

Can We Cope with the Complexity of Reality?

Why Craving Easy Answers Is at the Root of our Problems

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Why Craving Easy Answers Is at the Root of our Problems

Reflections on science, self-illusions, religion, democracy and education for a viable future

By

Rolf Jucker

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“We live beneath our level of knowledge – that’s the human comedy.”
(Braun 2019, 136; translated by Tom Cheesman)

“The only way to resist power’s determined madness is with determined reason.” (Braun 2019, 294; translated by Tom Cheesman)

“We have to speak clearly, no matter how uncomfortable that may be. (...) You are not mature enough to tell it like is. Even that burden you leave to us children. (...) We have not come here to beg world leaders to care. You have ignored us in the past and you will ignore us again. We have run out of excuses and we are running out of time. We have come here to let you know that change is coming, whether you like it or not.” (Greta Thunberg 2018; see also Thunberg 2019a)

“We don’t have the courage nor the capacity to admit that meaning for our individual and collective lives cannot be provided anymore by a religion or an ideology, cannot be given to us as a gift; that we have to create it ourselves.” (Castoriadis 2005, 327; my translation)

“One by one, we will see that past certainties are being dismantled.” (Rippon 2019, xix)

“Some people would like to persuade the curious to keep their hands off the beloved mysteries, not realizing that a mystery solved is even more ravishing than the ignorant fantasies.” (Dennett 2017, 10)

“Atheism is more than just the knowledge that gods do not exist, and that religion is either a mistake or a fraud. Atheism is an attitude, a frame of mind that looks at the world objectively, fearlessly, always trying to understand all things as a part of nature.” (attributed to Carl Sagan)

“All human institutions, programs, and activities must now be judged primarily by the extent to which they inhibit, ignore or foster a mutually enhancing human-earth relationship.” (Thomas Berry, quoted in O’Sullivan 1999, 43)

“To talk about the future is useful only if it leads to action now.”
(Schumacher 1993, 9)

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CHAPTER ONE

INTRODUCTION

When I discuss the prospects of humans on earth or the chances of a dignified future worth living – some call it sustainability – with friends and colleagues I invariably get two fractions. One side, usually the larger, has an apocalyptic outlook: everything is getting worse, and fast (and they would quote Rockström et al. 2009 to prove it). The other side, small but vocal, thinks that technical progress will deliver us to nirvana within at the very most ten years (and they would quote Pinker 2018 or Hans Rosling with his Gapminder website (Rosling n.d.) to prove it).

I will argue in this book that both positions, in their isolation, could not be further from the truth because they cannot do justice to the complexity of the world we live in. I will start from the basis I laid in an often-quoted *International Journal for Sustainability in Higher Education*-article from 2002, entitled “‘Sustainability? Never heard of it!’: some basics we shouldn’t ignore when engaging in education for sustainability” (Jucker 2002a), but also from my further work in later years (Jucker 2002b, 2014a, 2014b, 2016, 2019a). I have argued for a wide and complex notion of education and I will reinforce and expand on this notion here.

In this 2002 paper, I wrote:

“All too often proposals for education for sustainability refer to the current state of affairs and its unsustainability in passing, and then move on to the educational small print, often with good intentions and admirable dedication. Yet this approach forgets entirely that the status quo is setting parameters, which render much of what is done in education obsolete. Honest stocktaking can therefore prevent us from fostering the illusion that education will solve all our problems and lead us single-handedly into the desired sustainable society. (...) In other words, if we do not, at the same time, do everything we can to transform our political, economic and social systems into more sustainable structures, we might as well forget about the educational part.” (Jucker 2002a, 9) [non-withstanding that changing these other systems requires, among other things, educational interventions]

Obviously, the world has changed tremendously and at an incredible speed since 2002, for better and worse. Just think for a moment about the advances in neuroscience (Frith 2007; Rippon 2019), medicine (check out the issues of the Journal *nature* at nature.com for an in-depth regular update), mobile technology (the first iPhone was not released until 2007) and renewable energy (UNEP 2019)¹, but also consider the ‘advances’ in biodiversity loss and ecosystem destruction (IPBES 2019)², accelerated climate change (IPCC 2019a, 2019b, 4; Ripple et al. 2019 [signed by 11’258 scientists worldwide]; Lenton et al. 2019)³ and the dissolution of a functioning public sphere in many parts of the world (Taibbi 2018).

This change has been made strikingly visible by the multidisciplinary exhibition *Anthropocene*, by photographer Edward Burtynsky and filmmakers Nicholas de Pencier and Jennifer Baichwal (Burtynsky et al. 2019). By combining art, film, virtual reality, augmented reality, and scientific research, the project investigates human influence on the state, dynamic and future of the Earth. When I recently visited the exhibition, I was struck by the power of the images: Burtynsky manages in an ingenious way to show the scale of our impact on earth and the film is very powerful indeed (ANTHROPOCENE 2019). It is a complex notion with which you leave the exhibition: there is compelling evidence that we entered a new geological epoch, the anthropocene: humankind has altered the

¹ “Renewables are currently the cheapest source of new power generation in most of the world (...).” (UNEP 2019, 29)

² Bearing in mind that “nature is essential for human existence and good quality of life” and that “most of nature’s contributions to people are not fully replaceable, and some are irreplaceable” (IPBES 2019, 2), here is what we managed to do: “The rate of global change in nature during the past 50 years is unprecedented in human history. The direct drivers of change in nature with the largest global impact have been (starting with those with most impact): changes in land and sea use; direct exploitation of organisms; climate change; pollution; and invasion of alien species. Those five direct drivers result from an array of underlying causes – the indirect drivers of change – which are in turn underpinned by societal values and behaviours that include production and consumption patterns, human population dynamics and trends, trade, technological innovations and local through global governance. The rate of change in the direct and indirect drivers differs among regions and countries. (...) In the past 50 years, the human population has doubled, the global economy has grown nearly 4-fold and global trade has grown 10-fold, together driving up the demands for energy and materials.” (IPBES 2019, 3-4)

³ “In our view, the evidence from tipping points alone suggests that we are in a state of planetary emergency: both the risk and urgency of the situation are acute.” (Lenton et al. 2019, 595)

composition of the geological, soil and atmospheric spheres of the planet on a massive scale. However, you cannot help but marvel at the human ingenuity, which lies behind these changes. It is horrific to see the huge, 14,200 ton *Bagger 293* (225 meters long, 46 meters wide, 96 meters high) in operation. This excavator for open cast mining is the third biggest machine on earth. The daily destruction potential of this machine is immense, particularly if you include the climate change impact from digging up and burning coal. Yet this machine is unquestionably an incredible engineering achievement, leaving one wondering what this engineering spirit could do for sustainable production rather than destruction. Moreover, the digging up of raw materials sometimes even generates a visual beauty of its own:



Fig. 1-1: Edward Burtynsky: Uralkali Potash Mine #4, Berezniki, Russia, 2017 (Burtynsky et al. 2018, 144). Photo: © Edward Burtynsky, courtesy Nicholas Metivier Gallery, Toronto.



Fig. 1-2: Edward Burtynsky: Coal Mine #1, North Rhine, Westphalia, Germany, 2015 (Burtynsky et al. 2018, 123). Photo: © Edward Burtynsky, courtesy Nicholas Metivier Gallery, Toronto.

