuition

Gigerenzer, Hertwig & Pachur Eds. 2011. *Heuristics: The foundations of adaptive behavior.* OUP
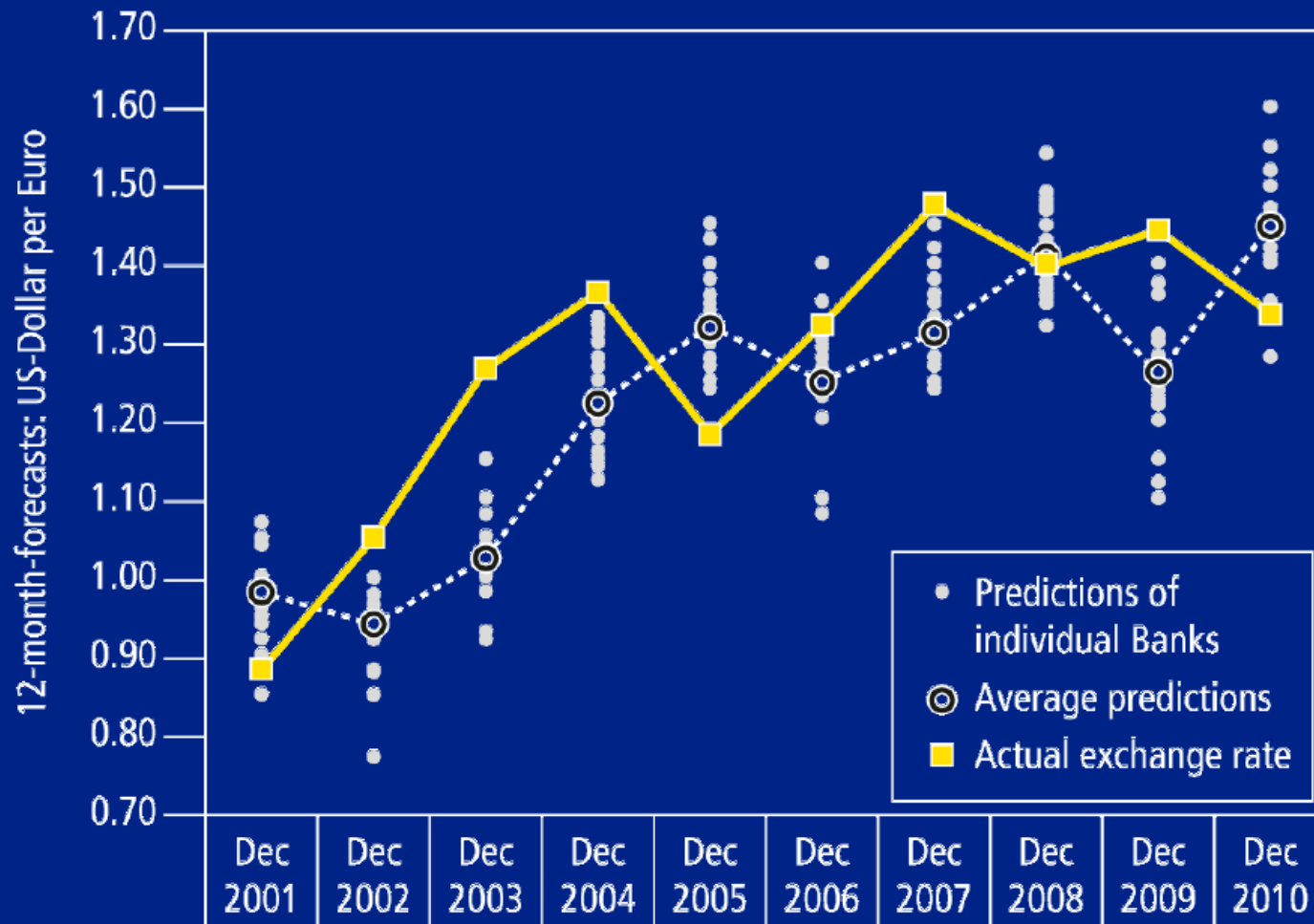
Illusion of Certainty
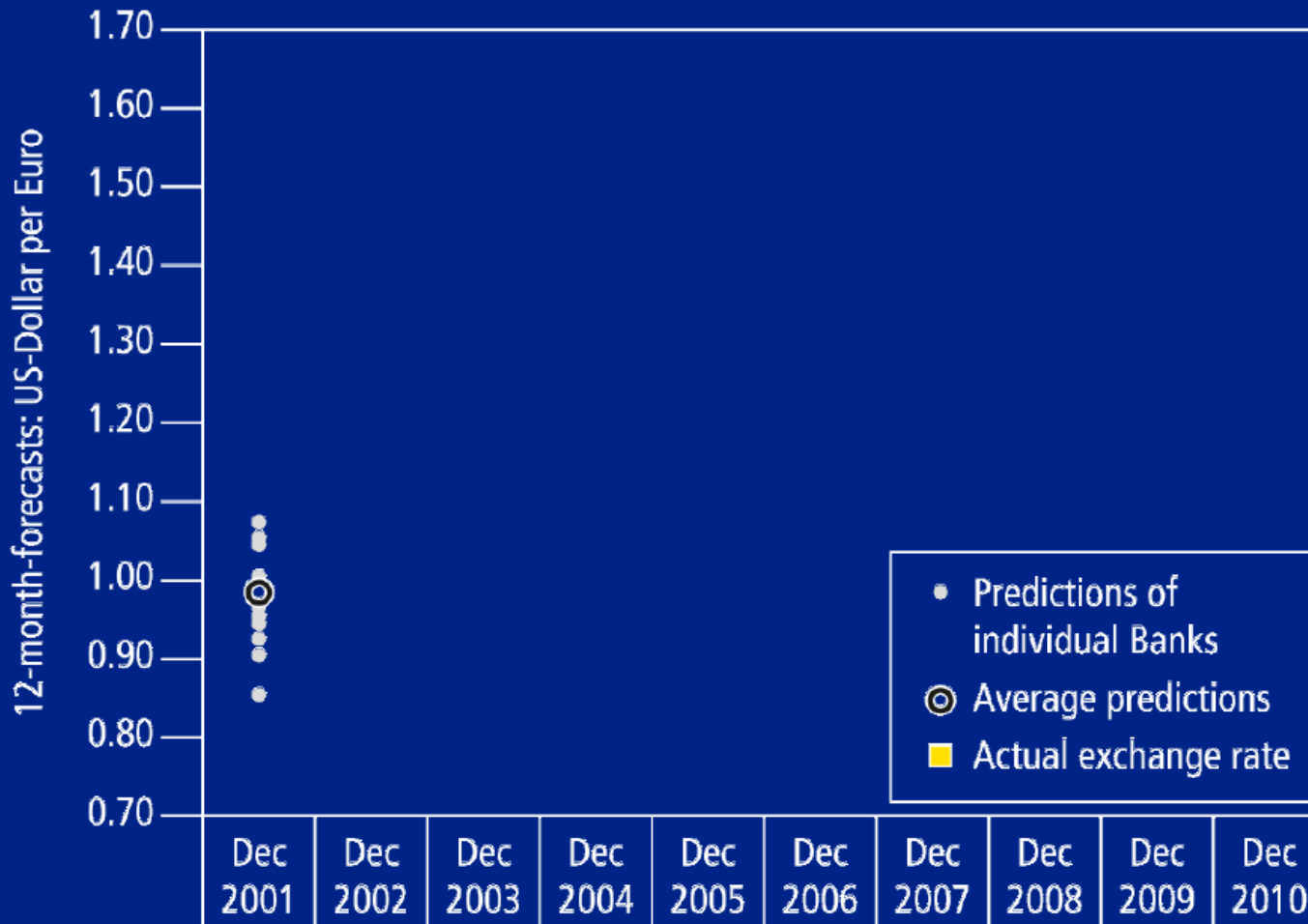
