What do we mean by uncertainty?

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Scientific/public: In scientific circles, uncertainty is what remains once you have been able to establish what you know or can work out at this point in time. In public life uncertainty usually refers to the broader difficulties of making judgements and decisions, rather than a precise assessment.

Bounded/unbounded: Some scientific uncertainty is bounded - you can identify what you don't know and be pretty certain the answer falls within a range. For example, in elections, we can be certain someone will be elected, we're uncertain which of the candidates it will be. Similarly, an estimate of climate warming is made from the available evidence; then the completeness of that evidence and the range of possibilities are used to give a percentage chance that the estimate is right.
Other kinds of uncertainty are unbounded, because there are too many unknown variables to estimate what will happen or the likelihood of an estimate being right. For example, we can make an economic prediction for 50 years from now, based on the evidence available, but there are so many variables we can't say how much of the prediction is uncertain.

Known/unknown: When we know what information we are missing, the uncertainty is "known" (the election result, the climate estimate, the size of the economy) whether or not it is bounded. This could be because of disputed facts or events yet to happen, or we are missing evidence of what happened in the past. It could also be because there is no reliable way to measure something, e.g. the factors that would determine the weather very precisely.
But we also face 'unknown unknowns' – questions not yet thought of, or information we do not realise is missing. Estimations about healthcare capacity for 2020 made in 2018 had a lot of known uncertainties, but did not account for Covid-19.

Understanding uncertainty

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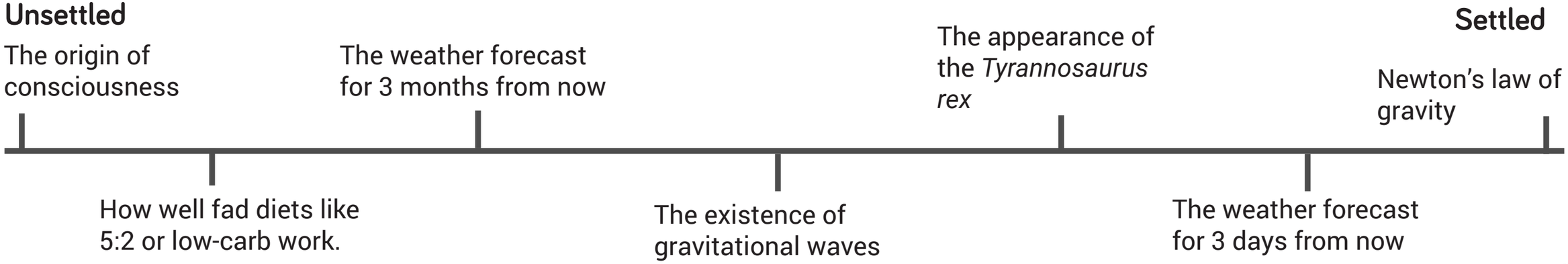
Covid-19 has made us more aware of the uncertainties in science. Acknowledging uncertainty is not a failing; it reminds us that science is based on the best available evidence at the time and must change with new information. What we do have is knowledge that is generally agreed upon, or “settled” and some that isn’t. All our knowledge is somewhere on a spectrum from “settled” to “unsettled”.

Scientists circumnavigate uncertainty by looking for things that are known (evidence) and by quantifying what is knowable vs what is not (with risk calculations and probabilities). Occasionally the conditions of knowing - even laws of physics – have changed because of a strong new insight. This has changed what is knowable, bringing new answers and casting doubt on others, but in settled knowledge it is very rare.

Understanding this difference between settled and unsettled knowledge is important for knowing how to judge new evidence. Claims that challenge settled knowledge need stronger evidence than those on unsettled knowledge. This is intuitive: we know that the evidence would have to be very strong to convince us that every disease spreads mainly in the air, but much less so to convince us that this is how SARS-CoV-2 spreads.



Managing Uncertainty

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In order to be able to make decisions based on scientific evidence we need to be able to judge what levels of uncertainty exist. By understanding this we can manage risk and make decisions accordingly, which we do every day - do we take an umbrella, do we cross the road right now, do we buy insurance?

Is it safe for children to go to school?

Clearly define the question

The more specific the question, the more precisely the certainty can be calculated. Don't ask "Are children safe at school?". Ask "How likely are children to transmit Covid-19 between households at school?"

Identify and assess the uncertainties

Work out what we don't know (Can masks stop children transmitting? How many children have Covid-19 asymptomatically? Can children give it to teachers?) and how significant that is.

Consider the weight you want to put on the evidence

Trying to get to a place of maximum certainty may not be worth the time if other factors will carry more weight. For example, even if we know that opening schools is risky, will the educational and emotional needs of the pupils outweigh it?

Make the decision

In some cases, it may be necessary to to wait until the information is more certain. However often more certainty won't be possible or wouldn't make the decision less complicated. In this case, it's important to look at how much more certainty will be possible and whether the decision will really be less complicated. It could be that uncertainty in public life, or lack of leadership in the decision are being confused with scientific uncertainty.

We asked a range of experts what they would want people reporting the uncertainty in predictions and research results to understand better. These were the most common three responses:

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1. Uncertainty is scientific – it doesn't need to be apologised for
2. Science doesn't eliminate uncertainty, it quantifies it.
3. Question if the uncertainty actually matters.