If we turn to the largest machine humans have built on earth, the Large Hadron Collider at CERN (home.cern) with 27 kilometres of circumference, we find it is almost the opposite of *Bagger 293*: a scientific instrument which has enhanced our understanding of the structure of matter and reality tremendously – a truly international, collaborative endeavour where often hundreds or even thousands of scientists from around the world work together to push the frontiers of science.⁴

When the world changes on such a scale, we have to be prepared to change our positions as researchers and educators based on new evidence and new understandings. We might find it as difficult as anybody to let go of old, dearly held convictions. However, I am convinced that as educators

⁴ The paper, which described the successful experiment to prove the existence of the Higgs boson, was co-authored by 5,154 scientists (Castelvecchi 2015). There is an increasing trend towards papers with more than 1'000 authors (1'315 papers from 2014-2019), reflecting the increasingly global nature of research across several fields, often with authors from more than 80 countries (Singh Chawla 2019).

– given that successful education is by its very nature a change in understanding and mental models⁵ – we have to take this never-ending process of learning seriously, adopting an openness to change our positions if warranted by new evidence.

I will just mention two things where I was forced to engage in a process of un-/relearning. I clearly was in the above-mentioned apocalyptic camp, for as long as I can think. I was convinced – in quite a self-castigating way – that modernity, progress and the white western male had put history on a downward path. Coming from a humanities background, it took me a very long time indeed to understand what science and establishing sound evidence meant. In my literary studies and philosophy world, outside reality hardly had a look-in. All that was required was a self-referential loop of texts citing texts citing texts. There was no attempt to refer to some independently corroborated theory or to experimental or empirical evidence. I was entirely caught up in the postmodern fog I will mention later. Little by little, I learnt to understand what a scientific approach actually meant. I started to appreciate Popper (who for me, following in the Critical Theory tradition, had earlier been one of the bad guys). I learnt to value what progress in scientific understanding over the last two centuries had contributed to real improvements in quality of life, medicine, nutrition, housing, public transport and so much more. Even if I am convinced that Steven Pinker severely downplays the scale of ecological destruction and ignores the destructive force of corporate and political power and wealth, I do have to agree with him that the “bleak assessment [of the apocalyptic side] of the state of the world is wrong” (2018, xv). Nobody in his or her right mind would want to turn back the clocks because there is clearly measurable progress:

“We penetrate the mysteries of the cosmos, including life and mind. We live longer, suffer less, learn more, get smarter, and enjoy more small pleasures and rich experiences. Fewer of us are killed, assaulted, enslaved, oppressed, or exploited by the others. (...) We will never have a perfect

⁵ I am borrowing this term from Peter Senge: “Mental models are deeply held internal images of how the world works, images that limit us to familiar ways of thinking and acting. Very often, we are not consciously aware of our mental models or the effects they have on our behavior.” (Senge 1990, 8) Mental models are sometimes called mental representations. According to Ericsson and Pool “all mental representations have in common (...) that they make it possible to process large amounts of information quickly, despite the limitations of short-term memory. Indeed, one could define a mental representation as a conceptual structure designed to sidestep the usual restrictions that short-term memory places on mental processing.” (2016, 61; see also Wikipedia 2019c)

world, and it would be dangerous to seek one. But there is no limit to the betterments we can attain if we continue to apply knowledge to enhance human flourishing.” (Pinker 2018, 453)

It is precisely because of this personal experience of fabricating ‘truth’ literally out of thin air – obviously enhanced by a good measure of impressive-sounding jargon⁶ –, still very wide-spread in much of the humanities and social sciences, that I insist below on the importance of a proper understanding of science for any education, but in particular for an education for a viable future worth living.⁷

The second deeply held belief I really had to unlearn was the romanticising and idealisation of so-called indigenous people. In my (previous) world indigenous people were always the ‘good guys’, historically cheated and fleeced over and over by the bad ‘white guys’. Of course, there is no question that colonialism in all its forms was an utterly destructive and hideous historical development (see, as a comprehensive example, Beckert 2014), and we should do all we can to restore justice to these peoples. Nevertheless, it is a logical fallacy to conclude from this that the victims of this process were by definition good, peaceful and flawless human beings. It is an equal fallacy to conclude that the fact that they were victims of colonialism infers any quality or validity statement on their epistemology, on their world-view. But it was my conviction that their relationship and understanding of nature was oh-so wonderfully holistic and non-destructive. This notion was fuelled by a flood of more than dubious books on the construct of the ‘anti-imperialist’ left, the *native American Indian*. However, an objective, non-emotional and non-emphatic reality-check yields quite different results. Harari provides good evidence in his book *Sapiens: A Brief History of Humankind* that within a few thousand years of the settlement of *homo sapiens* on any continent 50 to 80% of the biggest mammals (and in addition insect, bird and snail

⁶ See as an instructive example Alan Sokal’s experiment with the journal *Social Text* (Sokal 1996), referred to in more detail in chapter two.

⁷ I could easily complain that I wasted days, months, even years in the first twenty years of my professional life, as a literary studies ‘scholar’: reading all this fiction, most of it based on understandings of human mind and body as well as psychology and social interaction either in direct conflict with scientific evidence (as I know now) or at least seriously under-researched. However, this would clearly be an undifferentiated view: Reading fiction, just as reading any other subjective rendering of the world, gives you nevertheless an insight into how people function, how they construct their personal universe. Diving into these microcosms can also help you understand the world we live in, even if not necessarily in the way the authors might have intended.

species) were driven to extinction: “The extinction of the Australian megafauna was probably the first significant mark *homo sapiens* left on the planet. It was followed by an even larger ecological disaster, this time in America.” (2015, 69): “Within 2,000 years of the Sapiens arrival (...) North America lost thirty-four out of forty-seven genera of large mammals. South America lost fifty out of sixty” (2015, 71) – long before the bad white Western coloniser was born. Another example: there is good evidence that the indigenous people in the Amazon did not just live peacefully in the given environment, but to a large extent restructured the forest with domesticated tree species (Levis et al. 2017). In addition, there is no evidence that indigenous people were particularly kind or peaceful when it came to settling issues with their neighbours: utter cruelty, abduction of children, and rape of women were not the exception, but the norm – which sounds rather similar to our ancestors during the Barbarian Invasions and the middle ages (see Diamonds 2012). It is – I have to admit with embarrassment – just sloppy thinking on various levels. First, believing the beautiful self-declarations and manifestos of leaders of the *American Indian Movement*, for example, without checking their claims against historical and anthropological records, is like believing that a politician’s election manifesto can accurately describe his or her politics, or that a green party voter’s beliefs are reflected in their actual lifestyle.⁸ Second, it is simply silly to assume that these peoples would not have dealt with their environment differently, had they had the superior tools of the technologically most advanced countries. There is no historical evidence to my knowledge that any group of people ever refrained from using the tools at their disposal. Third, as for their better understanding of nature: here is true what is captured by Rippon’s opening motto. Given their limited tools, theories and understanding of what was going on around them, they crafted their own ‘naïve realism’ interpretations, mostly not better or worse than any we encounter in ‘indigenous’ western communities of a similar historical developmental stage. These understandings have mostly been found wanting over time like all the other non-scientific attempts at understanding the world and universe around us. There is simply no sound reason why we should privilege their world-views in any way. As with anything else, these should be judged in relation to current best knowledge, i.e. whether they hold up to a scientific

⁸ A rather interesting study from the German Environment Ministry has found that there is hardly any overlap between personal convictions on green behaviour and *actual behaviour*. In fact, the study found that those who believed that they were acting truly green and sustainably had in reality the second biggest negative ecological impact (Umwelt Bundesamt 2016, table 17, 86).

process “that rigorously vets claims” (Oreskes 2019, 141) against available, peer-reviewed, tried and tested evidence. Doing this shows us that most of their myths and genesis stories are as nonsensical as anything we know from our religious past.⁹

However, it would equally be sloppy thinking to blame indigenous people for the fact that an entire generation of frustrated people from overdeveloped countries romanticised them. After all, the ecological footprints of many indigenous peoples are still a fraction of those of their romanticisers. It is the uncritical idealisation of indigenous peoples, Buddhist monks, black activists, women or other easy projection targets, against which we should develop a healthy immunity.

