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Communication of Uncertainty: The Concept of Probability in Government Press-Conferences during the Early Covid-19 Crisis in Denmark

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Abstract: This article focuses on the Danish Prime ministry's press conferences during the first 3 months of the Covid-19 crisis in 2020 when stakes were high, and reliable information practically non-existent. It analyses various uses of the concept of probability in political communication focusing on aleatory and epistemic concepts of probability, i.e. its 'dual nature'. The question is whether and how different uses of the concept of probability can be identified in press conferences and how the uncertainty of the situation was communicated to the public. The analysis identifies how a space for decision-making can be extended and limited through the application of various probability concepts.

Keywords: Covid-19; epistemology; political communication; press conferences; probability; uncertainty

The intricate interplay of knowledge and authority shows clearly during times of crisis when the demand for reliable information and – correspondingly – authoritative decision-making is high. That was characteristic of the early phase of the Covid-19 pandemic when reliable information about the new variation of the virus was practically non-existent and the public's demand for prudent crisis management was at its highest. In the beginning, not much – if anything – was known about the Covid-19 variant. Experts on virology and epidemiology were soon interviewed by reporters, who on behalf of a frightened public urged the experts to provide speculative answers to the threat (Blom et al. 2021).

The problem for the authorities in the early days of the crisis was that the available knowledge was of formerly known variants of the virus, and not the new variety, Covid-19. On the one hand, if the new variant is not comparable to anything that has ever been seen before, then administrative and government decisions about

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restrictions, lockdown, reopening, etc. are not based on reliable information and, therefore, may seem arbitrary. On the other hand, if the new variant is somewhat comparable to previous coronaviruses, then it makes sense to base strategic and administrative decisions on previously observed consequences, i.e. to learn from history. Inspired by studies of uncertainty and political communication (Ongaro 2021; Zhou, Liu and Yang 2024), and by Blom et al.'s idea about studying interaction between journalists and experts in the early phase of the Covid-19 crisis in Denmark, this article focuses on how administrative authorities communicated the premise of uncertainty to the public through the Danish Prime ministry's press conferences in the early phase of the Covid-19 crisis in 2020 (March 6 to May 29, 2020).[1]

Transcriptions of the Danish government's press conferences during the early phase of the Covid-19 lockdown will be analysed with a focus on the various *uses* of the concept of probability. It is, therefore, an epistemological analysis of the communication of probability and decision-making under uncertain conditions. The inspiration for such an approach is found in the history and philosophy of science, particularly among those authors, who have inquired into the concept of probability such as Ian Hacking's *The Emergence of Probability* (2006[1975]), as well as classic and contemporary philosophy of probability (Carnap 1945; Rowbottom 2015; Suàrez 2020). The question that this article poses has less to do with the craft of statistics and more with the concept of probability in public discourse. It concerns the problems of inference, or whether and to what extent we may dare to learn from experience.

1 The Dual Nature of Probability and the Problem of Inference

Most processes in life and in nature over the long run generally seem to occur with relative stable frequencies, which lead us to expect that some outcomes are more likely to occur than others. Historically within the life sciences the unstable and irregular, yet relatively predictable, character of living organisms and processes has been debated and captured by the concept of the norm and the normal (Canguilhem 1943[1966/1998]). In probability theory, processes are considered random if they have an unpredictable outcome. It raises the question whether and how it is possible to make reliable predictions about the future, in this case concerning impacts of a virus. Depending on how the concept of probability is understood, there are two answers to this question, which have to do with 'the dual nature of probability', i.e. aleatory

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('stochastic laws of chance processes') and epistemic probability ('assessment of reasonable degrees of belief'), respectively (Hacking 2006[1975], 12; Radner 2000).

1.1 Aleatory Probability

Aleatory theories of probability conceptualise the inherent variable or coincidental character of events that depend on the physical properties of the world, such as for example the factors that determine the spread of a virus. They concern the tendency for certain events to occur with relative stable frequencies over time. The *frequency* view of probability, a variety of the aleatory view of probability, holds that probabilities must be understood as properties of groups, sets or empirical collectives (Rowbottom 2015, 93–95), which means that a single individual taken in isolation (such as a coin) does not have any chances or probabilities (for landing heads or tails). Only groups or classes of individuals can have probabilities, i.e. the observed frequency of heads relative to the total long run number of throws. Probability is, in other words, an empirical phenomenon depending on the calculated ratio of a particular occurrence within a sample, such as the number of hospitalised individuals in a population of individuals infected with Covid-19 virus and can only be analysed statistically and determined experimentally. The extent to which we can meaningfully speak of the probability of getting a '1' with the roll of a die is based on the implicit assumption that we speak of a collective of die rolls. Probabilities are, therefore, defined relative to the properties of the finite empirical collectives that may change over time. The frequency interpretation reflects the view that although we can observe relative stable frequencies (patterns such as normal distributions) of series of events, these events occur randomly, and we can only speak meaningfully about probabilities based on the calculation of the frequency of a sufficiently large number of observations (finite frequentism). Otherwise, it is guesswork.