Predictions by 22 international banks, including Bank of America Merrill Lynch, Bank of Tokyo Mitsubishi, Barclays Capital, Citigroup, Commerzbank, Credit Suisse, Deutsche Bank, HSBC, JP Morgan, Merrill Lynch, Morgan Stanley, and Societé Générale.
Source: Gigerenzer (in press). *Risk savvy.* Viking. Based on ConsensusEconomics, 2001-2010
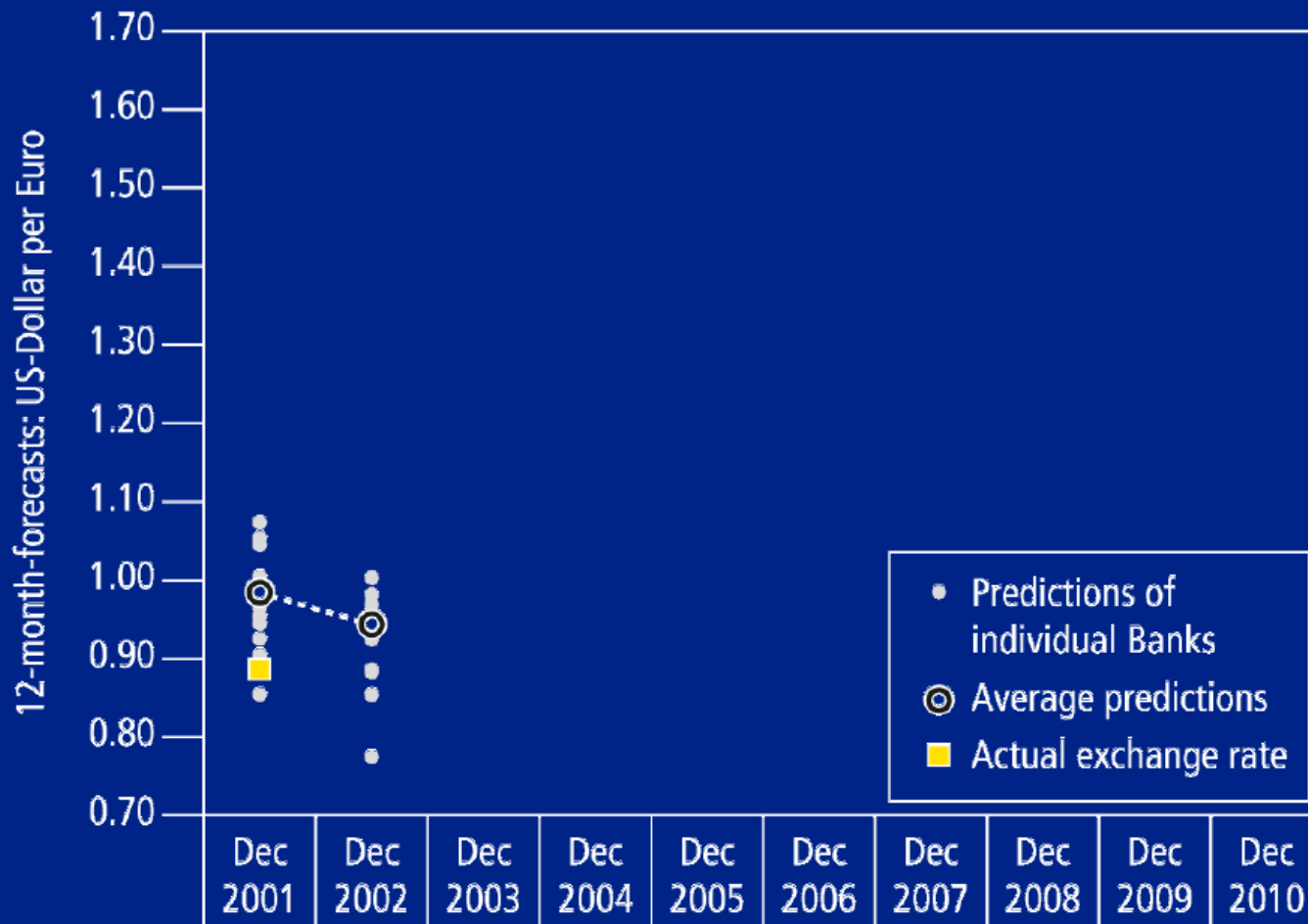