For the purpose of this book, this leads me to the following conclusion: With a view to all the changes in the political and social sphere and the immense deepening of understanding in many areas over the last few decades, there is a very strong sense that most of us, including those who call themselves progressive and green, simply have not tried hard enough to understand – to really dig down beyond our intuitions, our empathy, our preconceived ideas and our ‘progressive’ certainties. Harald Welzer has put this aptly:

“Time for reality, time to grow up. Being an adult means: to take note of facts even if they contradict one’s own wishes.” (Welzer 2019, 3; my translation)

“Should we not finally subject our lifelong lies to the same suspicion of self-serving Fake News as those of the growth believers and climate deniers and the completely perverted from the far right? That’s exactly the truth Fridays for Future is confronting politics with when they say policy-makers must finally do what is necessary (and not everything else). Thus

⁹ Again, let us be precise. There often seems to be a grain of truth in their world-views; we often find that their musings about ‘mother earth’ speak to us. Yet these ideas are mostly of such a vague, general nature – often just slogans, really – that they have a similar truth value as astrology: they can be applied to anything and everything, without revealing the underlying structure of reality which would allow an objective, independently verifiable or falsifiable understanding. A famous example is the speech by Chief Seattle from 1854 (we know today that parts of the speech were added by 20th century historian and ethnographic writer, A. C. Ballard): “This we know; the earth does not belong to man; man belongs to the earth. This we know. All things are connected like the blood which unites one family. All things are connected.” (Chief Seattle 1854) As Pinker rightly says, “this is the kind of statement that Dennett (quoting a young child) calls a ‘deepity’: it has a patina of profundity, but as soon as one thinks about what it means, it turns out to be nonsense.” (Pinker 2018, 433)

we are in the historically quite remarkable situation that today the children and young people are the realists and act knowledge-based and the adults the illusionists who have lost all contact with their reality.” (Welzer 2019; 13, my translation)¹⁰

What I offer here is an attempt to do this digging, this reality-check, to at least attempt an adult approach to some of the issues which seem most important. I am doing this in the spirit of Daniel Barenboim: irreverent to any political correctness, diplomatic niceties, or any enraged or hurt identity freaks of the right or the left. Just replace ‘artist’ with ‘scientist’ in the following quote: “(...) an artist, to be true to himself, has to have the courage to be totally uncompromising (...).” (Barenboim and Said 2004) Greta Thunberg has stated it razor-sharp: “We have to speak clearly, no matter how uncomfortable that may be.” (2018) Or, in Žižek’s words:

“We have to re-learn to argue in a tough way – even if this means that we are hurting people’s feelings. Their concern, their pain is no measure for the truth. And truth, after all, should be our guide.” (Žižek 2016; my translation)

The only thing I am interested in is truth, i.e. what we – not me personally, but we collectively at this point in time – *can* know and what sound knowledge we should base our political, social and educational approaches on.

This sounds arrogant, but is the exact opposite. It is the “arrogance of ignorance” (Leiva 2012) – amplified in echo chambers and filter bubbles¹¹ –, with its assumption that facts, knowledge and evidence count for nothing, which is harmful. It is obvious: I personally often do not have solutions or even the necessary detailed knowledge – in our days this is not something one person can ever hope to achieve again. But I am convinced that we have the tools and knowledge today to overcome not just the limitations, say, of tradition, upbringing, and cultural conditioning, but also to keep in check the illusions and misconceptions of the very functioning of our cognition and perception. But we can only do this

¹⁰ In other words, Welzer encourages us to adopt a cynical approach: “CYNIC, n. A blackguard whose faulty vision sees things as they are, not as they ought to be. Hence the custom among the Scythians of plucking out a cynic’s eyes to improve his vision.” (Bierce 1906, 27, last entry under C)

¹¹ Both work so well because they bolster up “confirmation bias”, a cognitive distortion we all share to a greater or lesser extent: “people (and scientists, quite often) seek data that are likely to be compatible with the beliefs they currently hold” (Kahneman 2011, 81).

collectively. Therefore, this book clearly aims to go beyond a merely personal opinion. To the best of my knowledge, I have taken great care that any argument I present in these pages is corroborated by evidence from specialist researchers in the relevant fields. It is not my personal opinion, it is my presentation of what I came to comprehend as the current state of understanding. If, based on sound evidence, you take issue with my arguments, I will be more than happy to reconsider. However, if the injunction is because of bad style, or because you feel that the argument lacks beauty, or because the arguments presented hurt your feelings, I'm afraid I won't be impressed. Simply shooting the messenger because you do not like the message, or not making the effort to provide evidence that the arguments presented are not sound, will not push our understanding towards more clarity. For me, this is the basis of any sensible dialogue and for any meaningful educational endeavour. This is the place where we should always start.

Coming to terms with our complex reality *is* hard, it *is* difficult and challenging, the conclusions often tough to accept. What follows will be a challenging read in many different ways. First, we have to tackle some of the barriers humanity faces in understanding our place on the planet and how many of our actions lead to an increasingly unsustainable lifestyle. Second, with Fridays for Future we have to acknowledge how our (however limited) understanding of science and its empirical evidence is not given the priority it deserves to determine the necessary actions. I will argue that we have no option but to persevere. We have to put in the effort. We cannot – lured into ‘business as usual’ by our craving for easy, convenient answers – give up too quickly. As Greta Thunberg (2018) and Niko Paech (2014) argue: the time for excuses is over. Business as usual is not an option any more...