The problem, however, has to do with the inferences that either can or cannot be made from one collective of events to another, which rests on the assumption of similarity. Ideally, statisticians adhering to the frequency view do not try to prove something to be the case, but rather try to calculate the degree to which an observed regularity could be coincidental. It is precisely the contingent character of the empirical world that leads them to be cautious about proofs, and rather to speak of degrees of probability by which they mean the degree of uncertainty. They try to challenge our immediate inclination to make inferences from the patterns observed by analysing the degree of probability (understood as uncertainty) that an inference holds. It automatically raises the question of how many tests are enough to establish the probability value of an outcome under such-and-such conditions. Probabilities must, therefore, be *discovered* empirically. The goal is to minimise the uncertainty so

that empirically calculated frequencies can render an outcome probable *relative to the body of evidence*. However, in cases of new viruses, we neither know the probability space nor the frequencies in advance, and no probability value can, therefore, be calculated.

Due to the above-described problem, the frequency view of probability is often supplemented by the *propensity* view of probability, which attributes probability – not to the frequencies themselves, but to the underlying state of the world that produces those stable, relative frequencies (Rowbottom 2015, 113). Where the frequency theory abstains from explaining *why* some collective appearances occur with relative stable frequencies, the propensity theory rather addresses the mechanisms or dispositions of the world that produce those kinds of regularities (for example, it could be the nature of viruses that they behave in certain ways). It provides a framework or model for interpreting those coincidental but relatively stable frequencies, but also carries with it a risk of speculation, which is exactly what the frequency theory wanted to avoid with its insistence on empirical observations.

1.2 Epistemic Probability

Epistemic theories of probability designate the degree of uncertainty with which a connection between two events can be justified and are, therefore, epistemological in the sense that they concern the degree of belief or reasonable expectations that one event will follow another. They concern the relation between a hypothesis and the available, relevant information that supports it (such as for example the behaviour of previous variants of the virus). Probability is, therefore, an analytical rather than empirical concept. One of the epistemic theories of probability is the *logical* view, developed by Rudolph Carnap and John M. Keynes, which considers probability as a proposition being conditioned on something else, i.e. the logic of probable inference (Carnap 1945; Suàrez 2020, 9). The logical theory is based on the 'principle of indifference' (i.e. avoiding bias), which asserts that equal probabilities should be assigned to alternatives for which no reason is known to be different (Carnap 1945; Hacking 2006[1975], 122). According to this view, probability involves thinking about alternative scenarios, other possible futures (possible worlds), and is a question of whether and how the truth of a proposition is entailed or supported by the available information (i.e. 'justified'). Even if we still lack systematically gathered data, and still haven't calculated any frequencies of infection rates, it still makes sense to suggest that people *probably* have better chances of avoiding contamination if they remember to wash their hands and keep a distance to each other, compared to a situation in which they do not. But we cannot say *how much* better the chances are. We can, therefore, reasonably speak of degrees of probability even if data are limited

or even non-existent – only it is not an empirical calculation but a logical assessment. It regards the probability (in the sense of reasonable expectations) we can have concerning possible future events, and it even makes sense to apply the concept to unique situations that have not yet occurred with any kind of frequency (because it is analytical and not empirical, i.e. 'possible to imagine'). The extent to which a decision can be said to be reasonable depends on the assessment of the information that points in one rather than another direction, i.e. the ability to 'read' the signs (Hacking 2006[1975], 43).

The problem with the logical view, however, is that it is not clear how probabilities are to be measured (Rowbottom 2015, 29). And even if reason constrains, we often need more solid, empirical grounds for making decisions. Therefore, the *subjective* theory of probability instead identifies probability with the degree of belief that a person may reasonably have in the plausibility of a future outcome, which, therefore, differs between individuals. The subjective interpretation was developed by Ramsey, de Finetti and Savage (Radner 2000; Suàrez 2020, 9), who identified probability with individual or aggregated betting quotients that are assigned to positive results of an event. There is no objective value, only subjective or group-level assessments. The theory thereby operationalises probability as subjective or group-level beliefs (i.e. betting quotients), and the strength of the theory is that subjective or intersubjective beliefs can be assigned a quantitative (although not objective) value. The problem with the subjective view, however, is that there is no 'objective' probability, only a sum or an average of subjective or intersubjective betting quotients or utility functions. In other words, what counts as evidence for a claim is subjective or intersubjective. However, there might be strategic reasons – or group level pressure such as tradition or collective pressure – for assigning different odds to the outcome of an event. For example, if someone begins to hoard toilet paper during the Covid-19 lockdown, even if that person does not really believe that the local supermarket will run out – just in case the neighbour thinks otherwise. Therefore, the intersubjective perspective appears as an independent aspect of epistemic probability theory because group level beliefs are more resistant to changes than individual beliefs (Rowbottom 2015, 81–82). Tradition or dogmas, or mass phenomena such as panic or hope, generally play a substantial role in defining people's collective beliefs (and often overrule personal beliefs), which was also the case during the Covid-19 situation (Cicerale, Blanzieri and Sacco 2022; Hayakawa and Marian 2023).

