Communicating uncertainty about the future, the present and the past

David Spiegelhalter

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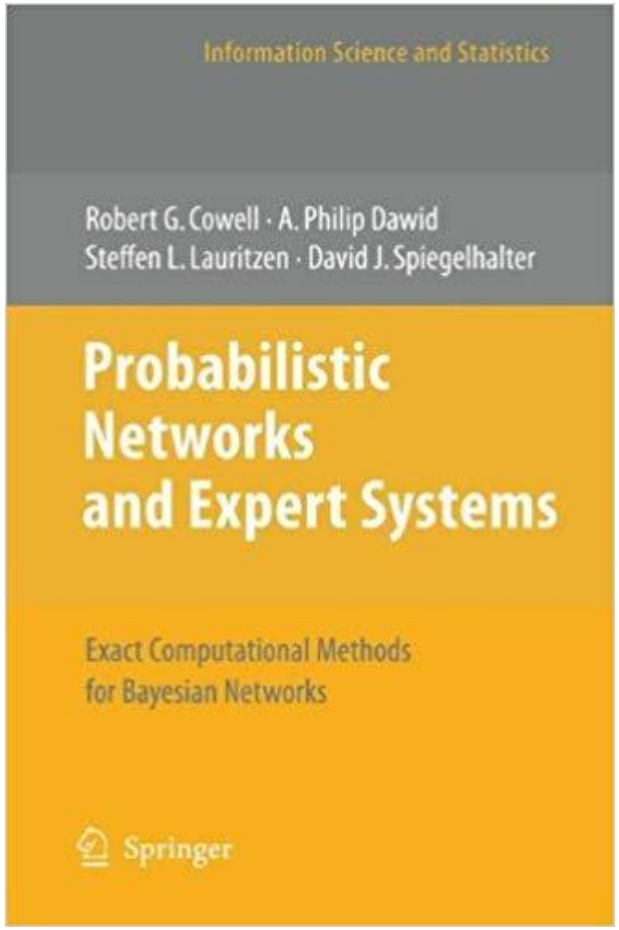
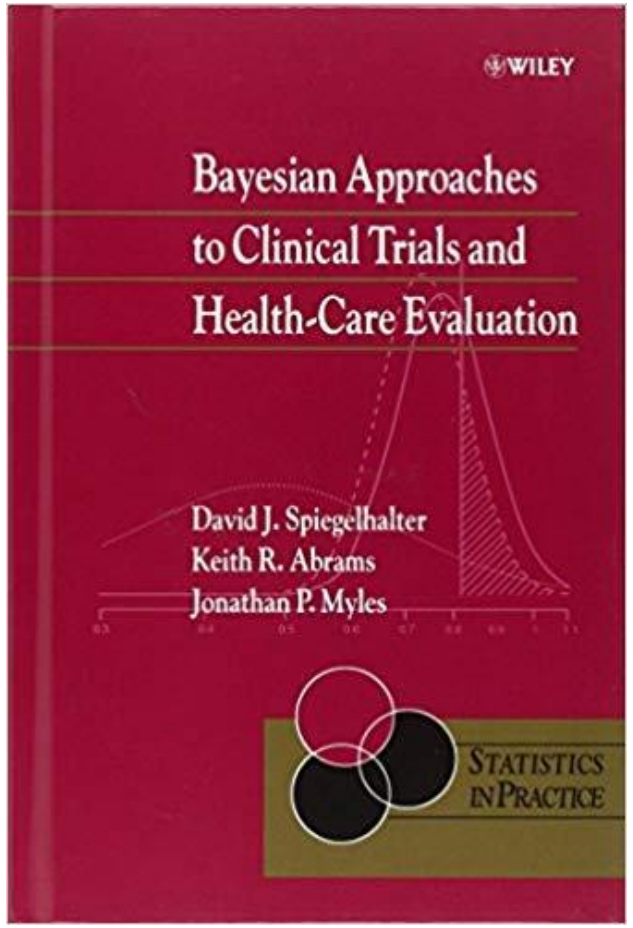
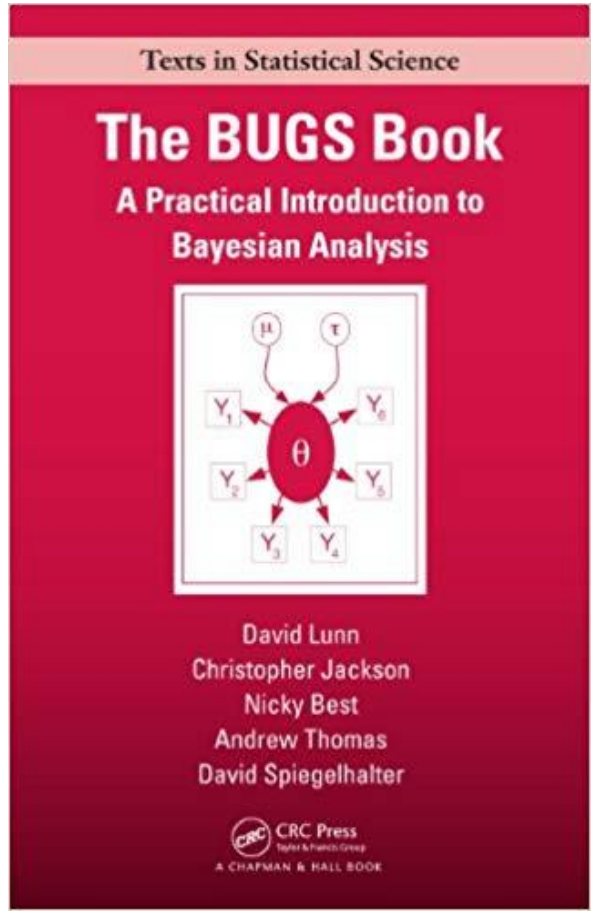
Bank of England, June 26th 2025







I used to do statistical methodology….

until I was philanthropically funded in 2007…..

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FOUR

Climate Change by Numbers

Home Clips

This programme is not currently available on BBC iPlayer

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FOUR

Tails You Win: The Science of Chance

Home Clips

DURATION: 1 HOUR

Smart and witty, jam-packed with augmented-reality graphics and fascinating history, this film, presented by Professor David Spiegelhalter, tries to pin down what chance is and how it works in the real world. For...