This is the reason why I am equally convinced that we need to talk about the issues I address below, particularly if they are considered taboo. In fact, I have chosen religion and overpopulation for precisely this reason, as I will explain in the relevant chapters. These topics can serve as insightful examples for what it means to take complexity and available evidence seriously. Of course, talking about it is not enough. According to change theory, we need to find ways to engage people's “elephants” (=emotions), not just their “riders” (=reason) (Heath 2011, 4-33). This is what we need to do in our educational practice. However, in order to change this practice, I can see no other way than to reason, to consciously switch from the automatic, often unconscious, but fallible “System 1”, to the analytic, critical, but also exhausting “System 2” (Kahneman 2012, 69-90, 415). There is no substitute for it, and there are no excuses not to do

this.¹² We have no choice, but to battle against extremely strong traditions, ideologies and entrenched, but erroneous mental models. We have to stand up against the wide-spread ridiculing of modernity, Enlightenment and science both on the left and the right of the political spectrum. We have to fight against cultural relativism which endorses human oppression and abuses of women in other cultures in ways which are intolerable and clearly incompatible with human rights. In short, it is our duty as educators not just to stand up against, but also to free ourselves from all forms of stupidity and tyranny (physical or by words). Education can, as history shows, change and transgress people's "self-imposed immaturity", as Immanuel Kant stated so aptly already in 1784 (Kant 1784). We have to reignite the appeal of the Enlightenment to reason, because by now we really do know from overwhelming evidence that emotions and intuition are very poor guides to sensible long-term action (Bloom 2018; Kahneman 2012). Or to quote the German feminist philosopher Svenja Flaßpöhler, a fierce critique of the undifferentiated nature of the #MeToo-movement (see 2019, 18-23; and Flaßpöhler 2018): "If feelings replace arguments, debate becomes impossible. It stifles everything." (2019, 18; my translation) We have to keep the debates going, otherwise learning and education is impossible.

I do not want to fall into the trap of individualising issues which are clearly collective challenges to be solved collectively (see below, chapters five & six). Nevertheless, I do think that there is an important element of self-responsibility here: This is about us, and our failure to do our homework, individually and collectively. Dee W. Hock, the 'father' of the VISA-card and an interesting proponent of democratic, co-creative leadership (Hock n.d.), phrases this with reference to a managerial role, but it has equal value for what concerns us here:

"The first and paramount responsibility of anyone who purports to manage is to manage self – one's own integrity, character, ethics, knowledge,

¹² At a recent conference, a speaker encouraged us not to rely on reason, but to use emotions and value the deeply held beliefs of people. This is correct in so far as we have to start from the fact that most people are guided by strong emotions and beliefs (i.e. Kahneman's System 1, see below). However, most of these are demonstrably false. It is clearly our job as educators to find ways to make them understand how these emotions are constructed by their cognitive system and cultural socialisation, why their belief-systems are at odds with reality (see Welzer above), and how they can arrive at an understanding of the world that is coherent with current knowledge (i.e. encourage them to use what Kahneman calls System 2, see below).

wisdom, temperament, words, and acts. It is a never-ending, difficult, oft-shunned task. The reason is not complicated. It is ignored precisely because it is incredibly more difficult than prescribing and controlling the behavior of others.” (Hock 2005, 48)

Self-responsibility in the end comes down to our capacity to differentiate, our willingness to apply a complex and evidence-based approach. Such a reasoned approach will not side with either the apocalyptic or the blue-eyed ‘technology is nirvana’-side. Inspired by Flaßpöhler (2019), I will use the terms differentiation or to differentiate throughout. I do not use these terms in the business sense of product differentiation in marketing, or in the biological sense of cellular differentiation or the geological sense of planetary differentiation. I borrow the term from systems theory where it is used to deal with the complexity of systems. For the purposes of this book differentiation is used when talking about the process of understanding. It means the attempt to be thorough, scrupulous, comprehensive, concise, discerning and penetrating in the analysis of the complexity of any given phenomenon. This immersion into the depth of understanding an issue almost by definition means that one person alone cannot do it. The opposite of differentiation is shallowness (see Carr 2010): superficiality, laziness, as in not bothering to question traditional ‘wisdom’ or belief-systems. Differentiation requires time, research, reflection, self-criticism and listening to and learning from others. Flaßpöhler gives the following example for differentiation:

“An enlightened society must be capable of differentiation. There is a difference, if a child has two fathers, two mothers, or a father and a mother. I am not talking about what is better or worse, but there is a difference. Why is it impossible to say this? Why can we not analyse this? There is a fear to be labelled as reactionary, if we go into differentiation. But this leads to the absurd stupidity of today’s debates, where I am suddenly a reactionary, right-wing feminist. As an intellectual my central competence is in differentiation. That is my job.” (Flaßpöhler 2019, 23; my translation)

Another example: a differentiated approach would not just blanket-label modernity as fundamentally destructive (see as an example Baumann and Lyon 2013), but it would differentiate between, on the one hand, the scientific approach chosen, and the contributions of politics, social movements, corporations, non-scientists and scientists alike, in making advances in the understanding of humans and the workings of the world, and, on the other hand, abuses of power and authority for personal and collective gain.

History has shown that as individuals and as humankind we are capable of the most amazing emergent developments – there is virtually no limit. And, over the last 250 years, we have developed the reliable tools of science to verify what works, beyond our fallacy-prone intuitions and traditional explanations. Even if the challenges seem almost insurmountable, as in the case of climate change or re-inventing democracy, there is no question that we can do it, if we focus our collective minds and political will on it (as the Corona crisis has shown). If learning and even excellence is within reach for every one of us (Ericsson and Pool 2016); if we managed to end slavery, destroy Hitler and render Stalinism obsolete; if we succeeded in putting humans on the moon, and managed to phase out numerous substances that deplete the Ozone Layer (Montreal Protocol; see Solomon 2019), there is no *a priori*, inherent, insuperable barrier to a better future. This is corroborated by history: there was never a time in history where so many people had such a high quality of life and access to freedom as today.

In this fight for a better future, we have to get our priorities right:

“Given the immense and complex problems of power, wealth, exploitation and oppression, we need the best, most accurate knowledge there is to solve them, from a wide range of disciplines. What we most often tend to do in our circles, though, is to give in to the craving to wish us back into a pre-modern simplicity where wishful thinking was thought to help. No: let us firmly arrive in the 21st century. Or, in other words: if we want eco-justice [or sustainability] to succeed we need five things:

- we need to remember Horkheimer and Adorno [see below] and fight oppression on all levels: within ourselves, between us and as exploitation of nature;
- we need to take Kant seriously and truly have the courage to emerge “from [our] self-imposed immaturity”;
- we need to be absolutely sure that our arguments are scientifically sound and watertight, and don’t rest on superstition, unreason or belief;
- we need to be the role models in everything we *do*; the preaching to others we can leave to our brothers stuck in medieval mindsets;
- we need to be sure that we pick the right friends (science rather than unreason) and the right enemies (corporations, power, wealth rather than science, modernity and the enlightenment).” (Jucker 2016, 39)

There might well be myriad pressing issues for each of us as a person. However, faced with climate change and other urgent challenges (such as equality and justice within and between societies¹³), we as a society, as

¹³ In their thoroughly researched book *Spirit Level* Wilkinson and Pickett show that

humankind, have to address the most important issues, the ones where we can make a real, long-term difference for the biggest number of people. No single book can deal with all of them. I therefore focus here on those topics, which do not receive the attention they deserve if we are to respond to our existential crisis on the basis of the “best available science” (Thunberg 2019b).