1.3 Learning about Probabilities

The *objective Bayesian* view of probability shares the point of view with the subjective and intersubjective positions that probabilities are rational degrees of belief

but disagrees what it takes for a degree of belief to be rational (Rowbottom 2015, 61–62). The theory views rationality as a process by which people's degrees of belief in one outcome rather than another, i.e. the conditional relation between two statements, will converge over time, as more and more information become available. As more and more people are tested for Covid-19, it becomes possible to calibrate or update probability expectations. The Bayesian position, therefore, sheds light on how probability assessments change over time, i.e. what is reasonable to believe at various points in time. The rationality in question has to do with our learning process rather than the possibility of assigning a quantitative value to a betting quotient or to calculate the frequencies of a data set. It is a processual view of rationality that identifies rationality with the ability to update or change expectations as new information emerges. The objective Bayesian view of probability is rational, not because it is non-subjective but because it promises to continually reassess or calibrate the (subjective) belief in the likeliness of future outcomes based on analyses of the incoming empirical stream of information or data. The problem with the Bayesian position is that it does not take model uncertainty and evaluative uncertainty into account, since there is no unique way to model a decision problem, nor to evaluate the possible consequences (Ongaro 2021). And two different prior conditions can continue to yield different outcomes, even in the long run. It is, therefore, necessary to constantly return to the prior conditions built into the model, i.e. using the outcomes of a test to re-evaluate the assessments on which the model was built.

2 Probability Concepts in Political Communication

2.1 Case Selection

The Nordic countries are generally known to have a state-oriented risk culture, which means that people place their trust in public expertise and authorities to have an emergency plan (Johansson et al. 2023) and are known to uphold a considerable degree of trust in their governments and institutions. As a part of the Nordic countries, Denmark is traditionally depicted as a small, open and democratic society with an administrative tradition conventionally characterised as transparent, accessible, and based on a culture of rule-of-law (Sandberg 2023) and, therefore, makes an interesting case for studying uncertainty in political communication with the public. Several studies focusing on the political and administrative communication of mitigation strategies and collective protection measures have found that responsibilities and managerial competences were framed differently across the Scandinavian countries (Nord and Gardell 2023; Rasmussen, Ihlen and Kjeldsen 2023).

2.2 Materials: The Danish Prime Ministry's Press Conferences

Seven press conferences held by the Danish Prime Ministry will be analysed: From March 6, 2020, when the first patient with Covid-19 had been confirmed in Denmark, to May 29, 2020, when the borders were reopened, and all pupils were back in school. The press conferences (March 6, 10, 11, April 6, 14, and May 12, 29) were recorded, transcribed and subsequently posted on the Danish prime ministry's web page (downloaded March 1, 2023).[2] The citations were subsequently translated to English by the author.

The press conferences held in especially the beginning of the Covid-19 crisis were rare occasions for the government and administrative authorities to speak almost directly to an unusually large proportion of the public. The prime minister participated in all the press conferences and initially took the word. The minister of Health also participated in all the press conferences, except one. Other ministers participated, when necessary (Ministers of Justice, Internal Affairs, Foreign Affairs), as did representatives from relevant administrative authorities (the Head of the Health Authorities, the head of the State Police, the Municipalities' Association, and the Serum Institute etc.). All names are omitted, *not* for reasons of anonymity, but because it focuses attention of the analysis on their official roles rather than the person. Importantly, representatives from the Danish press also participated in the conferences, asking questions after the briefings. This aspect of the press conferences is particularly interesting, because the journalists' questions sometimes urged the political and administrative authorities to push the decisions to their logical conclusions (Blom et al. 2021; Gerken 2020; see Bro 2008 for a mapping of the various roles of the press).

2.3 Method and Analytical Focus

The transcripts were first categorised by identifying sentences that implied estimates of probability (for example, 'We expect to see an increase in infections over the next couple of weeks'). These statements were initially either categorised as 'political' (decision-making, political justification) or as 'health expertise' (estimates, scientific justification), and subsequently categorised according to the above-described probability concepts. The analysis focuses on the following questions: First, whether and how uncertainty or coincidence is reflected in political communication as something

2 The transcriptions (in Danish) can be located on the Prime Ministry's webpage (https://www.stm.dk/statsministeren/taler/). They can also be made available through contact with the corresponding author.

that can meaningfully and rationally be determined or assessed as *probabilities*. Second, how it is possible for politicians and experts to learn about those probabilities, i.e. whether they must first be *discovered* (empirically) or *constructed* (propositionally or hypothetically) as logical inferences. And last, whether and how policy *decisions* under uncertain conditions can be justified.