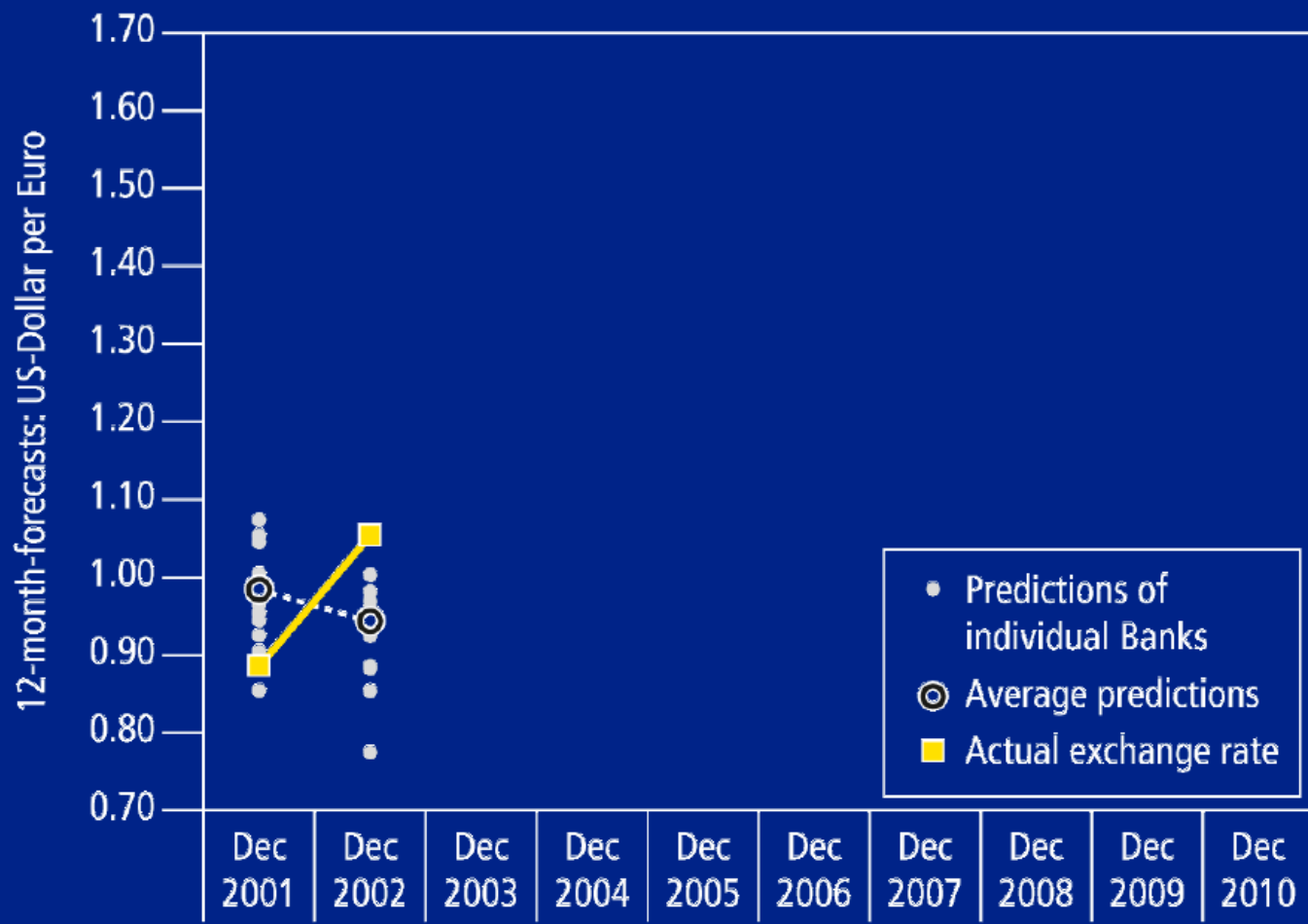
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Source: Gigerenzer (in press). *Risk savvy.* Viking. Based on ConsensusEconomics, 2001-2010