Globally, there is a frantic search for quick fixes to complex problems such as climate change, immigration, technological change or political disintegration. This book is a warning not to repeat mistakes of the past. Climate change is a colossal danger to the future of human life on this planet. We simply cannot afford to get it wrong. We need to complement any calls for urgent action with equally urgent calls for thoroughness and best available evidence. This is why the book addresses five fundamental questions:

- What are our tools and methodologies for understanding reality which can make us confident that we get the answers right? (chapter two)
- What are the world-views and mental models, which are clearly *not fit* to help us arrive at sound solutions? (chapter three)
- What are the most pressing problems we *also* need to solve so that we stand a chance to win the battle against climate change? (chapter four)
- What are the political structures we need so that the best available solutions are actually implemented and that traditional impediments to change – like manipulation of the people, structures of power and wealth – are overcome? (chapter five)
- How can education contribute to all of this? (chapter six)

The reasoning will at times be provocative: take it as a proposition for debate. My goal throughout was to write *not* in the spirit of ‘I know’, but in the dedicated spirit of ‘let us not fool ourselves’, ‘let us really get down

equal societies consistently score significantly better than unequal ones. Almost all problems which turn our modern societies into “social failures” are more common in unequal societies: “level of trust, mental illness (including drug and alcohol addiction), life expectancy and infant mortality, obesity, children’s educational performance, teenage births, homicides, imprisonment rates, social mobility” (Wilkinson and Pickett 2010, 18-19). The conclusion from their book: “The evidence shows that reducing inequality is the best way of improving the quality of the social environment, and so the real quality of life, for all of us. (...) this includes the better-off.” (2010, 29)

to understanding our complex reality, even if the best shot is a limited attempt’.

Greta Thunberg says: “You are not mature enough to tell it like it is.” (2018) The book aims to provide tools so that we *can* grow up and get out of our echo chambers. However, even if we tell it as it is, we will not create a meaningful future without a perspective. Therefore, I give you a sketch of a vision of the future – a vision which can only be attained if we all do our individual homework, but also put the democratic and economic structures in place to make sure that abuse by power, wealth and free-riders cannot happen or is at least minimised.

Vision of a sustainable society

Without wanting to endorse Max Horkheimer and Theodor W. Adorno (and the Frankfurt School of Critical Theory) as a whole, I nevertheless think that they have defined the three dimensions of human liberation succinctly:

- (1) freedom from oppression within oneself,
- (2) freedom from oppression through other people (or corporations or states or organised crime etc.),
- (3) absence of exploitation of nature (1986, 61).

You could also describe this as a situation where (virtually) no hierarchies between people exist and where there is no abuse of power, or indeed no power structures that allow such an abuse. In such a world, there would be no exploitation of nature, or other species, or other people elsewhere in the world, or future generations, to facilitate our lifestyle. In other words, there is no way that our lifestyle would be beyond what a just and equitable share of global biocapacity would allow (Global Footprint Network 2020). Yet Horkheimer and Adorno’s vision importantly also focuses on the world within. In this vision there is also no oppression from within: no belief systems or traditions or social structures or social media (Turkle 2011), or peer or family pressure (Frank 2020) to force us into an acceptance of subjugation which undermines self-determination, free will, freedom from fear and the true development of our human potential. To me this is the vision of becoming truly human, of a truly human society, without the shackles of slavery, religion, inequality, injustice, wealth, aristocracy, economic exploitation, capitalism, communism, nationalism, patriarchy, sexism, ...

With John Lennon's "Imagine" in the ear (Lennon 1971), it seems easy to imagine such a world where the aims of the French Revolution become reality: "liberty, equality, brother- and sisterhood"; a world where a person is a human being and not a refugee; where woman and girls are equals in a true sense with men and boys, and not pressed into a state of dependency through moral laws which have long lost their validity; where all people respect the fundamental values of an open, democratic, secular society, based on knowledge and understanding, and not on myths or oppressive belief systems such as religions, autocratic rules, and power structures based on status and wealth.

A note on style and form

If I take seriously the insights into the limitations of our subjective perception and cognition, which are elaborated in chapter two, I *must attempt* to do both at the same time: on the one hand, I must label and make transparent that I cannot but say 'I' because the book as a whole is clearly and distinctly my perspective and my understanding. On the other hand, given the evidence that our own perception is prone to error and that reliable knowledge and understanding only flows from the accumulated, best collective knowledge we have in any given field, it is evident that I cannot claim the presented insights as mine. 'Translating' this knowledge into 'my narrative from my own heart and head' would be grossly misleading you, the reader. It would also be hubris. Giving you the evidence as much as possible 'straight from the horse's mouth', from the specialist scientists in the field, seems to me the best possible way to make transparent and palpable that arriving at an understanding of our complex world is in our days *always* a collective, multi-voice endeavour, which is necessarily inter- and transdisciplinary. In this book, I map this collective endeavour to understand the territory with numerous quotations. To me, this is far more honest than translating what these scientists found into my own words – whether in an 'I' or 'We' narrative. Too much would be lost in translation. I know that this is unusual, but I think that we should heed Greta Thunberg's insistence on honesty, on the need "to speak clearly" (2018). Given the urgency of our predicament in the face of climate change, biodiversity loss and overpopulation we need to find new forms of talking and writing to each other, reflecting truth and honesty.

We live in a dramatically complex reality and understanding this reality takes a lot of conscious effort. Kahneman's System 1 thinking, our craving for easy answers, for an easy style, for a neat, light and sweet narrative will never allow us to understand this reality in an adequate way.

CHAPTER TWO

SCIENCE *VERSUS* OBSCURANTISM: ... AND UNDERSTAND WE MUST

In our world of over-abundance of ‘information’, via search engines, social media, traditional media, advertising, books, videos, podcasts and much more, it is admittedly not an easy thing to move from mere words, images and sounds on a (web)page to knowledge and understanding. Yet over the last 250 years, what I call the scientific approach has become a truly unique tool – different in quality from any other tool we had before – for understanding how the world (including humans) works. The scientific approach is the best epistemology – i.e. theory of knowledge, especially with regard to its methods, validity, and scope, and the distinction between justified belief and opinion – that we have.¹⁴ Why is it so different? Why should we prefer it to any other approach? What makes us so sure that it is the best tool on offer? There are a number of reasons, which really have convinced me that we have no other option.

2.1 Don’t believe me, go check the available evidence for yourself

Here is the first:

“Science is born from this act of humility: not trusting blindly in our past knowledge and our intuition. Not believing what everyone says. Not having faith in the accumulated knowledge of our fathers and grandfathers.

¹⁴ I call this epistemology the “scientific approach” rather than the “scientific method”, since, as Oreskes rightly states, “there is now broad agreement (...) that there is no (singular) scientific method” (2019, 55). Rather, what I call the “scientific approach” is a meta-method, which primarily consists in the willingness to accept and transcend one’s own limitations to knowledge and understanding, and to acknowledge the openness of knowledge to changes and corrections over time. In Oreskes’ view “open, critical, and communal vetting of evidence” is crucial to producing reliable knowledge (2019, 66).