A note of caution must be made, which has to do with the spoken language in the press conferences. The politicians and experts communicated directly to a large proportion of the population and presented the most important points through everyday language. It was, therefore, sometimes difficult to determine in detail the probability concepts applied. However, to the extent that the sentences *did* communicate specific probability concepts, and to the extent that these were analytically distinguishable (sometimes due to the pressure of the critical questions from the press), there are several points to be made, which have to do with *how a political space for decision-making can be either extended or limited by implicitly applying different probability concepts*. This point will be made clear in the analysis, but for now it suffices to say that applying a frequentist perspective allows the speaker to treat Covid-19 as a completely novel phenomenon, of which the authorities are apparently ignorant (because there is yet no relevant data available), which opens a space for political decision-making (focusing on stakeholders' hopes, fears, values, etc.), whereas the application of either a propensity view or a logical view of probability enables decision-makers to emphasise the relevance of certain facts to be used as premises for making inferences and subsequently policy-making.

3 Framing the Uncertainty of the Situation

In Denmark on March 11, the prime minister, the head of the Danish Health Authority, and the head of the state police went on National TV to address the situation concerning the spread of the Covid-19 virus, and to announce a lockdown of all unnecessary activity across all public institutions for a period of initially 2 weeks (beginning on March 13). Public employees, who did not maintain critical functions, were sent home with pay and instructed to work from home to the extent that it was possible. Private companies were strongly advised to follow their example. The political communication reflected a strong appeal to the moral sentiment of the Danes, thereby referring to social (intersubjective) norms when arguing for a specific decision during the press conferences, for example by changing the traditional strategy of crisis management: 'We usually seek community with each other as Danes by being close. Now we must stand together by keeping apart'. (Prime minister, March 11, 2020). The prime minister emphasised the seriousness and the uncertainty of the situation, applying a 'precautionary principle' (Prime minister, 11

March, 2020), by which she meant that since the government did not yet have reliable data on which to base decisions, it is better to be safe than sorry. 'As prime minister, I'd rather have the authorities take one step too far within a specific area, than not far enough. Then we must evaluate later'. (Prime minister, March 6, 2020). Applying the principle of precaution in this situation is problematic, since it was uncertain whether the consequences of a policy would be more harmful than refraining from introducing the policy (Martin et al. 2020; Mormina 2022). The lockdown included day care centres, primary schools, upper-secondary education and other educational institutions. All public employees, who did not maintain critical functions, were sent home with pay and instructed to work from home to the extent that it was possible. Private companies were strongly advised to follow this example. Schools and day care institutions remained open for the children of the employees who performed emergency functions in society or who could not find an alternative solution. The prime minister also emphasised the novelty of the situation and the corresponding lack of knowledge and took a political and personal responsibility:

> I will also say this to the whole Danish population: That we stand on untrodden lands in this situation. We have never tried it before. Will we be making mistakes? Yes, we will. Will I be making mistakes as prime minister? Yes, I will. (Prime minister, 11 March, 2020)

With the expression 'untrodden lands', the prime minister unmistakably says that there is (yet) no reliable evidence (frequency calculations or knowledge of propensities) on which to base decisions, which therefore precludes the possibility for decisions based on expertise (calculation and prediction models), and rather warrants a climate for political decision-making (assessment and judgement) for which she takes responsibility. She thereby applied an aleatory, specifically a frequentist, perspective: Nobody knows anything about probabilities unless they have calculations of frequencies of infections relative to a sufficiently large data set. However, a week before, on March 6, when the first few cases of Covid-19 had been detected in Denmark, she explained that 'the authorities plan for different scenarios' (Prime minister, March 6) implying an epistemic (or logical) perspective, since politicians must make decisions about possible future scenarios and their probabilities (possible worlds, relative to the available information), i.e. assessments of which scenario is most likely to occur. Thereby, and addressing the whole population, the prime minister implicitly switched between various notions of risk, uncertainty and ignorance, i.e. such as for example the technical inexactness implied by error bars (risks assessment and planning) and the methodological problem of modelling, which concerns confidence levels (and thereby uncertainty and reliability). Yet, the phrase 'untrodden lands' implies a knowledge gap and, therefore, ignorance (Funtowicz and Ravetz 1990, pp. 23, 1993), or perhaps even that the pandemic is

indeterminate (Wynne 1992), i.e. that there is no way of knowing how the pandemic will develop, since it might be inherently unstable or random.