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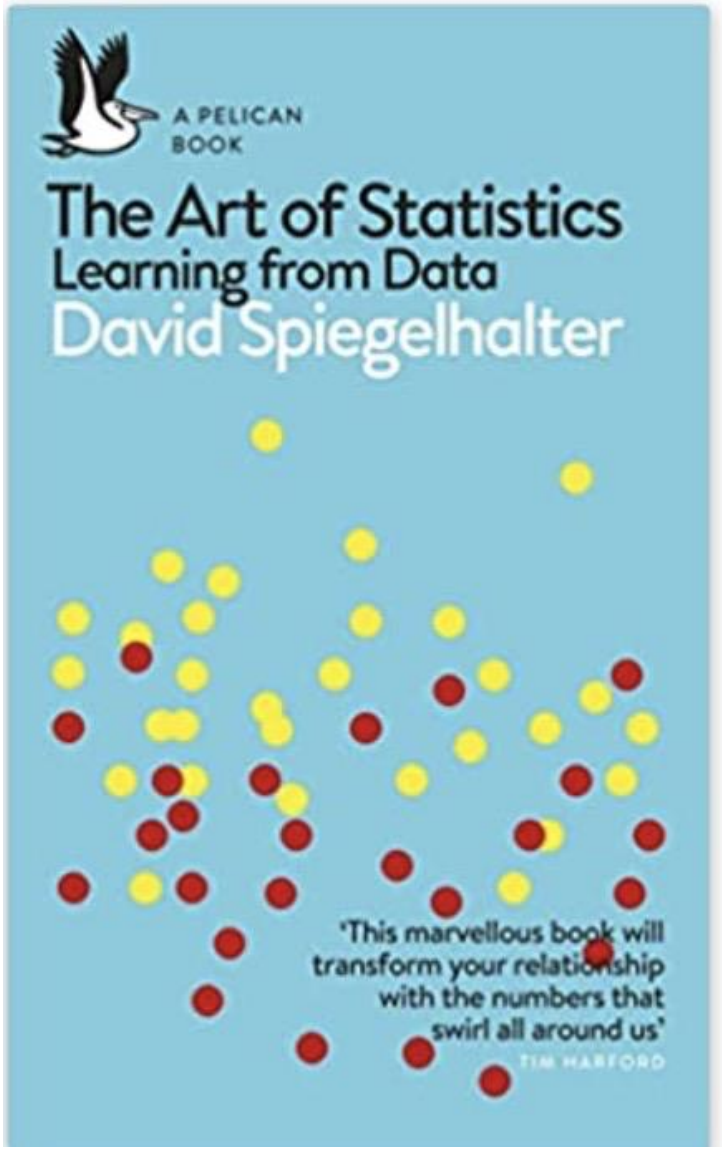
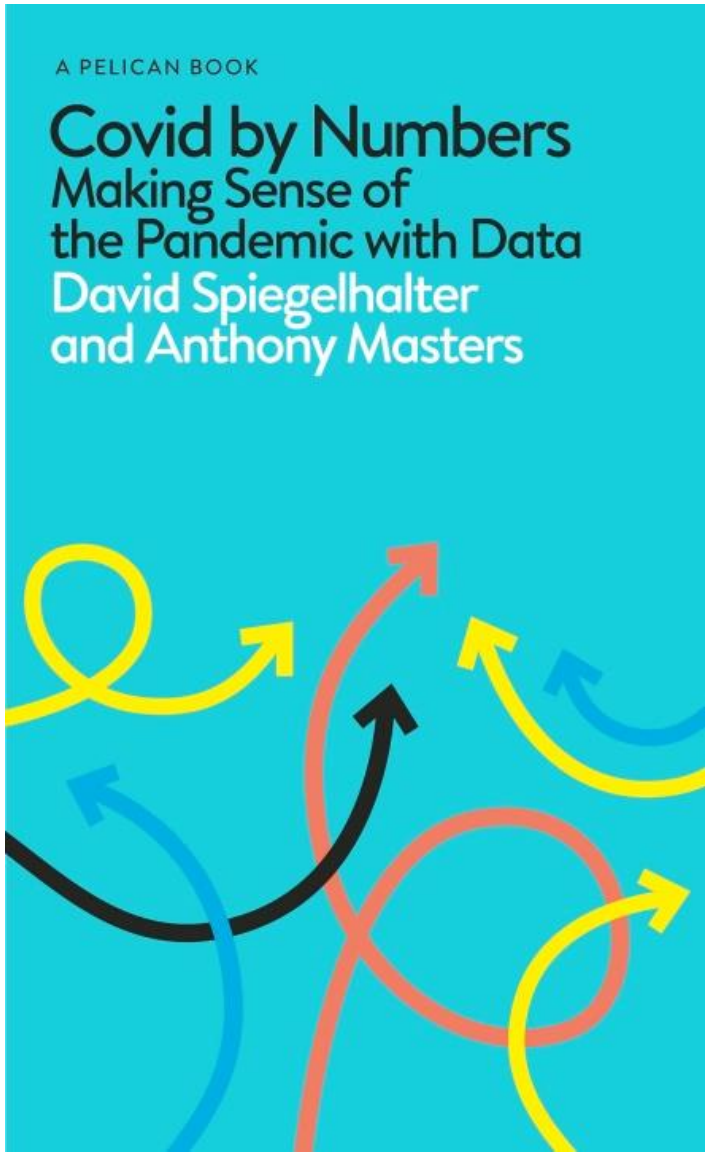
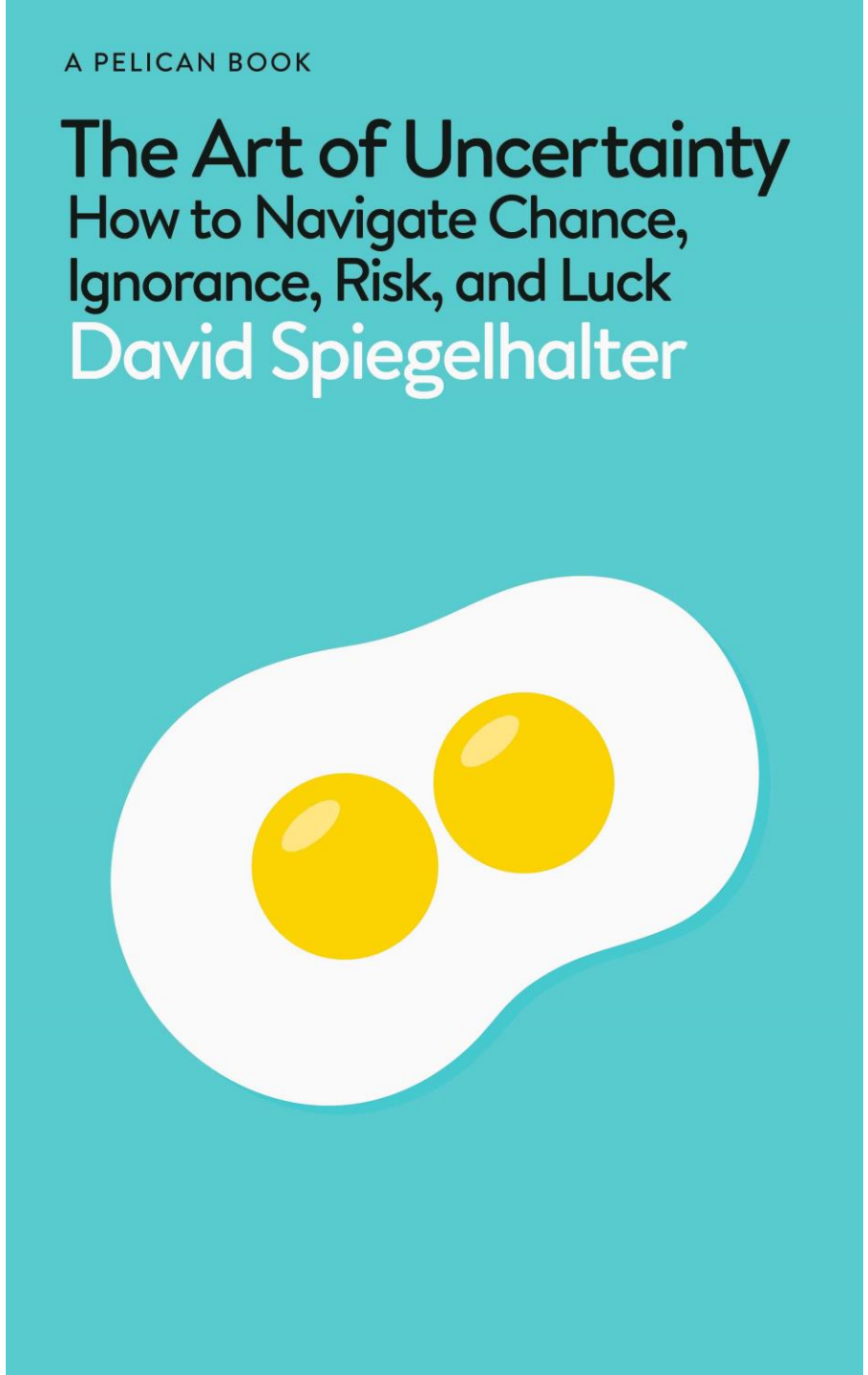

A PELICAN BOOK
The Art of Statistics
Learning from Data
David Spiegelhalter
'This marvellous book will transform your relationship with the numbers that swirl all around us'
TIM HARFORD


A PELICAN BOOK
Covid by Numbers
Making Sense of the Pandemic with Data
David Spiegelhalter and Anthony Masters



A few topics -

Putting your ignorance into numbers
Probability
Surprises and coincidences
Luck
Randomness
Bayes theorem
Scientific uncertainty
Attribution of causes to events
Confidence in models
Predictions
Risk
Deep uncertainty
Communicating uncertainty
Making decisions
The future!

……

What is uncertainty?

- *"The conscious awareness of ignorance"*
- May be ignorant about the future, the present, the past, or why things happened
- It's a *relationship*, with a subject (eg *You*) and an object
- Uncertainty can be
  - *Aleatory* – chance, can't know
  - *Epistemic* – ignorance, don't know
- But any probability is constructed from assumptions and judgements

Bay of Pigs

- 1959; Cuban revolution under Castro

- 1960-1; CIA plan invasion by 1,500 Cuban exiles into the Bay of Pigs

- 1961; President Kennedy is told of plan, and commissions intelligence report by Joint Chiefs of Staff

- 1961; JCS thought chances of success were 30:70, ie 70% chance of failure

Bay of Pigs

- But in the final report that went to Kennedy, the numbers were replaced by the phrase '*a fair chance*' of success, by which they meant 'not very good'

- Kennedy approved the invasion

- It was a fiasco

Putting Uncertainty into Numbers

- Words are easily misunderstood
- Best to – at least roughly - define words
- For UK Intelligence Services, ‘likely’ means 55 - 75% probability

2011: Was Osama bin Laden in the compound at Abbottabad ?

- President Obama heard multiple assessments of the probability that bin Laden was in the compound
- “Some thought that it was only a 30-40% chance”. Others thought that it was as high as 80-90%.
- Long discussion, then Obama said “this is basically 50–50”
- He approved the raid
- Should the intelligence officers have got together beforehand to produce a single joint assessment?

Assessing the quality of a probability

Quantifying your ignorance

- Think whether you prefer (A) or (B) for each question
- Then think of how confident you are with your answer
- Give your confidence a number 5 to 10
- Score yourself when you hear the correct answer

- (answers from Wikipedia)

Your 'confidence' in your answer	5	6	7	8	9	10
Score if you are right	*0*	*9*	*16*	*21*	*24*	*25*
Score if you are wrong	*0*	*-11*	*-24*	*-39*	*-56*	*-75*

1. Which head of state is older? A) President Trump (USA) or B) King Charles III (UK)

   A (born 14th June 1946 vs 14th November 1948)

2. Which was founded first? A) Sveriges Riksbank or B) Bank of England.

   A (1668 vs 1694)

2. Which has the bigger area? A) Hungary or B) Iceland

   B (93 vs 103 000 sq km)

3. Which capital is further North? A) Brussels or B) Kyiv?

   B (50.1 ^{0}N vs 50.5^{0}N)

4. Which is bigger? A) Venus B) Earth

   B (6051 vs 6371 km radius)

Your 'confidence' in your answer	5	6	7	8	9	10
Score if you are right	*0*	*9*	*16*	*21*	*24*	*25*
Score if you are wrong	*0*	*-11*	*-24*	*-39*	*-56*	*-75*

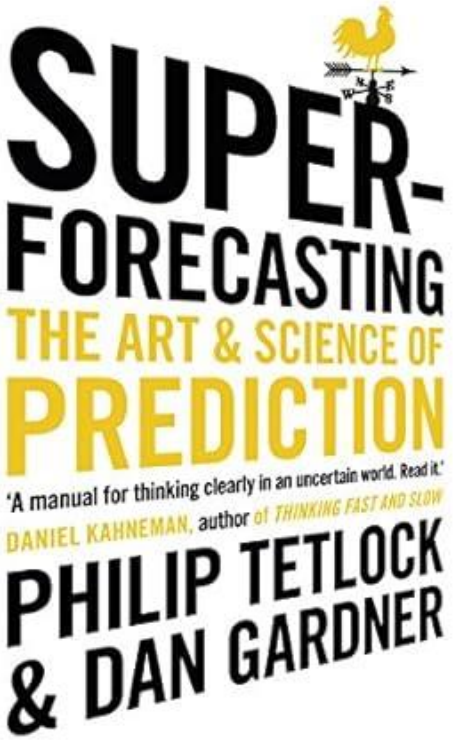
Subtract all scores from the maximum, 25