We learn nothing if we think that we already know the essentials, if we assume that they were written in a book or known by the elders of the tribe.” (Rovelli 2016b, 229)

If we are serious about the above notion of freedom, access to knowledge and understanding should be, at least in principle, absolutely free, with no barriers or pre-requisites. It should not depend on your social status, on your wealth, on your hierarchical position in relation to power, on your race, sex, age, or anything else. It should also not depend on other people – such as those you might depend on for your livelihood –, regulating access or indeed filtering and transmitting knowledge to you. You should have free access not just to the knowledge itself, but also to the evidence it is based on. No authority should ever be in a position to tell you: “It is just as I say, believe me!”¹⁵ You have every right in the world to reply as suggested by the Royal Society of London or Horace:

“A real scientist wants to make her own, independent check on the measurements reported by someone else: ‘*Nullius in verba*’ is the motto of the Royal Society of London: ‘Don’t believe what people tell you, however authoritative they may be.’ [Footnote 8: *Nullius addictus iuratae in verba magistri*: ‘I am not bound to swear allegiance to the word of any master.’ Horace, *Epistulae*.]” (Frith 2007, 6)

This approach to knowledge should make us sceptical about the following:

- Gurus, doctors, dieticians, sects or politicians who claim that they single-handedly and for good solved a long-standing mystery.
- All religions of the world, because they rely on an authoritarian knowledge model: we, the church, clergymen, the holy book, tell you the truth, and you have no option but to believe us (see chapter three).
- Everybody who tries to convince you that there is a short, simple, black-and-white answer to any problem we face. Think of “Brexit

¹⁵ Glenn Strachan has helpfully pointed out that I should clarify why I try to avoid the word ‘believe’. In this book, I tend to use it as shorthand for blind faith in unsubstantiated stories and opinions, for ‘not evidence-based’. Yet Glenn rightly insists that some people use the term quite in line with what this book is all about. They accept that knowledge is emergent and can change and the word ‘believe’ is a shorthand summing-up of the position: ‘As far as I can tell this is the case, but I know that this might change’ (Glenn Strachan, Email to the author, November 8, 2019).

will solve all our problems.” / “The wall to Mexico will solve all our problems and make America great again.” / “All women are victims and all men are rapists.” / “All women are there to obey and pleasure men.”¹⁶, etc.

Whenever someone or a group or a self-help book or a so-called expert tells you “I know, you can trust me, I have found out what the others didn’t, I will solve all your problems, I have all the answers”, you can safely ignore them. Unless what these people say has been independently tested, corroborated by many people, unless it has stood the test of time, the likelihood that there is much valuable insight in the proclaimed truth is very slim. We have learnt from history, that finding solutions to complex problems simply does not work this way. Even Einstein wouldn’t have been the impressive scientist he was, if it weren’t for hundreds of thousands of experiments testing every possible claim and prediction of his General Theory of Relativity, trying to prove it wrong. He himself would never have said: “believe me”. He would have said “Go check for yourself!”

It might be worth reclaiming the term ‘expert’ here, as Glenn Strachan suggested.¹⁷ Many populist politicians – in particular the ‘leave’-campaign in the UK, but also notoriously Donald Trump – have invested a great deal of effort into rubbishing the notion of experts. Below in chapter five, we will see why this is an ingenious ploy by totalitarian politicians to make people follow them blindly. We need a differentiated approach. We must arrive at a clear understanding of what we ourselves can know and cannot know, but we also need to humbly acknowledge that without the careful and collaborative efforts of many scientists the world over, we individually cannot know very much. We need a clear distinction between ‘false’ experts, who have not tested their assertions, on the one hand, and genuine experts on the other, who have put in the hard work to support their assertions, to build and evaluate their understanding on the basis of the best available evidence.

I like to call this triangulation. It works for any problem we might investigate, linear, non-linear, wicked, or seemingly not open to a scientific

¹⁶ It took Switzerland until 1985 to revoke its old marriage law, which guaranteed the husband’s role as head of the family by allowing him to prevent his wife from working, to choose the couple’s place of residence, and to manage the savings his wife had accrued before the marriage as well as her inheritance. It also prevented a wife from opening a bank account without her husband’s approval (The New York Times 1985, Section A, 6).

¹⁷ Glenn Strachan, Email to the author, November 8, 2019.

approach. If you cannot confirm a claim by arriving at the same conclusions from various angles, through different, methodologically independent experiments, through tests by different people, you know it is not a truth, but at the very most, a hypothesis in need of further research and proof.

2.2 The limits of human cognition

Here is the second reason why I am convinced that we have no better tool than the scientific approach which deliberately goes out of its way to corroborate anything by external, objectively verifiable methods, also with the help of machines and independent measurements. The mere fact that our cognition and our perception, the way our brain constructs our conscious understanding of the world is so prone to errors, misconceptions, illusions and plain delusion, means that no approach to knowledge which places too much faith into subjective readings of the world can muster much confidence. I know that this statement sounds harsh, but there is no flattering way of putting it. If we look at history, this seems blatantly obvious. If you just think of some of the most monstrous examples, say Stalin, Hitler or any of the world's religions, you immediately see that it is easily possible to make millions of people believe totally absurd things with utmost conviction, and then to make them act on these convictions, i.e. displace and kill millions of their own countrymen, exterminate six million jews or wage wars against non-believers.

There is a wealth of thoroughly tested results from neuroscience, psychology and memory research, which should make us very humble indeed, whenever we – or anybody else, for that matter – individually claim to know something for sure.

In pulling together the experimental evidence in his field, Chris Frith aims to show how our conscious cognition system works. Our perceptual senses, the nervous system and the computations going on in our brain construct and treat any thought, emotion, or pain before it enters our consciousness. Frith does not bemoan this fact. In his and others' view, it is simply a necessary set-up, developed through evolution, to be able to live and navigate in a world replete with myriad stimuli. However, in order to appreciate how we work and how perception of the world is constructed we need to understand these processes: "By seeing through these illusions created by our brain, we can begin to develop a science that explains how the brain creates the mind" (Frith 2007, 17):

“(...) even an ordinary, healthy brain does not always give us a true picture of the world. Because we have no direct connection to the physical world around us, our brains have to make inferences about that world on the basis of the crude sensations they receive from our eyes, ears, and all the other sense organs. These inferences can be wrong.” (Frith 2007, 60)

“(...) our experience of an effortless interaction with the world – through our perceptions and actions – is an illusion. We have no direct contact with the world or even with our own bodies. Our brain creates this illusion by hiding from us all the complex processes that are involved in discovering about the world. We are simply not aware of all the inferences and choices our brain constantly has to make.” (Frith 2007, 81; see Kahneman 2012, 52)

“What I perceive are not the crude and ambiguous cues that impinge from the outside world onto my eyes and my ears and my fingers. I perceive something much richer – a picture that combines all these crude signals with a wealth of past experience. My perception is a prediction of what ought to be out there in the world. And this prediction is constantly tested by action.” (Frith 2007, 132)¹⁸

“So, what we actually perceive are our brain’s models of the world. They are not the world itself, but, for us, they are as good as. You could say that our perceptions are fantasies that coincide with reality. Furthermore, if no sensory signals are available, then our brains fills in the missing information.” (Frith 2007, 134-135)¹⁹

¹⁸ Linden expresses this fact as follows: “Our brains naturally bind together information from multiple senses to create a holistic perception of events and objects.” (Linden 2016, 203) Using the example of pain, he makes clear that this creation is a construction, read manipulation, based on expectations and experiences: “The truly amazing fact is that *the brain is exerting control over the information that it receives*. It is not just taking in all the data and then biasing its perceptions and responses based upon the present emotional or cognitive state; rather, through these descending nerve fibres, it is *controlling* which sensory information will be received from the spinal cord. This is a weird and counterintuitive state of affairs. The brain actively and subconsciously suppresses or enhances pain information on a moment-to-moment basis. It spins the media, so to speak.” (Linden 2016, 164) Another example is if somebody kisses you. You have exactly the same sensory input, but a very different conscious feeling, depending on whether it is a complete stranger or your lover.