The underlying question was whether the development of the infections and the spread of the virus were rationally calculable or whether the event was uncertain and unforeseeable and, therefore, required deliberation and assessment of the scarce reports that were available. As mentioned above, the prime minister emphasised the uncertainty of the situation due to delay of the incubation period of the virus rather than the calculable risk of the situation: 'There is a delay from the time of infection to hospitalisation. Likewise, the way we behave now won't appear in the data until in three to four weeks'. (Prime minister, 11 March, 2020). In other words, the sound empirical basis for the determination of the frequency of hospitalisations does not appear in time to serve as a basis for decision-making. The prime minister later referred to the virus as an 'insidious disease' (Prime minister, April 6), which emphasised the indeterminacy and, therefore, the political nature of the situation and the need for swift government action.

Five days prior to the announcement of the lockdown, on March 6, and after the prime ministers' introduction to the situation, the Head of the National Health Authorities downplayed the unpredictability of the existing knowledge of the Covid-19 virus. On the one hand, it is a completely new variant of the virus, but on the other hand, the health authorities possess the relevant and general knowledge of how to prevent the spread of viruses: 'We know how this virus infects [people]. We shouldn't cough into each other's faces. Hygiene, handshakes, handwash, etc.' (Head of the National Health Authorities, March 6, 2020). In the above quote, the head of the health authorities claims to know how 'this' new virus infects people, although he implicitly refers to the infection rates etc. of *previous* or *similar* variants of the type of coronavirus (frequency calculations, or the general propensities of viruses). Moreover, he refers to knowledge of how already familiar coronaviruses generally spread (thereby applying a logical or conditional view of probability). Furthermore, he claimed to be able to speak of the probabilities of various forms of population behaviours, communicating these premises in everyday language. In other words, knowledge of the general propensity of how viruses spread is sufficient for assessing the probabilities of various scenarios relative to each other. Therefore, the experts can speak meaningfully about the probability of these scenarios, even if we do not yet possess solid data and frequency calculations of the new Covid-19 type. On the one hand, this is a 'propensity' view of probability (referring to the nature of viruses) or a frequency view (referring to initial frequency calculations from other countries). On the other hand, it is a 'logical' concept of probability where information of previous examples serves the role of evidence that the outcome of one scenario is more probable than another (although not yet calculable). The expert probably felt the need to assure the citizens, who were watching the press conference and felt

uncertain about the whole situation, that the health authorities possess the relevant expertise to manage the situation, even if it is a new variant of the virus.

After the briefing, a journalist asked about the limit of 1.000 people at social events and required justification for the decision. The head of the national health authorities responded:

> Well, I thought I might say something, first, about the health scientific documentation [for our recommendations] regarding large events. We're standing on good documentation, but at the same time it is a new disease that we have only known for a few months. [However], we have experience with widespread outbreaks of flu, also with historical cases and previous preventive initiatives like these. (Head of the National Health Authorities, March 6, 2020)

In the above quote, historical cases are mentioned as relevant information. The health authorities have seen something that – possibly – resembles the new virus and, therefore, it would be safe to base decisions concerning mitigation strategies on such experiences. Even if there is previous 'scientific documentation' (in the sense of statistical calculations of frequencies of hospitalisations or of risk groups in large data sets and for many kinds of known viruses), still no, or only very limited frequencies have yet been calculated empirically for the new Covid-19 virus.

> We have experience from previous outbreaks of pervasive epidemics. It seems that 10–30 % of the population can be affected in the first wave of an epidemic – because we don't have immunity. We know that from historical cases. (Head of the National Health Authorities, March 10, 2020)

In other words, the head of the health authorities must appeal to both an aleatory conception of probability (the natural propensity to affect 10–30 % of the population) and to an epistemic conception (using historical examples of outbreaks of pervasive epidemics) as relevant information for making (conditional) inferences about plausible, future outcomes in the absence of systematic, experimental tests.

4 The Gradual Reopening: Learning as We Go

After the initial 2 weeks, the lockdown was prolonged for another 3 weeks (5 weeks in total). After the Easter break on April 20, schools and other institutions were gradually reopened. During the lockdown, the authorities had emphasised the experiential character of the situation:

> At the same time, we're using the situation as a chance to know more about the virus. And learning from experience we can now say that on average people are hospitalised for about three weeks now. I must be honest and declare that it is much longer than we first thought. (Minister of health, April 6, 2020)

The minister openly communicated the uncertainty of the health expertise that strongly influences the procedures, strategies and management of health care. It was a balance, because on the one hand, a large proportion of the population was worried that the country might open too soon, risking a further spread of the virus. On the other hand, shop owners and others were desperate to get their businesses going again and questioned the need for the precautions. It seemed to be a 'wicked problem' (Rittel and Webber 1973), introducing a post-normal framework of decision-making (Funtowicz and Ravetz 1993; Rainey et al. 2021), which entails coping with complexity, ambiguity and mutually excluding perspectives in decision-making and risk governance (Renn, Klinke and Asselt 2011). The government had to emphasise that the existing knowledge so far was highly uncertain, based still on a very small, or at best belated, calculation of the frequencies of the regularities in the patterns of the observations, thereby maintaining a characterisation of the situation as political (in the above-mentioned sense). However, the minister of health also had to refer to some kind of certainty to justify the decisions made:

> We know one thing for certain, which is that the positive development depends entirely on the behaviour of the Danes. Therefore, we must continue to sneeze into our sleeves, keeping a distance to each other, and not getting together too many people etc. (Minister of health, April 6, 2020)

This statement transfers responsibility to civil society, i.e. that people must be capable of following the recommendations concerning the general spread of viruses (Nord and Gardell 2023).

However, members of the press kept driving at the uncertainty of the situation, implying that the policies are arbitrarily decided. After a while, the suspicion was too much for the Head of the Serum Institute who consequently felt the need to articulate a more solid form of knowledge:

> The decision that the government has made is grounded in a mathematical model, so *this is not guesswork*! It is based on investigations demonstrating that the regulated, careful and gradual reopening is responsible, so we can go through with it without the health care system breaking down. (Head of the Serum Institute, April 6, 2020)

According to the head of the Serum Institute, the model is not arbitrary since it is based on the – at the time – available and seemingly relevant data. However, as previously mentioned, stating that it is better to base decisions on available data rather than no data at all is not a valid claim, since data can be misleading. There could be dark figures, i.e. undetected presence of virus in the population, which would make the initial beliefs (Bayesian prior) about the extent of the infection not only inaccurate but directly misleading. In the beginning of the pandemic, taking a test was often a strong indicator of the pre-test probability of infection (Piltch-Loeb

et al. 2021). The head of the Serum Institute does not state it directly, but it is implied that the predictions of the mathematical model are gradually calibrated and thereby improved as more data flows in, and the Serum Institute will continue to monitor the effects of the reopening. The emphasis that 'It is not guesswork!' implies that even if the prior assumptions, on which the model is based, were chosen arbitrarily (for example, based on misleading data from previous epidemics), the experts will gradually optimise the model's capacity to make more precise predictions. And herein lies the rationality of the Bayesian principle of learning.

As the examples above demonstrate, it was a difficult task for the administrative authorities to communicate directly with the public. On the one hand, they tried to express a confident attitude and downplay the appearance that the decisions were arbitrary (basing decisions about the new virus on data regarding previous viruses). On the other hand, they also wanted to communicate the uncertainty of the calculations and predictions (that they are on uncharted lands, upholding a watchful alertness and scepticism, and disclaim responsibility). In the following quote, the head of the Serum Institute first makes a prediction with certainty but quickly corrects himself and stresses that the conjecture is an *expectation*:

> However, we will see an increase – we *expect* to see an increase – in the number of sick, and in the number of hospitalisations. (Head of the Serum Institute, April 6, 2020)

Probability thereby concerns expectations about future outcomes. The question is to what extent the uncertainty is calculable and manageable, and how and to what extent the uncertainty should be communicated. The meaning of the concept of probability continually slips back and forth between various kinds of aleatory (frequentist, propensity) and epistemic (logical-inductive, subjective and Bayesian) conceptions. On the one hand, it seems important to maintain an awareness of the unpredictability of the situation, but on the other hand, there is also a possibility to learn and to justify decisions about the future course of events even if the observed cases are limited. From the beginning of the lockdown, the head of the health authorities had emphasised the contingent nature of the situation:

> At some point, the containment strategy [tracking the contamination chains, keeping the possibly infected quarantined] won't hold anymore. I can't say exactly when. It is an hour-to-hour, a day-to-day assessment of the situation. (Head of the Health Authorities, March 10, 2020)

It is a reminder that probability theory is based on the need to interpret the signs (of nature, of things) and to assess the degree to which these signs could work as evidence for a conclusion (Hacking 2006[1975], p. 44). The improved reliability of the statistical calculations and thereby the predictions based on a larger 'n' do not

eliminate the need for interpretation (see also Piltch-Loeb et al. 2021). As the head of the Health Authorities states:

> We have some experience regarding this disease – especially from China and Northern Italy – so we know the burden of disease, the distribution of the disease, that is, how many people will only be lightly affected, and how many will have to go to the hospital. We must translate the Chinese and Italian data to Denmark. There is a different age distribution in Denmark compared to Northern Italy. Northern Italy has a larger group of seniors so perhaps that is why they have an increased rate of sickness and a heavier strain on the capacity for intensive care. (Head of the Health Authorities, March 10, 2020)

As the communication above demonstrates, the public was invited to co-reflect on the uncertainty of scientific research during the early Covid-19 press-conferences. They were an occasion for a large part of the population to witness these continual deliberations, which is an important part of research practices.