The Turkey Illusion

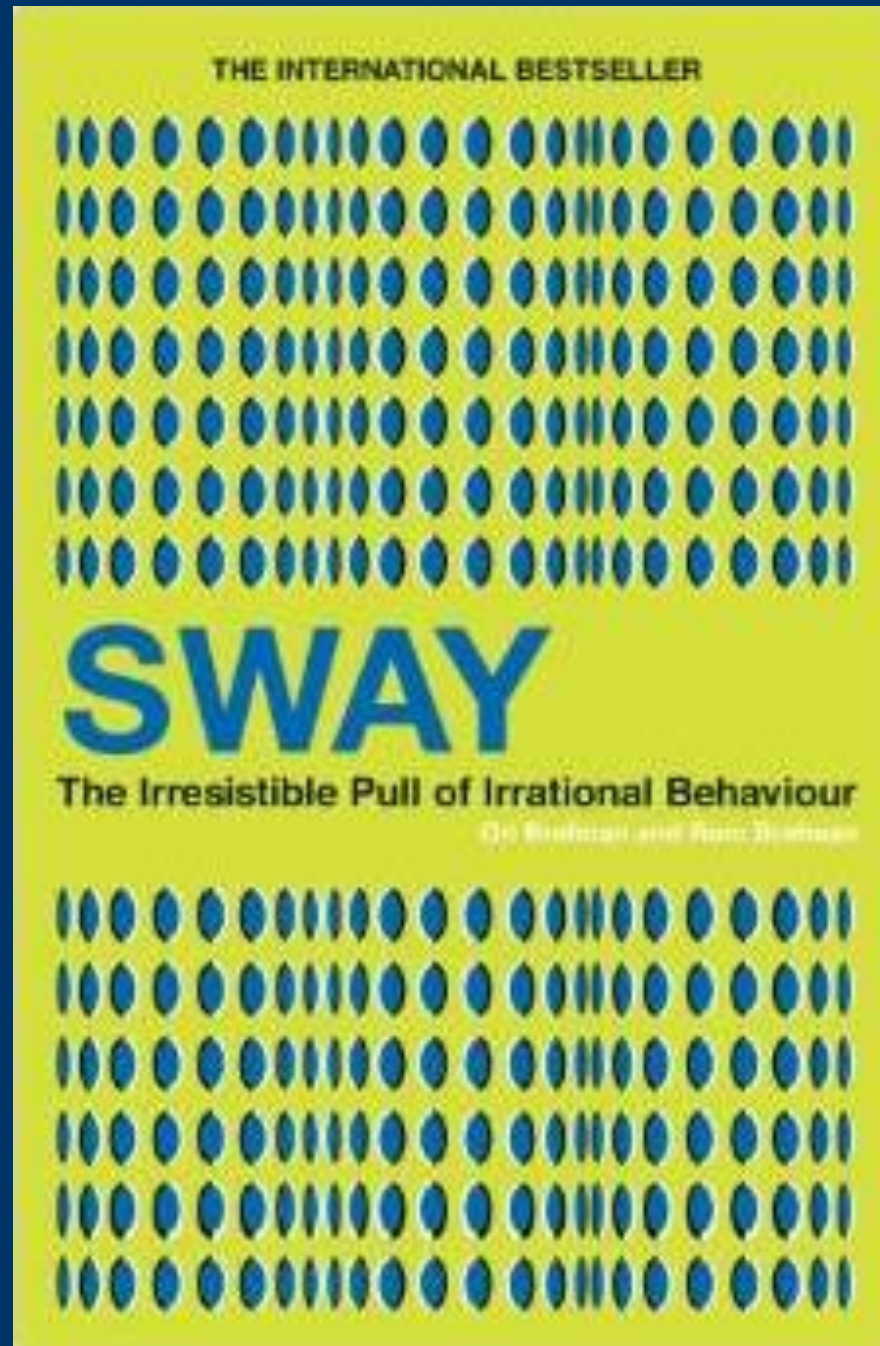Imagine you're a turkey – a man approaches & you're frightened ....

But he gives you food & looks after you

The next time you're not so scared

This happens every day – it's safe

THEN ....