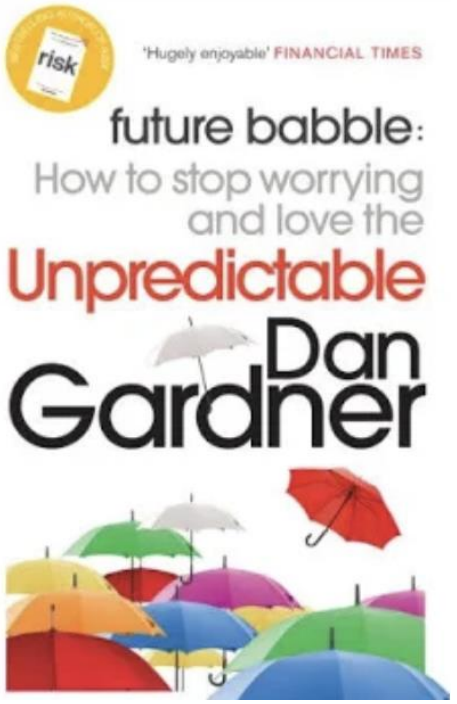
Your 'confidence' in your answer	5	6	7	8	9	10
Score if you are right	*-25*	*-16*	*-9*	*-4*	*-1*	***0***
Score if you are wrong	*-25*	*-36*	*-49*	*-64*	*-81*	*-100*

Squared-error loss Brier (1950)

Super-forecasting

- Questions which will be answered in near future
- Probabilities scored using the Brier squared-error penalty



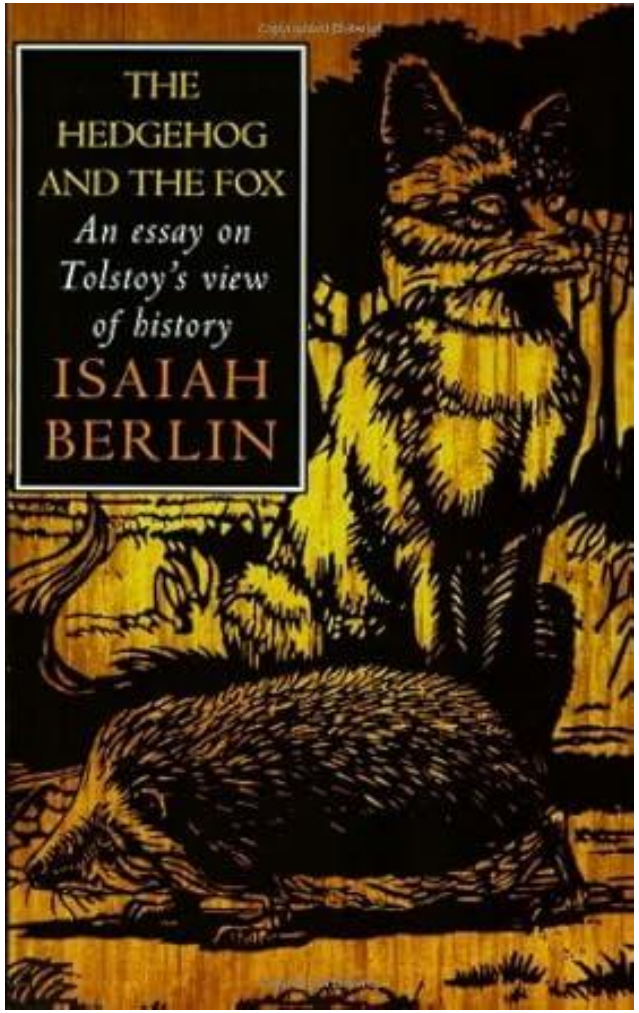


Characteristics of good forecasters:

- *Aggregation*: use multiple sources of information, open to new knowledge and are happy to work in teams.
- *Meta-cognition*: insight into their own thinking and biases
- *Humility*: they have a willingness to acknowledge uncertainty, admit errors and change their minds

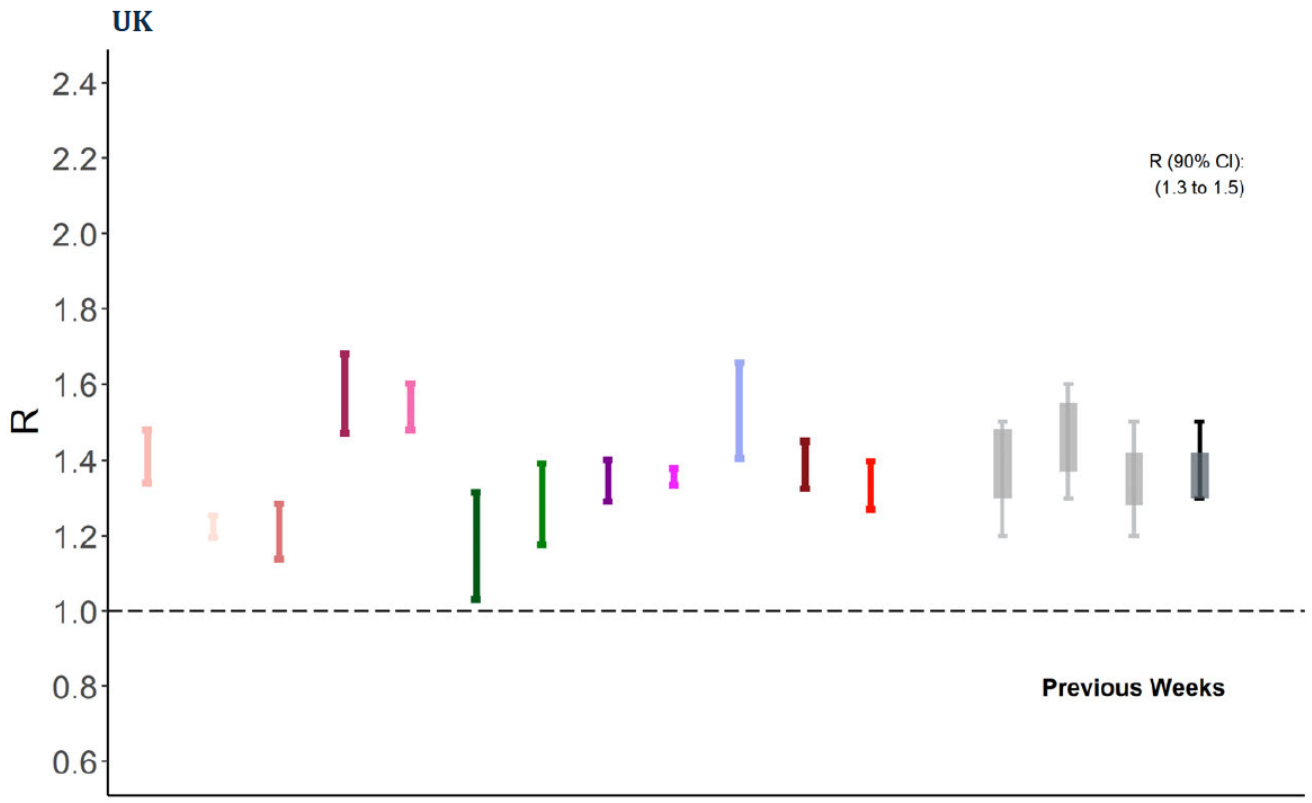
They are *foxes* rather than *hedgehogs*

"The Fox knows many things, but the Hedgehog knows one big thing"



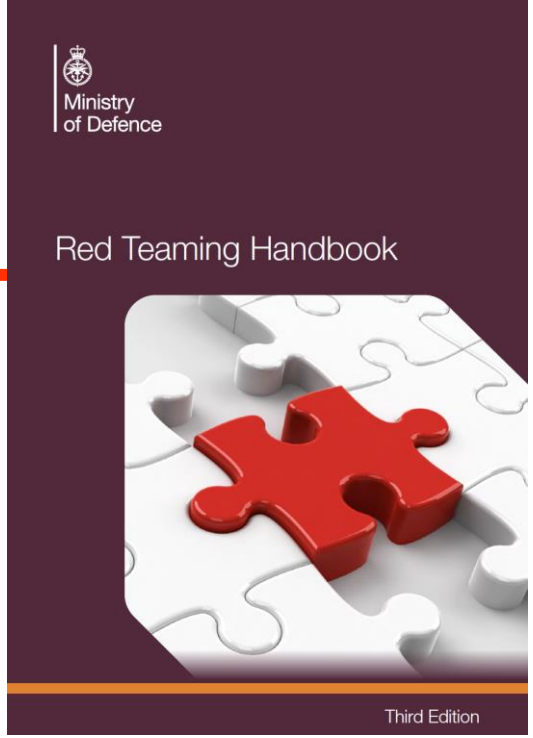
The importance of multiple perspectives

- In the UK pandemic, 8 teams using 12 models to estimate *R* (average number of infections passed on)
- Varying estimates, intervals often not over-lapping
- **All intervals too narrow**, as they assume truth of model
- Teams met and produced a pooled estimate and interval
- Published all the results.



Red Teams

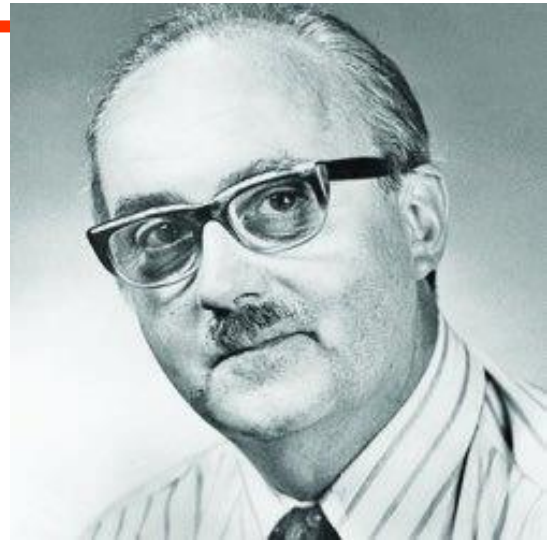
UK Ministry of Defence encourages a ‘red-team’ mindset



The ways red teaming approaches can assist teams and individuals

Aphorisms

- *"All models are wrong - but some are useful"* George Box



Does probability exist?

Probably not – but it is useful to act as if it does.