5 Justifying Decisions in the Face of Uncertainty: When and How to Reopen the Schools?

One of the interesting questions during the lockdown was when and how to reopen the schools. Children were very early on identified as those who were neither infected, nor infected others, very easily. That was already announced by the Head of the Health Authorities on the first press conference:

> This disease does not seem to infect children at any high rate. And unlike the epidemic that we had in 2009 children do not seem to spread the virus very much. Whereas [in contrast to children] the chronically ill and the elderly comprise a risk group. (Head of the Health Authorities, March 6, 2020)

Speaking of 'infection rates' testifies to the frequentist (aleatory) use of the concept of probability, since the probability value has been calculated statistically. Notice the careful use of the word 'seem' in the above, expressing due uncertainty, about the preliminary calculations. But it also signifies a willingness to learn from previous experiences, i.e. to make informed guesses ('in contrast to the epidemic in 2009'), which indicates an epistemic concept of probability.

The difficulty for the health authorities in the very early days of the outbreak was to identify and define the risk groups with the purpose of targeting and differentiating the recommendations, and without having to do it through trial-and-error. Was it more dangerous to send the kids back to school if they could spread the virus unknowingly because of very mild infections – for example to their grandparents who would presumably in many cases pick them up from school or daycare? The

problem here is not so much whether the various scientific analyses are accurate (statistical frequency calculations), but rather a question of which scientific result to use as evidence and give the appropriate weight (inductive, logical probability), and how to make decisions under such uncertain conditions and irreconcilable disagreements (Ongaro 2021; Qvortrup and Lykkegaard 2023). The calculations themselves do not answer these questions, but the various probability theories provide a framework for analysing the justifications for the decisions.

After the first 5 weeks of lockdown, and as the weeks progressed, the epidemiologists observed a favourable trend in the infection rates. Less people than expected had been hospitalised, so after the Easter break, the youngest children (0–5) and pupils (6–11) were sent back to daycare and school by April 20, 2020, which was sooner than expected. On April 14, when society was about to reopen, the prime minister held another press conference and announced the change of plans.

> We have commenced what we call 'phase one' in the reopening of Denmark. It is a difficult task. The municipalities are reopening the daycare centres and schools for the small children. And the number of hospitalisations we see now mean that we can do more during phase one than we had first imagined. (…) We must continue to have the virus under control. And things are going quite well with the joint venture. Therefore, the idea right now is to open slightly more. (Prime minister, April 14, 2020)

By using the phrase 'the idea right now', the prime minister emphasised the provisional character of the situation.

Perhaps therefore, the prime minister emphasised that the professionals in daycare centres, schools, libraries, etc. will handle the changes much more efficiently if decisions are made locally. 'You [the Danes] can do a lot when common sense is allowed to rule instead of asking permission 10 levels up' (Prime minister, April 14). According to the prime minister, the most efficient way to administer and temporarily re-organise society will, therefore, be to encourage each professional and citizen at the local levels to make their own (subjective or group-level) evaluations of what makes sense in a particular context. In that sense, the subjective and intersubjective assessments work as betting quotients, which will allow personal as well as common sense to rule (like an invisible hand). However, this is also where we saw the most conflicts during the Covid-19 crisis, when individual and group-based probability assessments conflicted with each other. Professional and commercial interests sometimes clash, and so does personal judgement.

The press soon picked up these disagreements and became a vehicle for the diversification of opinion and shifted its attitude from pure mediation to scepticism towards administrative and government expertise. After the briefing, one of the journalists asked the representative from the health authorities about the intensification of the reopening:

> My second question goes to the Head of the Serum Institute: Seven days ago, you presented a model demonstrating that even with the most probable course of events there would be 200 patients hospitalised in intensive care by now. The actual number is 93. Now you say that you can open society a bit more than planned without the spread getting out of hand. But why should we believe [these estimates] when the previous models have been totally off the mark? (Journalist, April 14, 2020)

It is unclear from the context whether the journalist finds the statistical uncertainty intolerable (the margin of error), or whether he (also) thereby implicitly applies an exact understanding of knowledge: Either the models make precise predictions, or they cannot be trusted at all. Journalists during the press conferences generally seemed to ignore the question of probability, presumably because it is easier in that way – rhetorically – to hold authorities accountable (see Blom et al. 2021). Therefore, the head of the Serum Institute began to explain how the calculation of probability becomes more credible as data increase:

> I won't say that the models have been totally off the mark. But more data has been added. So, the more data points that are added to the model the more accurate the projected curve will be. So, it is simply a question of more data making the model more accurate. And that also means that there is this opportunity to expand the reopening [of society] slightly more without the health care system breaking down if we continue to keep a distance to each other. (Head of the Serum Institute, April 14, 2020)

The head of The Serum Institute holds on to the Bayesian rational model of decision-making and explains how decisions are based on continual calibration of long run calculations and analyses of frequencies. The purpose of the continual calibration is to gradually minimise the uncertainty of the projected curve (Bayesian learning) and yet at the same time retaining the small chance that an apparent connection between a hypothesis and a conclusion may be a coincidence (frequentist).