Irrational Behaviour

Risk Aversion

Loss Aversion -

Confirmation Bias -

Fairness -

Culture -

Risk Aversion

Loss Aversion -

Confirmation Bias -

Fairness -

Culture -

Risk Aversion

Loss Aversion -

Confirmation Bias -

Fairness -

Culture -

Risk Aversion

- **Loss Aversion** – at Tenerife Los Rodeos, North Airport

- Plane diverted due to a bomb threat at Gran Canaria
- Pilot Jacob Veldhuyzen van Zanten, KLM's chief flying instructor
- 235 passengers
- Dense fog developing
- Bomb threat lifted at Gran Canaria
- Obtained clearance for flight plan

Risk Aversion

Loss Aversion – The Tenerife air disaster

Obtained flight clearance but not runway clearance

583 killed

Led to Crew Resource Management – 3 steps

Risk Aversion

Loss Aversion – The Tenerife air disaster

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Led to Crew Resource Management – 3 steps
1. State facts
2. Challenge – name – quantify
3. Intervene – take action

Risk Aversion Confirmation Bias

- *Sir Karl Popper, swans, and the general practitioner*

What is truth? And what is truth in the encounter between a patient and a general physician? Is truth always determined either from the "observer" or the "patient's" perspective and thus subjective? Or does something like objective truth exist? During my journey as a patient … I did not worry about philosophical questions relating to truth in general or truth as it applies to medicine and the medical encounter. Questions relevant for the philosophy of science seem to be far removed from the sickbed and the delivery of professional medical care and treatment. But are they?
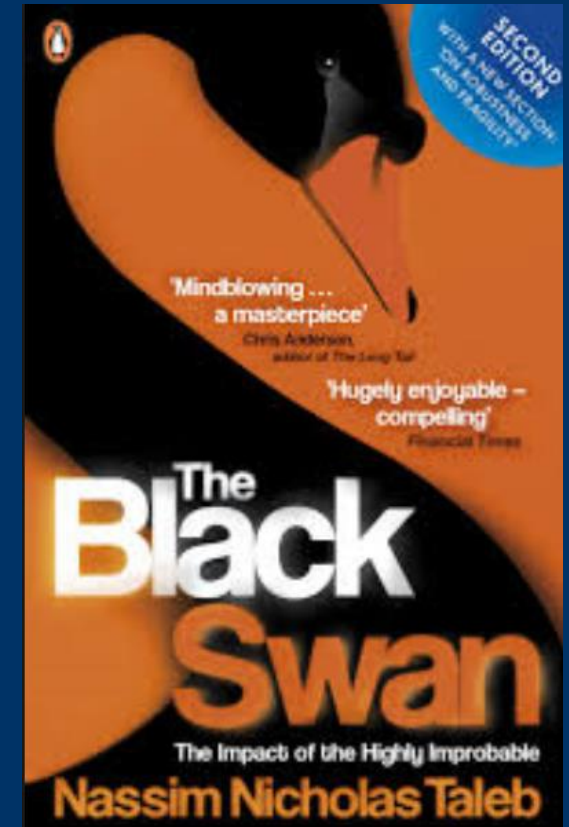
Risk Aversion

Fairness – Rolling dice – tossing coins – winning the lottery - etc
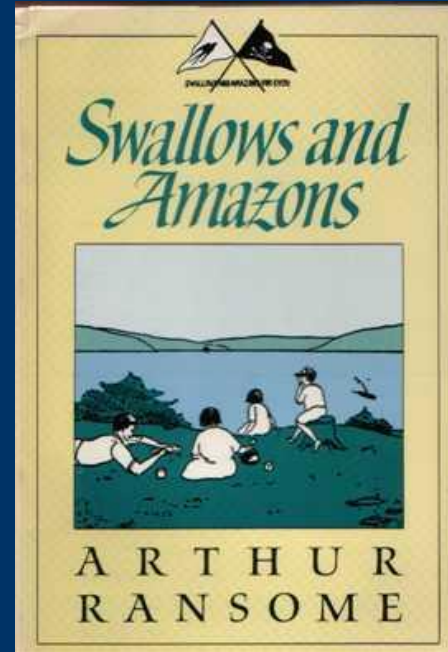
Risk Aversion

Culture - Germany

UK

Culture

Then

Now

Culture

Here

Culture

Here

There

Dread Risk

Scientists have moved closer to being able to stop a huge asteroid colliding with the Earth and potentially wiping out human life.