By David Spiegelhalter

Life is uncertain. None of us know what is going to happen. We know little of what has happened in the past, or is happening now outside our immediate experience. Uncertainty has been called the 'conscious awareness of ignorance'[1] – be started corresponding in the 1650s that any rigorous analysis was made of 'chance' events. Like the release from a pent-up dam, probability has since flooded fields as diverse as finance, astronomy and law – not to mention gambling.

When estimates and intervals are not enough

Allowing analysts to express their confidence in their analysis / evidence

Scales for confidence/quality-of-evidence are established in -

- Intelligence
- Health interventions (GRADE scale)
- Climate modelling (IPCC reports)
- UK Policy analysis (low / low-moderate / moderate / moderate-high / high

Infected Blood Inquiry

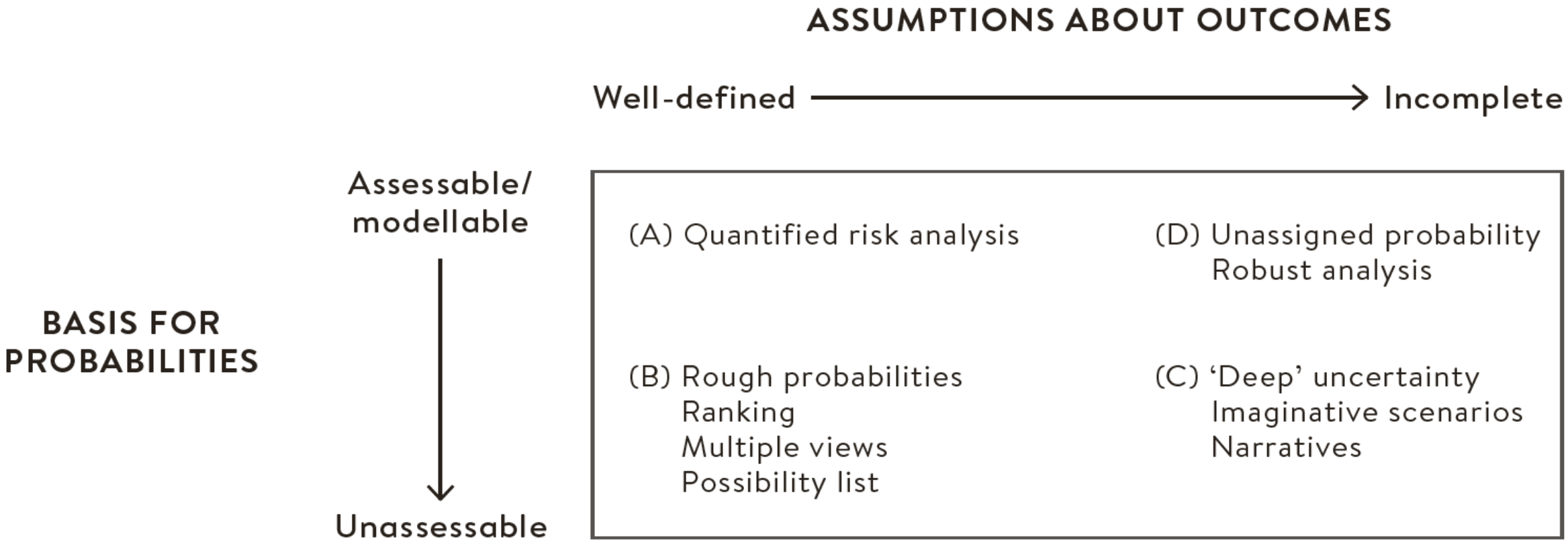
- Investigating infected blood and blood products given between 1970 and 1991 to people with blood disorders and receiving transfusions
- Statistics Expert Group (SEG) asked to estimate infections and attributable deaths

HIV infections: *high confidence*

Hepatitis C : *medium confidence*

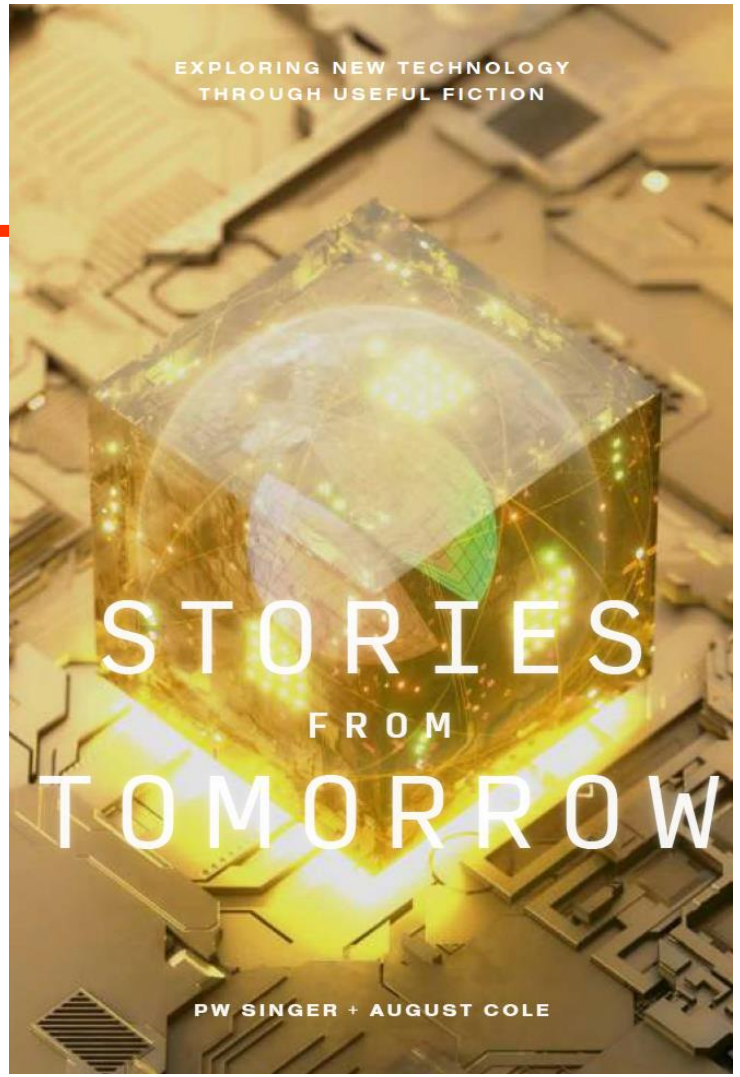
Hepatitis B: *low confidence*

We can’t always put things into numbers…..



Decisions and ‘deep uncertainty’

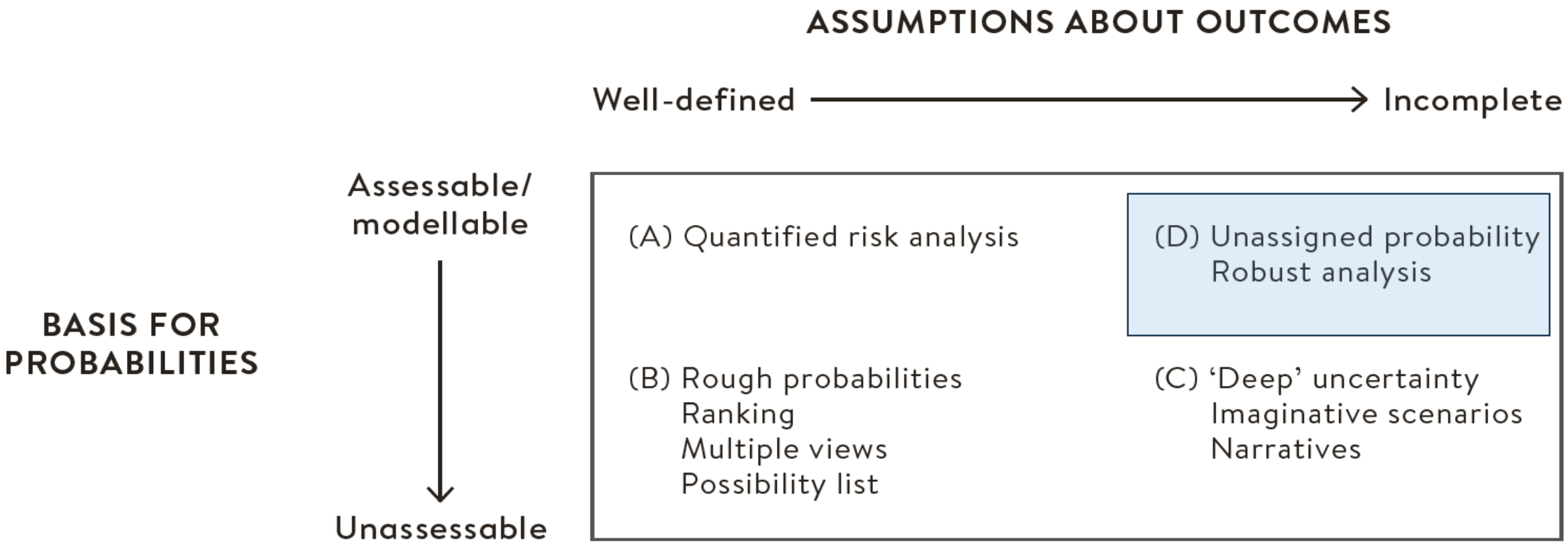
- Not generally feasible to specify all possible outcomes, with their probabilities and their values.
- Donald Rumsfeld’s *unknown unknowns*
- UK Ministry of Defence employ science fiction writers to envisage possible futures.
- With ‘deep uncertainty’, we need humility, making decisions that are resilient to things we may not have thought of.