¹⁹ “(...) the brain is an inference machine, generating hypotheses and fantasies that are tested against sensory data. Put simply, the brain is – literally – a fantastic organ (fantastic: from Greek *phantastikos*, able to create mental images, from *phantazesthai*).” (Friston 2013, 1328)

“We are embedded in the mental world of others just as we are embedded in the physical world. What we are currently doing and thinking is moulded by whomever we are interacting with. But this is not how we experience ourselves. We experience ourselves as agents with minds of our own.” (Frith 2007, 184)

Dennett uses the image of a graphical user-interface on a computer (or tablet or mobile phone) to explain this construct/illusion of our self. Windows 10 or macOS Mojave or Linux Ubuntu are hiding as well as translating and interacting with the computer code and hardware running in the background:

“And what is this self? Not a dedicated portion of neural circuitry but rather like the end-user of an operating system. (...) Curiously, then, our *first-person* point of view of our own minds is not so different from our *second-person* point of view of others’ minds: we don’t see, or hear, or feel, the complicated neural machinery churning away in our brains but have to settle for an interpreted, digested version, a user-illusion that is so familiar to us that we take it not just for reality but also for the most indubitable and intimately known reality of all.” (Dennett 2017, 345)

“Our access to our own thinking, and especially to the causation and dynamics of its subpersonal parts, is really no better than our access to our digestive processes; we have to rely on the rather narrow and heavily edited channel that responds to our incessant curiosity with user-friendly deliverances (...).” (Dennett 2017, 346)

“Collaborating with other investigators on the study of your own consciousness (adopting, if you like, the ‘second-person point of view’) is the way to take consciousness, as a phenomenon, as seriously as it can be taken. Insisting, in resistance to this, that you know more about your own consciousness just because it’s yours, is lapsing into dogma.” (Dennett 2017, 351)

Our brain creates illusions – such as a distinction between the physical and the mental world as well as the illusion that our mental world is isolated and private – so that we can actually live and act in the world. These illusions underplay the fact how deeply and utterly we are tied to, and dependent on, interacting with the physical and social world,²⁰ in

²⁰ Beautifully expressed by Haskell: “Atmosphere and plant make each other: plant as a temporary crystallization of carbon, air as a product of 400 million years of forest breath. Neither tree nor air has a narrative, a telos of its own, for neither is its own. For the air, the tree, and the forest, form and narrative emerge from

order to see, sense, think, and understand. These illusions also conceal that the brain creates the mind, hiding a lot of sensory and information processing from our consciousness. It underplays the fact that we do not live in a Cartesian dualist world, but in one, continuous materialist world, not in need of anything transcendent. There is no immaterial world. What we casually call immaterial, including social interactions, love, beauty, or consciousness, either can be explained in materialist terms, or is simply an emergent phenomenon of material reality. The dualist world is dead, such is, I would argue, the scientific consensus in the 21st century. As Capra and Luisi put it: “Mind is always present in a bodily structure; (...). The same holds for human consciousness. Consciousness is not a transcendent entity, but it is always manifest within an organic living structure.” (Capra and Luisi 2014, 142) This means that “the human mind is inherently embodied. The very structure of reason arises from our bodies and brains” (Capra and Luisi 2014, 274; see also Kahneman 2012, 51): “There is no immortal soul, collective energy, or other non-biological component that encodes our individual mental selves.” (Linden 2012, 175)

Kahneman is very useful in illustrating what we have seen above. His research makes palpable the conclusions we should draw from these insights for our everyday and political lives. What Frith calls “all the inferences and choices our brain constantly has to make” (2007, 81) and Peters calls “our inner chimp” (Peters 2012), Kahneman calls “System 1”. He characterises it as follows (Kahneman 2012):

- “System 1 operates automatically and quickly, with little or no effort and no sense of voluntary control.” (20)
- “The capabilities of System 1 include innate skills that we share with other animals. We are born prepared to perceive the world around us, recognize objects, orient attention, avoid losses, and fear spiders. Other mental activities become fast and automatic through prolonged practice. System 1 has learned associations between ideas (the capital of France?); it has also learned skills such as reading and understanding nuances of social situations. Some skills, such as finding strong chess moves, are acquired only by specialized experts. Others are widely shared.” (21-22)
- “It appears to be a feature of System 1 that cognitive ease is associated with good feelings.” (66)

relationship. Selves are ephemeral aggregations, made of the enduring substances of life – connections and conversations. (...) Instead, like olive groves, bonsai trees bring to the surface what is harder to discern elsewhere: that human lives and tree lives are made, always, from relationships.” (Haskell 2017, 249; see also *ibid.*, x, 45, 73-74)

- “(...) many people are overconfident, prone to place too much faith in their intuitions. (...) This experiment has discouraging implications for reasoning in everyday life. It suggests that when people believe a conclusion is true, they are very likely to believe arguments that appear to support it even when these arguments are unsound. If System 1 is involved, the conclusion comes first and the arguments follow.” (45)
- System 1 “effortlessly originat[es] impressions and feelings that are the main sources of the explicit beliefs and deliberate choices of System 2 [our conscious self].” (21)
- “(...) System 1 can respond to impressions of events of which System 2 is *unaware*. Indeed, the mere exposure effect is actually stronger for stimuli that *the individual never consciously sees*.” (67; italics added)
- “These findings add to the growing evidence that good mood, intuition, creativity, gullibility, and increased reliance on System 1 form a cluster.” (69)
- “The main function of System 1 is to maintain and update a model of your personal world, which represents what is normal in it. The model is constructed by associations that link ideas of circumstances, events, actions, and outcomes that co-occur with some regularity, either at the same time or within a relatively short interval. As these links are formed and strengthened, the pattern of associated ideas comes to represent the structure of events in your life, and it determines your interpretation of the present as well as your expectations of the future.” (71)
- “System 1 is *radically insensitive* to both the *quality and the quantity* of the information that gives rise to impressions and intuitions.” (86; italics added)
- “System 1 has been shaped by evolution to provide a continuous assessment of the main problems that an organism must solve to survive: How are things going? Is there a threat or a major opportunity? Is everything normal? Should I approach or avoid? The questions are perhaps less urgent for a human in a city environment than for a gazelle on the savannah, but we have inherited the neural mechanisms that evolved to provide ongoing assessments of threat level, and they have not been turned off. Situations are constantly evaluated as good or bad, requiring escape or permitting approach. Good mood and cognitive ease are the human equivalents of assessments of safety and familiarity.” (90)²¹

The conclusions from this analysis are both straightforward in evolutionary terms, but rather frightening when it comes to our ‘uncritical’ self-awareness and its implications for rational reasoning as advocated

²¹ You can find a good summary of the features of System 1 on p. 105 of Kahneman 2012.

above: “Humans today rely on cognitive faculties that worked well enough in traditional societies, but which we now see are infested with bugs.” (Pinker 2018, 25) For Kahneman it is quite clear that we have the capacity to overcome the limitations and cognitive biases and errors associated with System 1 (for a good compilation of these cognitive biases see: Wood 2015, Desjardins 2018), bearing in mind that on the whole it works quite well in everyday situations. System 2, as he calls it, allows us to consciously compare, make choices, reason analytically, rationally and slowly (hence the title of Kahneman’s book, *Thinking, fast [System 1] and slow [System 2]*), think through issues, come to reasoned conclusions and override the suggested decisions and fallacies of System 1 (Kahneman 2012, 415). However, there are also various issues with System 2 which we have to bear in mind (Kahneman 2012):