They were studying asteroid 1950 DA, which first became infamous in 2002 when astronomers estimated it had a one in 300 chance of hitting the planet on 16 March, 2880. However, the odds of a collision were later revised to a more reassuring one in 4,000

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Dread Risk

Dread Risk

RISK SAVVY
HOW TO MAKE
GOOD DECISIONS

GERD GIGERENZER

Gerd Gigerenzer at TED Zurich
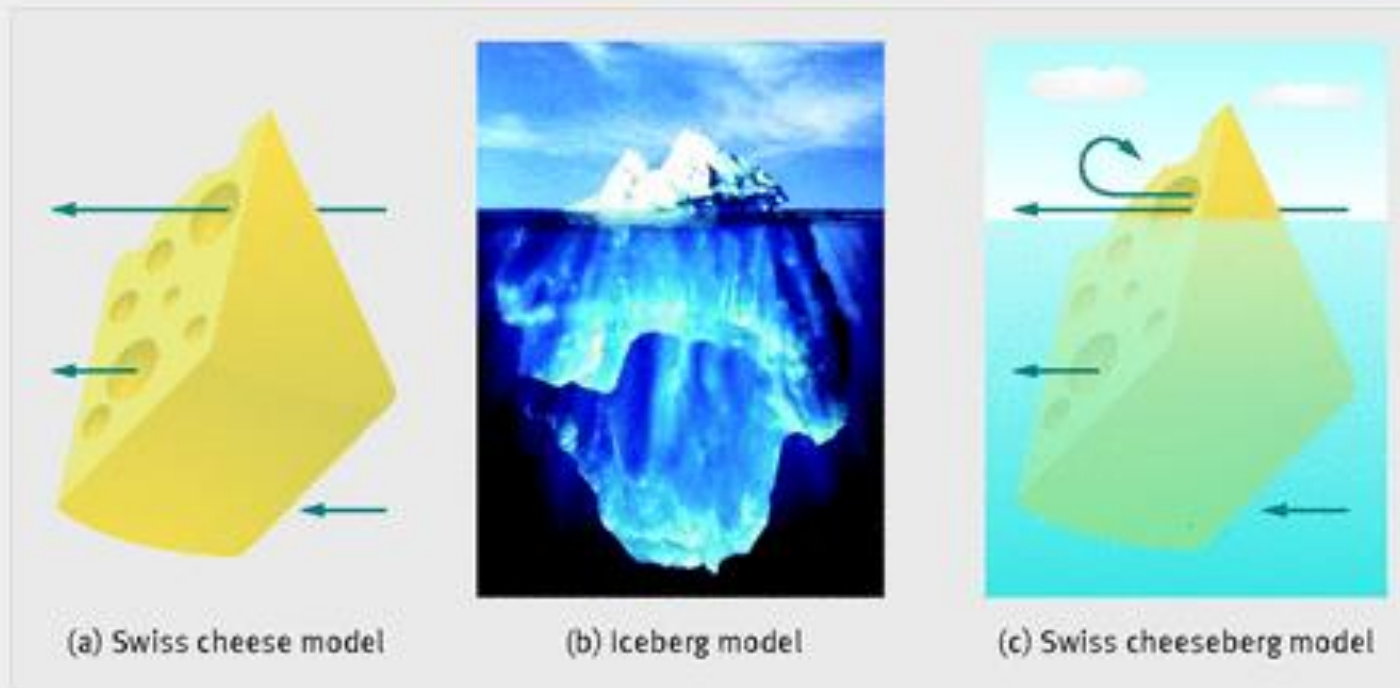
https://www.youtube.com/watch?v=g4op2WNc1e4

Video on being Risk Savvy

Chaos & the Swiss Cheeseberg

A unified model of patient safety (or "Who froze my cheese?")
Christmas BMJ 2013
errors occur despite organisational defences but we rarely detect them

(a) Swiss cheese model   (b) Iceberg model   (c) Swiss cheeseberg model

Combining the classic Swiss cheese (a) and iceberg (b) models produces the Swiss cheeseberg (c)