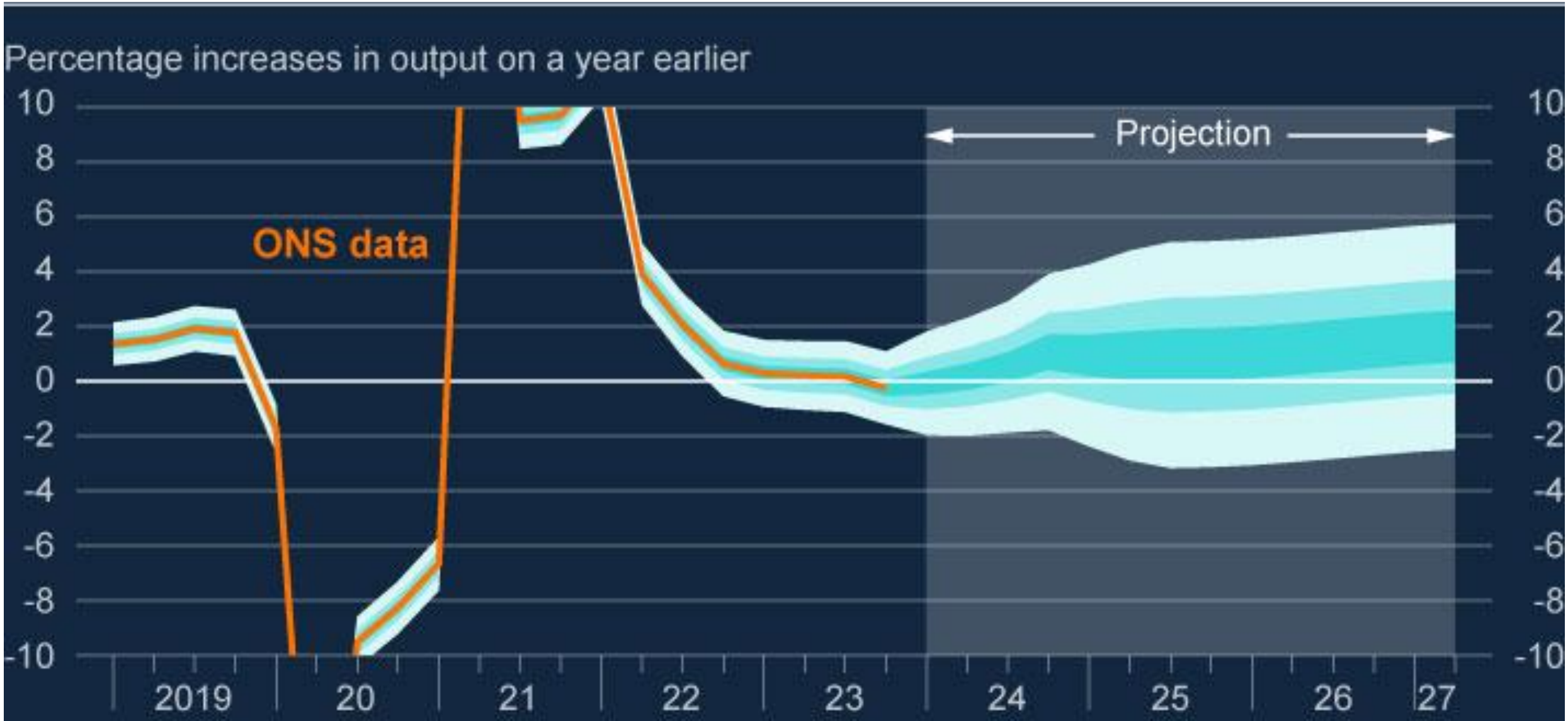
[dstl]
The Science Inside

Ministry of Defence

We can’t always put things into numbers…..



Bank of England Fan Chart: 30%, 60% and 90% bands
Final 10% probability is not assigned – ‘something else’



Communication of risk and uncertainty

- There is no ‘correct’ way to do this
- Need to

  a) Identify multiple audiences
  b) Decide what it is important for each audience to understand
  c) Try different methods and see which works best!

- Need multiple layers
- Words and numbers and graphics
- Over-riding factor: ***trustworthiness***

Professor Onora O'Neill

- Organisations should not be aiming to 'increase trust'

- Rather, they should aim to demonstrate *trustworthiness*

Code of Practice for Statistics

Ensuring official statistics serve the public

Edition 2.0
February 2018

Office for Statistics Regulation

UK Statistics Authority

The pillars and principles of the Code of Practice for Statistics

Trustworthiness

Confidence in the people and organisations that produce statistics and data

T1 Honesty and integrity

People in organisations that release statistics should be truthful, impartial and independent, and meet consistent standards of behaviour that reflect the wider public good.

T2 Independent decision making and leadership

Organisations should assign a Chief Statistician/Head of Profession for Statistics who upholds and advocates the standards of the Code, strives to improve statistics and data for the public good, and challenges their inappropriate use.

T3 Orderly release

Organisations should commit to releasing their statistics in an open and transparent manner that promotes confidence.

T4 Transparent processes and management

Organisations should have effective business processes and appropriate resources to support their statistical functions and be open about their plans, priorities and progress.

T5 Professional capability

People producing statistics should be appropriately skilled, trained and supported in their roles and professional development.

T6 Data governance

Organisations should look after people's information securely and manage data in ways that are consistent with relevant legislation and serve the public good.

Some guidance for trustworthy communication

COMMENT · 18 NOVEMBER 2020

Five rules for evidence communication

Avoid unwarranted certainty, neat narratives and partisan presentation; strive to inform, not persuade.

Michael Blastland, Alexandra L. J. Freeman, Sander van der Linden, Theresa M. Marteau & David Spiegelhalter

Consider what information — in what format — would best support your audiences' decisions. Credit: Matthew Horwood/Getty

1. Inform, not persuade
2. Balance, but not false balance
3. Disclose uncertainties
4. State evidence quality
5. Pre-bunk misinformation

Michael Blastland, Alexandra L. J. Freeman, Sander van der Linden, Theresa M. Marteau & David Spiegelhalter

How does it work? The PROVE[4] framework has been developed and tested by researchers to ensure effective evidence-based communication. It can be used to develop clear, informative messaging using scientific evidence to explain nuance and uncertainty around complex issues. It is not supposed to advocate or persuade, only inform.

- Pre-bunk: anticipate mis- and disinformation through media monitoring and risk assessment and prepare to pre-emptively warn the public
- Reliably Inform: trust is built by informing openly rather than persuading. This means ensuring that information reflects expertise, honesty, and good intentions
- Offer balance: do not skew or ignore evidence, but rather ensure balance in how evidence is presented
- Verify quality: be open about the quality of the underlying evidence so that the credibility of the information is clear
- Explain uncertainty: disclose any uncertainties, gaps and risks with the current evidence

Communicating the potential benefits and harms of the Astra-Zeneca COVID-19 vaccine *(with John Aston and Alex Freeman)*

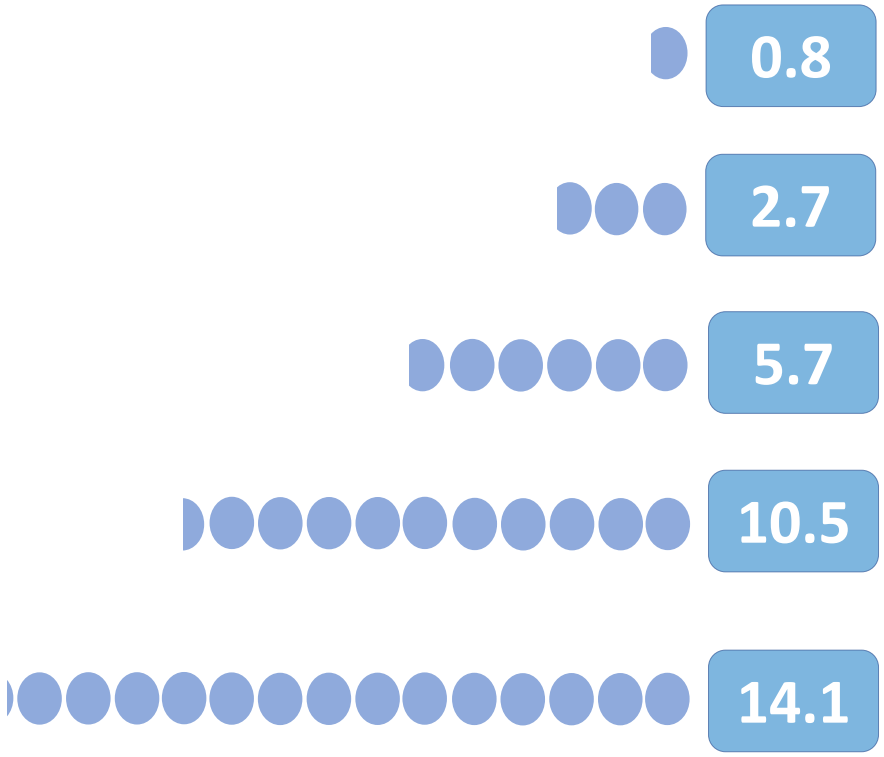
Jonathan Van-Tam, Deputy Chief Medical Officer, at briefing on 7th April announcing that Oxford/ AstraZeneca vaccine was not recommended for under 30s

Weighing up the potential benefits and harms of the Astra-Zeneca COVID-19 vaccine