The purpose of the calculations made by epidemiologists and virologists is to minimise the risk through calculation and analyses of frequencies that the observed regularities are coincidental (statistical uncertainty). Rather than proving something to be the case, they try, through the continuous collection of data, to improve or calibrate the model for decision-making, Thereby, they try to provide a basis for decision-making by interpreting how the partial data could meaningfully count as evidence for preliminary conclusions.

The prime minister also recognised the preliminary character of the knowledge that was developed, but at the same time emphasised the need to make swift decisions (see also Radner 2000 for a discussion of cost-effectiveness and rationality in decision-making):

> If we were to wait for the calculations until we are certain then we would have to wait forever. They [the scientists] constantly make new calculations. Because… because it is a new situation. It has no prehistory. (Prime minister, 29 May, 2020)

She, therefore, continued to emphasise the uncertainty of the situation (applying a frequency perspective), and thereby opened a space for political decision-making based on assessments of the available information (logical inferences).

6 Conclusions

The above analyses have demonstrated how various government authorities communicated the coincidental character of the Covid-19 crisis and thereby how various conceptions of probability in political communication justify different policy decisions. Perhaps not surprisingly, political decision-makers on the one hand try to emphasise that the situation is uncertain, that no relevant knowledge of the situation exists, and that immediate action is required (see also Zhou, Liu and Yang 2024). They do that first by appealing to a frequentist concept of probability, i.e. that it is not possible to objectively determine the situation, since the variant of the virus is new, and no solid data yet exists. Then, by appealing to single-event experiences, they argue for the probability of a full-blown epidemic (experiences from Italy and China with outbreaks and pressure on the health services) and, thereby, emphasise the necessity for a swift assessment of the situation (logically, inductively) and prompt action. The strategic (or selective) use of different concepts of probability in communication at the press meetings enabled politicians to sidetrack the administrative expertise and conquer a space for political decision-making. This is most evident in the case of the prime minister's communication, since the ministers of Health, Foreign affairs, and Justice – besides being politicians – (in Denmark) also play an administrative role as heads of the ministries and their adjacent public institutions. These ministers' communication is balanced between on the one hand respect for the public institutions that they represent and, on the other hand, being members of the government. They oscillate between different uses of the concept of probability, but most often apply logical-hypothetical constructions such as 'If the spread of infections increases, then…'. Thereby, the decisions are conditioned on the plausibility of the inferences. They try, subtly, to emphasise the expert knowledge when available and strategically opportune, yet at the same time downplay the plausibility of the available knowledge to open a space for political decision-making.

Something similar is the case for the heads of the public research institutions, such as the health authorities, who – sometimes in the same sentence – apply two different concepts of probability. Even if data concerning the new variant is limited,

these authorities give the impression that they still possess the relevant expertise to handle the situation based on historical cases of epidemics. The Serum Institute that calculates the frequencies and constructs models of the probabilities of various scenarios on the one hand expresses confidence in the general knowledge already available (of past experiences, logical-inductively) but also emphasises the uncertainty of the available knowledge of the new virus (thereby applying a frequentist perspective). Moreover, the statistical insight that there is always a small chance that the calculated correlation between current behaviours and future outcomes is a coincidence is sometimes downplayed and replaced by a propensity perspective (i.e. believing to know the very nature of past as well as future epidemics, i.e. that they come in waves with certain distributions etc.). As more data flow in, the applied probability concept shifts to a Bayesian view in the sense that these models will continually improve as more data are added. Rationality, from a Bayesian perspective, does not mean 'determinable beyond doubt' but rather 'gradually more precise', which emphasises the developmental, evolving character of knowledge.

As indicated in the analyses above, the various uses of the concept of probability thereby either extend or limit a space for justification and decision-making concerning risks. By adhering to a frequentist perspective, decision-makers can sidetrack the influence of experts in decision-making (since no relevant risk assessments are available), thereby opening a space for political decision-making (emphasising specific stakeholders' perspectives, values, hopes or fears). At other times, the application of a logical concept of probability (using historical examples or references to natural propensity) serves the role of relevant evidence for making inferences about the credibility of a suggested policy, which thereby enables decision-makers to limit the relevant options and to render some of those options more important than others. The application of different aspects of the concept of probability in communication thereby enables authorities to frame the uncertainty of a situation, and to justify different approaches to risk management. Therefore, it is important for citizens and journalists to be aware of the implicit shifts in the communication, and generally to recognise that the dual nature of probability plays an important role in the framing and justification of knowledge in support of decision-making.

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