↓ Download figure   📄 Open in new tab   🖥 Download powerpoint

Teaching Risk Literacy – P2 & P4 example

At the school of magic –

Out of every 20 trainee wizards – 5 have a wand
Of these 5, 4 also wear a wizard's hat
Of the 15 without wands 12 have a wizards hat

Teaching Risk Literacy – P2 & P4 example

At the school of magic –

Out of every 20 trainee wizards – 5 have a wand
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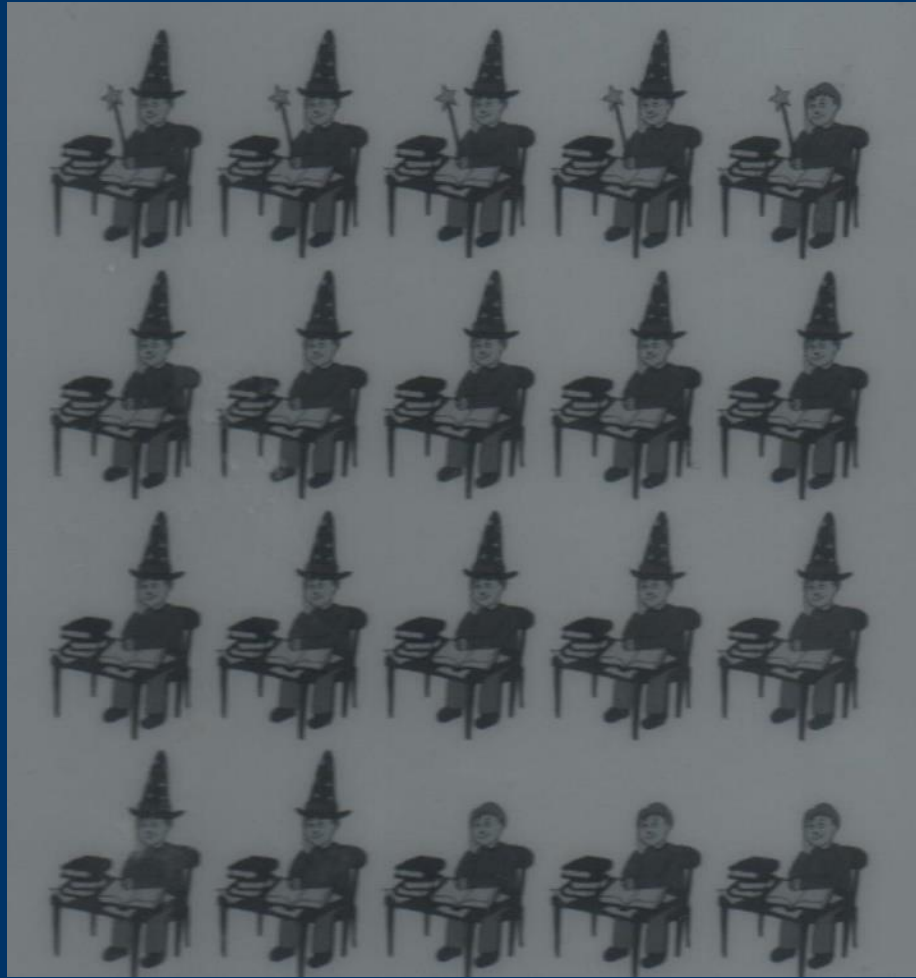Of the 15 without wands 12 have a wizards hat

QUESTION 1;

Imagine the trainees with a wizard's hat

1, Are there more with a wand?

2. How many with a wizard's hat also have a wand?

Imagine the trainees with a wizard's hat

1, Are there more with a wand?

2. How many with a wizard's hat also have a wand?

Results

	with text	with icons
P2 –	14%	22%
P4	51%	60%

- http://understandinguncertainty.org/ David Spiegelhalter, Professor of the Public Understanding of Risk in the Statistical Laboratory, University of Cambridge

- ***Simple tools for understanding risks: from innumeracy to insight***
http://www.bmj.com/content/327/7417/741

- Risk Communication Institute
http://www.riskcomm.com/challenges.htm