For 100,000 people with low exposure risk*

Potential benefits

ICU admissions due to COVID-19 prevented **every 16 weeks:**



Age group

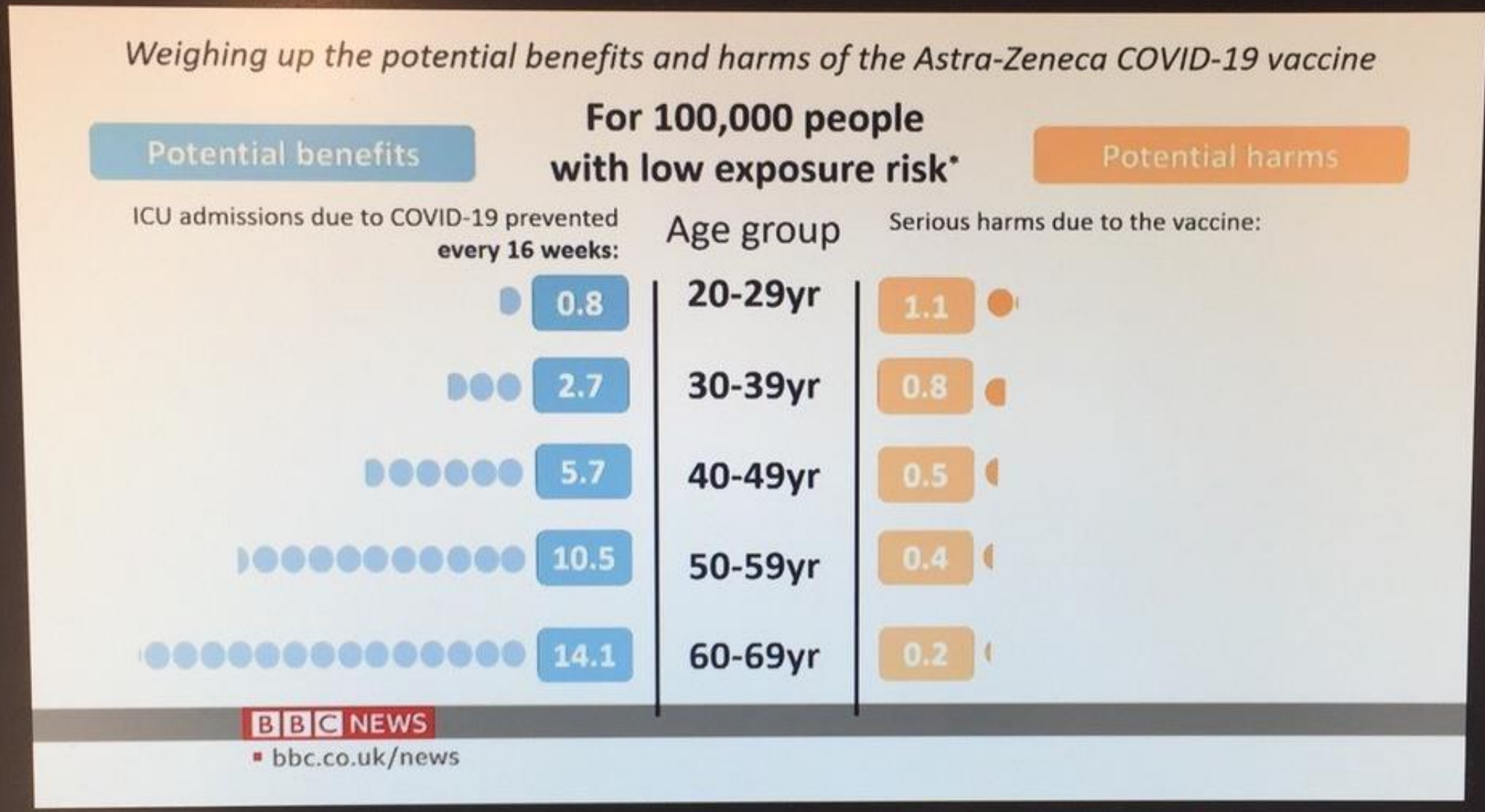
- 20-29yr
- 30-39yr
- 40-49yr
- 50-59yr
- 60-69yr

Potential harms

Serious harms due to the vaccine:

* Based on coronavirus incidence of 2 per 10,000: roughly UK in March

Watch live: Media briefings on AstraZeneca vaccine



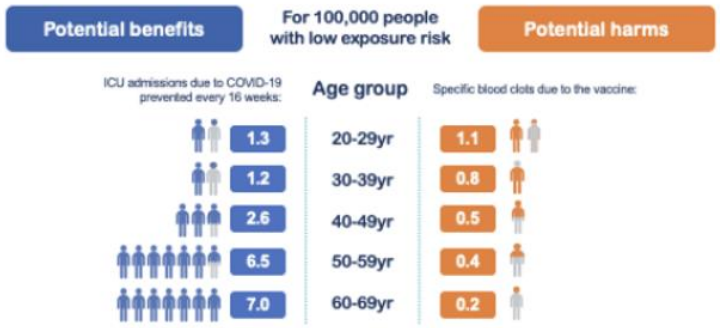
LIVE Regulators making statements on AZ vaccine safety

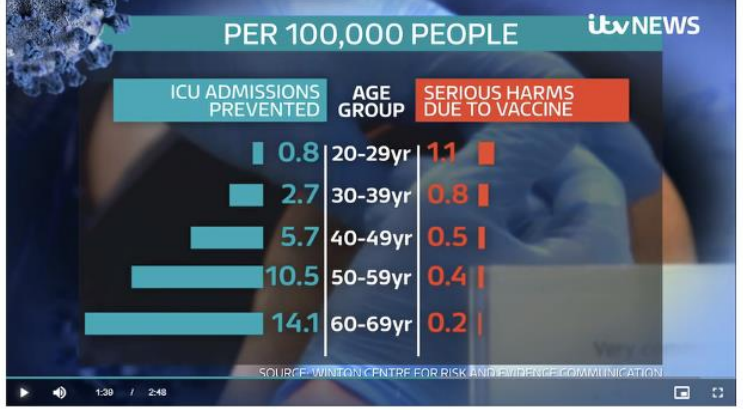
NOW PLAYING Watch live: Media briefings on AstraZeneca vaccine

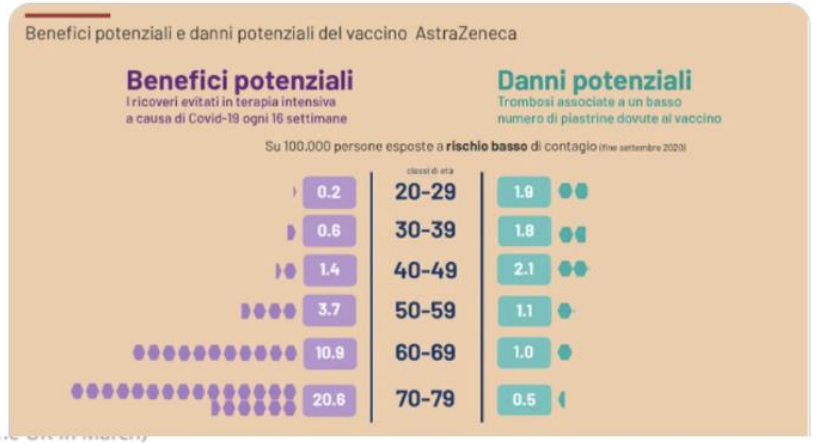
136,285 viewing this page

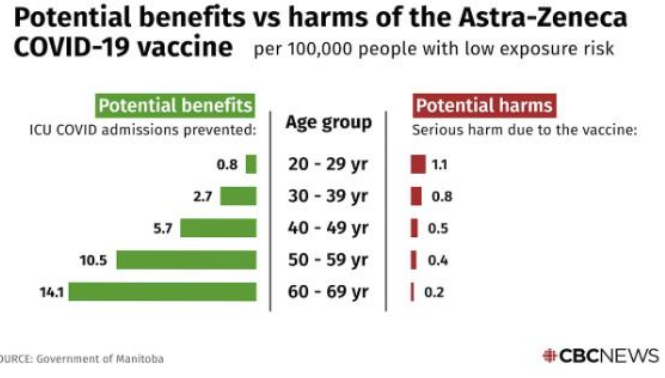
The differences between the

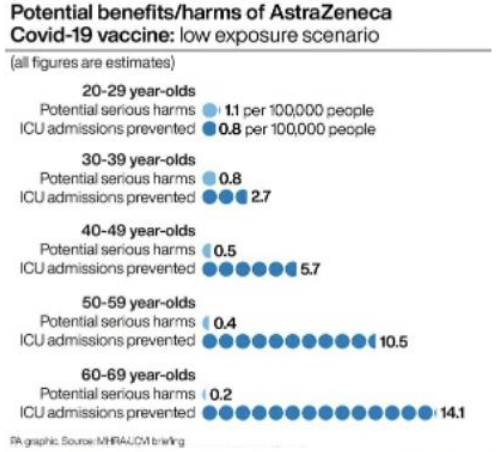
How does a vaccine get

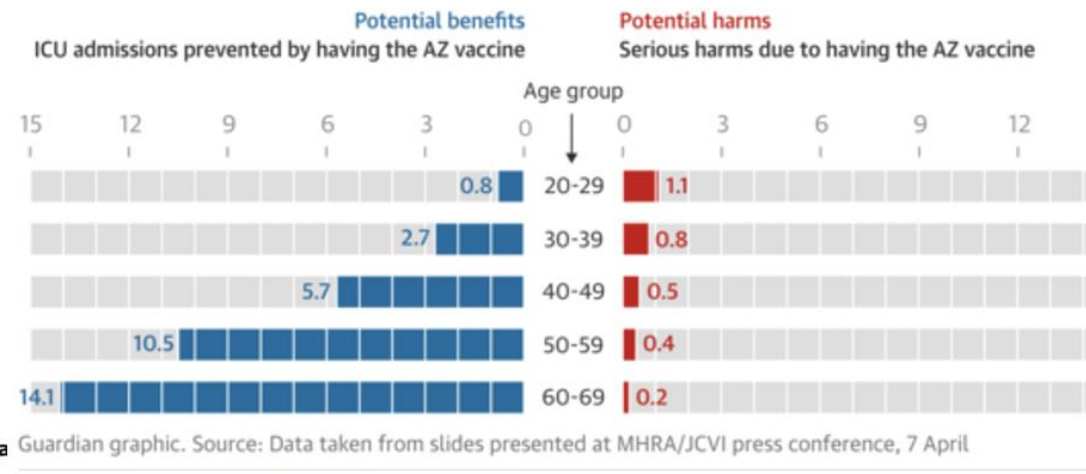




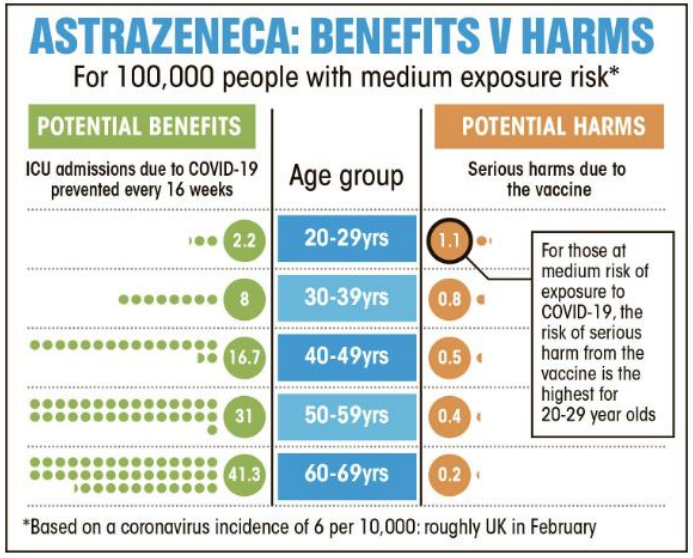






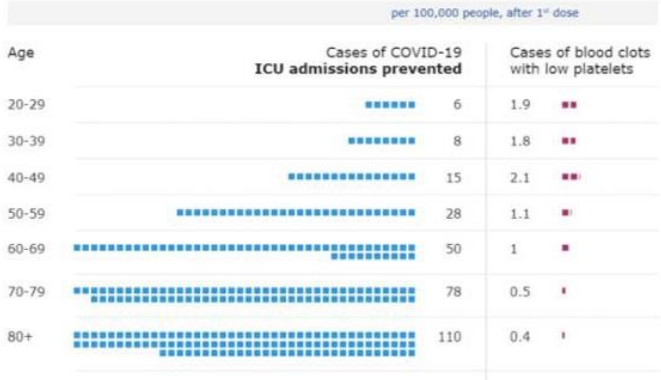


Guardian graphic. Source: Data taken from slides presented at MHRA/JCVI press conference, 7 April

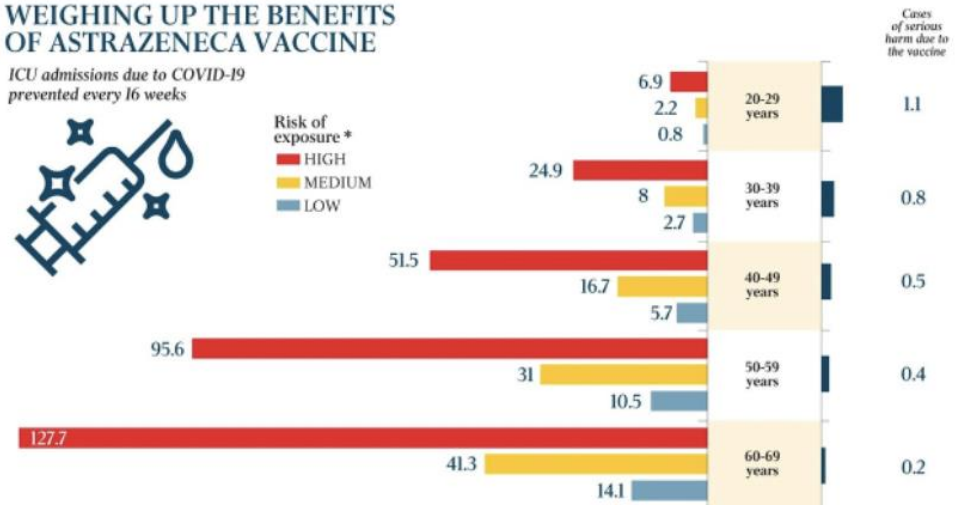


3. COVID-19 ICU admissions prevented with Vaxzevria compared with unusual blood clots with low platelets

High infection rate*



* "High" exposure: using virus circulation for January 2021 (incidence 886/100,000 population)



But will people trust us less if we admit our uncertainty?

The evidence suggests the opposite

PNAS nexus

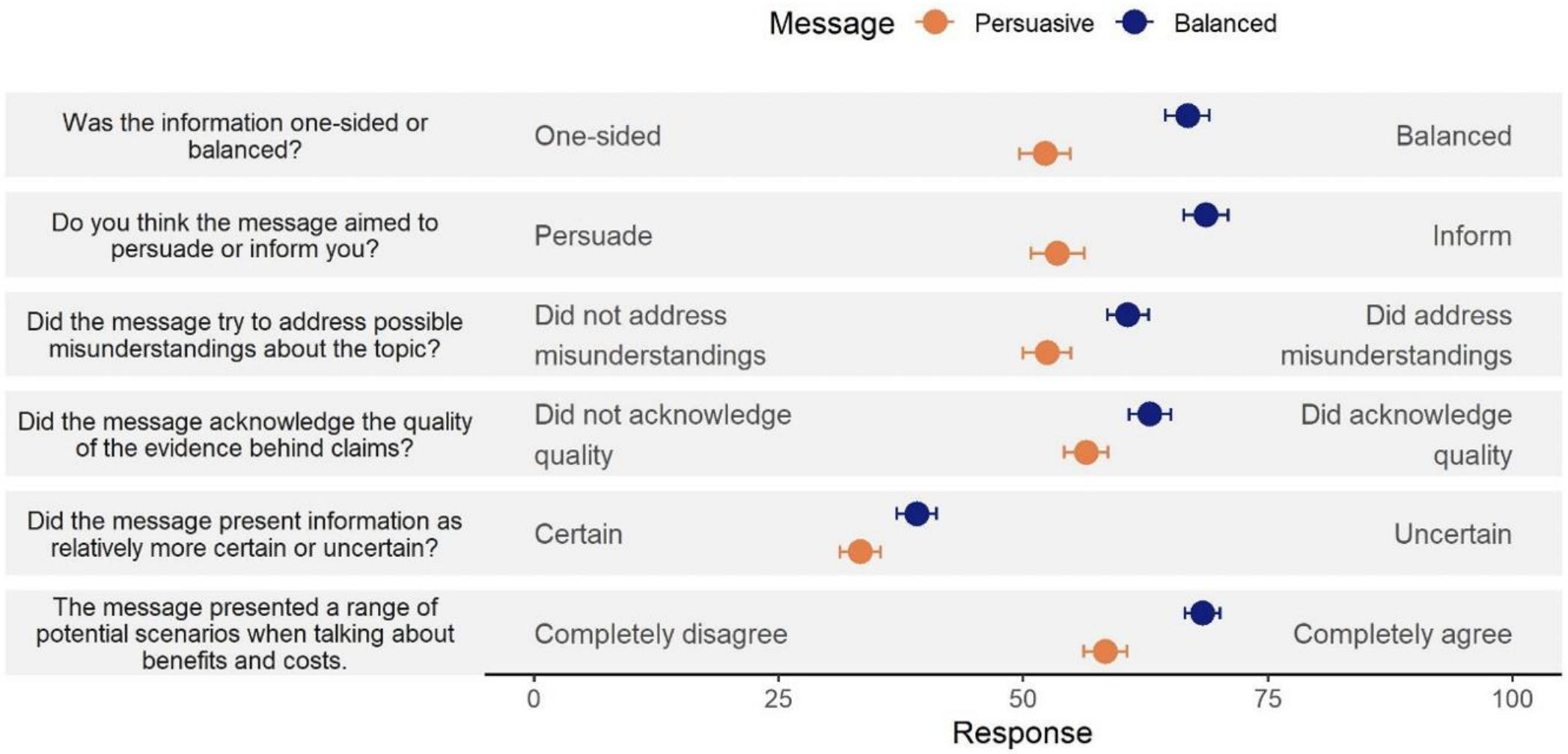
PNAS Nexus, 2022, 1, 1–11
https://doi.org/10.1093/pnasnexus/pgac280
Advance access publication date: 7 December 2022
Research Report

Transparent communication of evidence does not undermine public trust in evidence

John R. Kerr [a,b,*], Claudia R. Schneider [a,b], Alexandra L. J. Freeman [a], Theresa Marteau [c] and Sander van der Linden [b]

[a]Department of Psychology, School of Biological Sciences, University of Cambridge, Downing Street, CB2 3EB Cambridge, UK
[b]Winton Centre for Risk and Evidence Communication, University of Cambridge, Wilberforce Road, CB3 0WA Cambridge, UK
[c]Department of Public Health and Primary Care, University of Cambridge, Worts Causeway, CB1 8RN Cambridge, UK
*To whom correspondence should be addressed: Email: john.kerr@otago.ac.nz
Edited By: Jay Van Bavel

- Participants randomized to see either ‘persuasive’ or ‘balanced’ messages about Covid vaccines and nuclear power.



- Participants correctly identified the key differences in the messages (n=1,034)

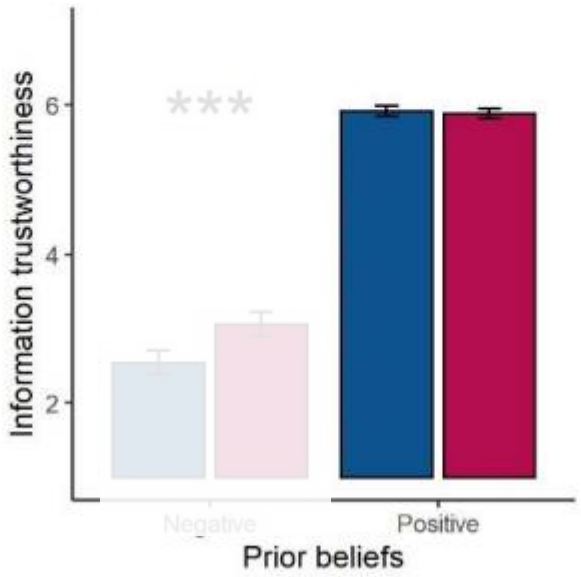
Message

Current

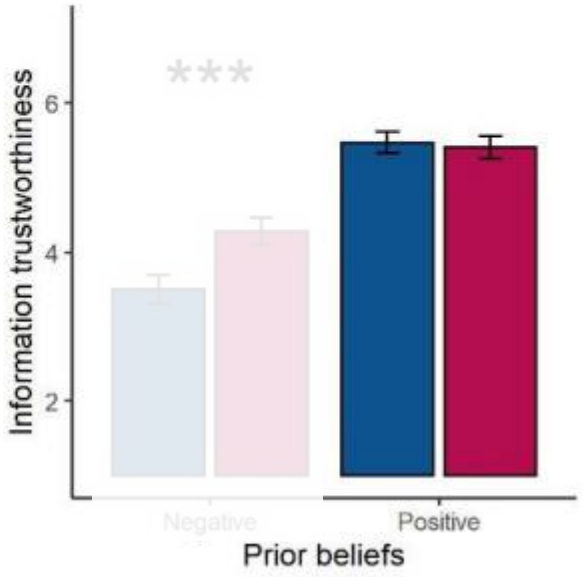
Informing

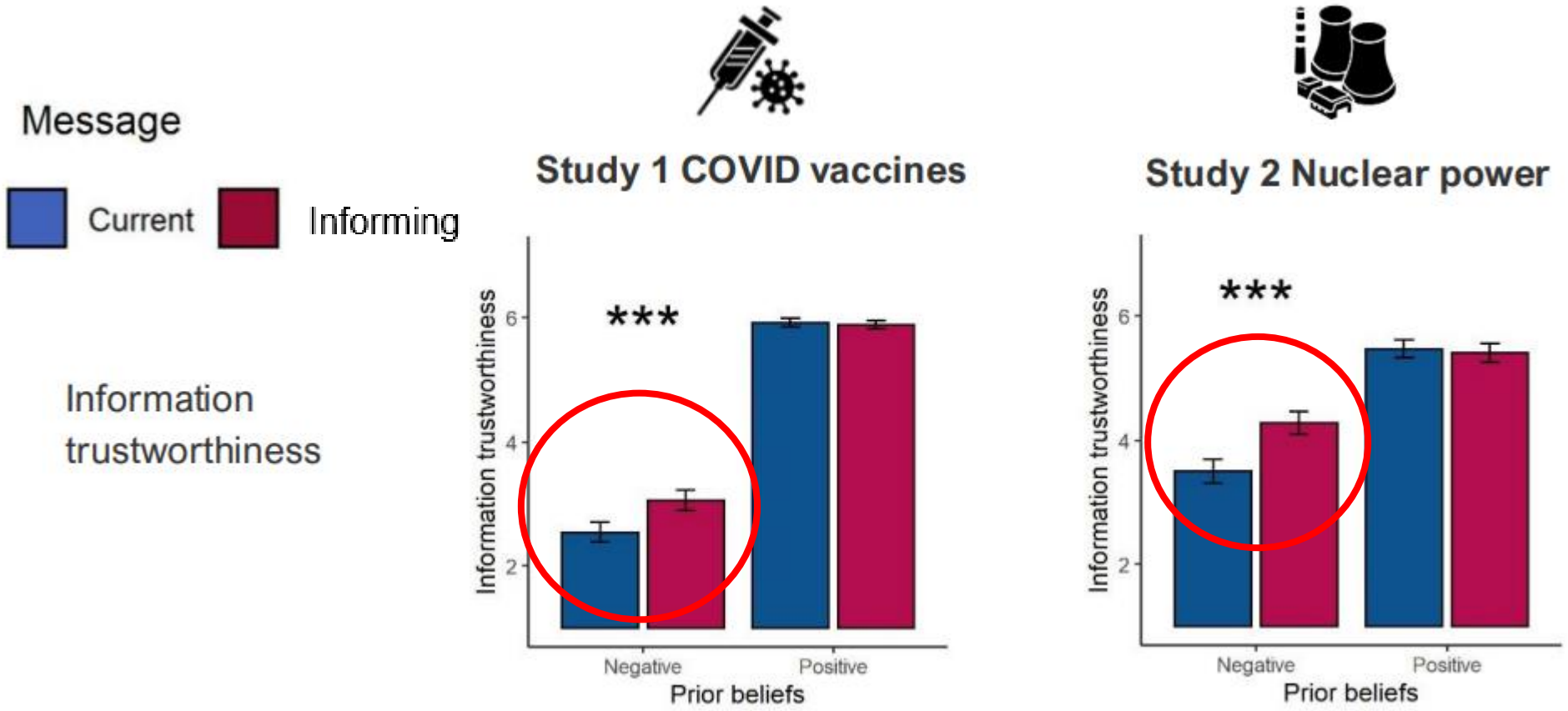
Information trustworthiness

Study 1 COVID vaccines



Study 2 Nuclear power





Balanced, informative communications considered more trustworthy among those with more sceptical views.

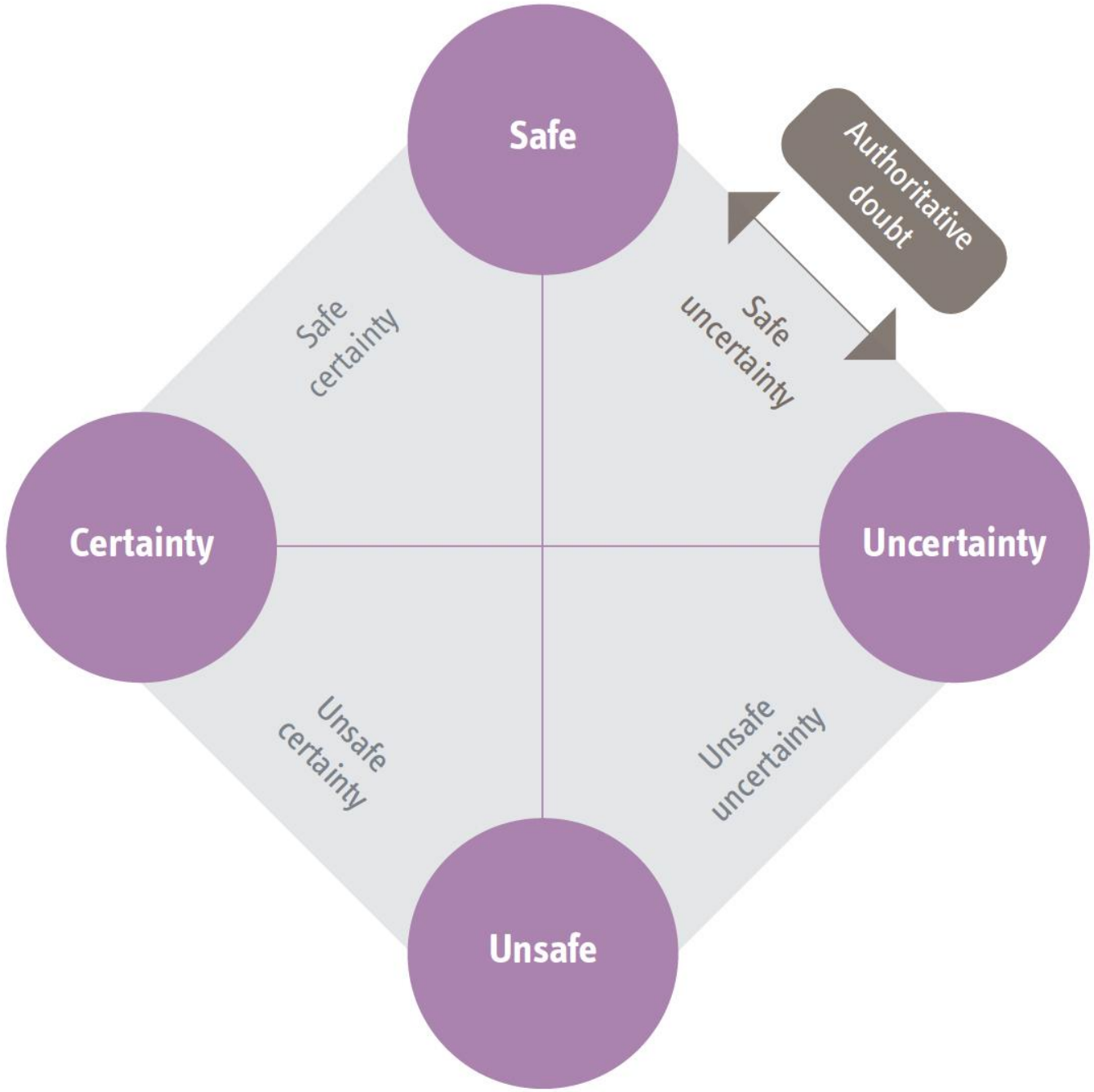
Communication in crises

(Lord) John Krebs (Chair, Food Standards Agency): recommended saying -

1. what we know;
2. what we don’t know;
3. what we are doing to find out;
4. what people can do in the meantime to be on the safe side;
5. *that advice will change*

Safe uncertainty

- Idea developed in family therapy (Mason, 1993)
- People may want to move from *unsafe uncertainty* to *safe certainty,* where the problem is ‘solved’
- But this is impossible, so aim for *safe uncertainty*
- *Authoritative doubt* combines expertise and uncertainty
- Since applied in child protection social work



Conclusions

- Combine (multiple) models and judgement
- Value of multiple perspectives
- Acknowledge limitations – with humility
- Acknowledging uncertainty does not reduce trust in the source (and may even increase it)
- Pre-empt misunderstandings
- Combine numbers/graphics and narratives
- Aim for '*safe uncertainty*'

Probability calculations…

Once I got six double-yolked eggs!

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From The Times

February 2, 2010

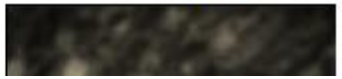
Beat that: double yolks defy one in a trillion odds

All the eggs in the box had double yolks

TIMES RECOMMENDS

- How the Saints preserved New Orleans
- Please God, can I have a daughter next?
- We need a new capitalism to take on China

EUREKA ZONE ››



Egg Council said 1/1000 eggs double-yolked

So chance of 6 eggs = 1/1000 x 1/1000 …

= 1 in 1,000,000,000,000,000,000

What's wrong with this?

How did I get 6 double-yolked eggs?


Double Yolk
Free Range Eggs
hand selected
British
Lion Quality
DISPLAY UNTIL
31 MAR
BEST BEFORE
06 APR
SIX LARGE
EGGS

London

Clarence Court Double Yolk Eggs

£3.80

Waitrose & Partners

Glenrath Double Yolk Eggs Large Box Of 6

£2.00

Tesco

London

Journey's End Stonegate Eggs Large Double Yolk

£2.95

Waitrose & Partners

Good Luck!