- “You can also feel a surge of conscious attention whenever you are surprised. System 2 is activated when an event is detected that violates the model of the world that System 1 maintains. (...) In summary, most of what you (your System 2) think and do originates in your System 1, but System 2 takes over when things get difficult, and it normally has the last word.” (24-25)
- “System 2 allocates attention to the effortful mental activities that demand it, including complex computations. The operations of System 2 are often associated with the subjective experience of agency, choice, and concentration. (...) When we think of ourselves, we identify with System 2, the conscious, reasoning self that has beliefs, makes choices, and decides what to think about and what to do. Although System 2 believes itself to be where the action is, the automatic System 1 is the hero of the book.” (21)
- “The moral is significant: when System 2 is otherwise engaged, *we will believe almost anything*. System 1 is gullible and biased to believe, System 2 is in charge of doubting and unbelieving, but System 2 is sometimes busy, and often lazy. Indeed, there is evidence that people are more likely to be influenced by empty persuasive messages, such as commercials, when they are tired and depleted.” (81; italics added)
- “Several psychological studies have shown that people who are simultaneously challenged by a demanding cognitive task and by a temptation are more likely to yield to the temptation. (...) People who are cognitively busy are also more likely to make selfish choices, use sexist language, and make superficial judgments in social situations.” (41)
- “The attentive System 2 is who we think we are. System 2 articulates judgments and makes choices, but it often endorses or rationalizes ideas and feelings that were generated by System 1. You may not know that you are optimistic about a project because something about its

leader reminds you of your beloved sister, or that you dislike a person who looks vaguely like your dentist. If asked for an explanation, however, you will search your memory for presentable reasons and will certainly find some. Moreover, you will believe the story you make up.” (415)

- “However, System 2 is not a paragon of rationality. Its abilities are limited and so is the knowledge to which it has access. We do not always think straight when we reason, and the errors are not always due to intrusive and incorrect intuitions. Often we make mistakes because we (our System 2) do not know any better.” (415)²²

While we clearly have a tool to make sound, rational, informed judgements, to understand issues deeply and in all their complexity, this tool itself has its limitations. System 1 is fast, automatic and always offers a way forward, however unsound that may be at certain times. System 2, on the other hand, takes a lot of effort and energy and it is generally lazy. So if System 1 has a solution at hand, System 2 will go with it, unless there is a conscious, deliberate effort. Kahneman:

“A general ‘law of least effort’ applies to cognitive as well as physical exertion. The law asserts that if there are several ways of achieving the same goal, people will eventually gravitate to the least demanding course of action. In the economy of action, effort is a cost, and the acquisition of skill is driven by the balance of benefits and costs. Laziness is built deep into our nature.” (2012, 35; see Martin and Schumann 1997, 28)²³

I am going about this at great lengths because we should not underestimate the consequences of these insights and also the fact that *nobody* is an exception or ‘better’. Kahneman does not mince words:

“The notion that we have limited access to the workings of our minds is difficult to accept because, naturally, it is alien to our [subjective] experience, but it is true: you know far less about yourself than you feel you do.” (Kahneman 2012, 52)²⁴

²² Keith Stanovich calls these limits to System 2 thinking “dysrationalia” (see Robson 2019, 44).

²³ Nicolas Carr made the very important point that we have invented a very powerful technology with the internet, which strengthens System 1 approaches, playing into this ‘law of least effort’ (Carr 2010, 116-166).

²⁴ There is nothing to indicate that this particular statement by Kahneman is not true. However, Kahneman 2012, chapter 4, from which I am partly quoting, is a very interesting test case of the scientific approach in action. In a recent podcast with Shane Parrish Kahneman admits that he was totally convinced at the time that

This means in conclusion – with tremendous implications for education – that we should become decidedly less confident and more humble about the value, correctness and accuracy of our own subjective experiences, thoughts and world-views – and equally of those of others who claim that their specific unique experience and insights are particularly valid and true.

Moreover, do not think this does not apply to you or me. Kahneman and others have made a convincing case that these limitations in cognition are pretty much universal. We think that we only have to “apply [our] own experience, knowledge, and reasoning” to arrive at sound judgements. But “this process is fraught at every stage with the potential for distortions in judgement that result from cognitive biases”. We are literally “incapable of recognizing [our] own biases”: “You may accept that you have biases, but you cannot eliminate them in yourself”. What we can do is “apply rational thought to detect others’ faulty intuition”, “in other words, we can use System 2 thinking to spot System 1 errors” in others (Kahneman et al. 2011). This is the reason why we need others, why we need collective reasoning processes – as the scientific approach requires – to arrive at sound judgements. We cannot do it on our own:

“Without a thought collective, science could not exist. [Fleck] wrote: ‘A truly isolated investigator is impossible ... Thinking is a collective activity. (...)’ (...) Science (...) has a democratic character: all researchers can participate in an equitable way, and through their interactions with each other, refine and change the views of the whole”. (Oreskes 2019, 30-31)

A clear call for diversity, one might think. However, diversity on its own, so much foregrounded by Oreskes, does not necessarily help.²⁵ The

the priming effect, discussed in said chapter 4, was well proven. But priming – the idea that subtle cues in people’s environment can have strong effects on their behaviour outside their awareness – is one of the ‘victims’ of the replication crisis in psychology. Kahneman, to his credit, has no issue with accepting that he was wrong (Kahneman 2019). Part of the problem was that the sample sizes were too small and only significant results were reported. The researchers analysing the initial studies conclude: “We can only hope that social psychologists will learn from the train wreck of social priming research and improve their research practices.” (Schimmack et al. 2017; see also Chivers 2019) However, another part of the replication crisis is that there are a number of pitfalls in how replication is practised. Reflecting on this, Kahneman suggested a “new etiquette for replication” to solve these issues (Kahneman 2014). Kahneman argues, here as well, for an increase in reasoned, slowed-down approaches.

²⁵ For a historian of science Oreskes often works rather unscientifically. Many of her claims, in particular her main point about diversity, are only supported by

mere fact that women, people of colour, indigenous peoples or LGBTQ people take part in science does not *a priori* make for better science or better understanding of reality, as inversely the participation of white, heterosexual men does not necessarily make for bad science. Scientists are outstanding scientists not by virtue of their feminist, queer, or socialist beliefs, as Oreskes implies, but because they are original, ground-breaking, innovative, rigorous biologists, chemists, sociologists, system thinkers. The moral values, political views or qualities as a human being are not a causal predictor of the qualities and capabilities as a scientist. Given the democratic character of science mentioned by Oreskes, there are clearly no sound reasons whatsoever to exclude *anybody* from science. However, all the limitations of our cognition and all the psychological biases just mentioned, as well as the limitations by traditions, upbringing, and socialisation apply to all of us equally. In addition, very often minority groups have – not unlike the petroleum industry Oreskes finds “we have reason to distrust” (2019, 66) – a specific political agenda, a particular interest, often for very good historical reasons. Obviously, these moral or political interests can get into the way of good science – just as much as economic interests of industry often do. Here again we need to differentiate and do so every time: as Oreskes states, there are many industry scientists which make “fine contributions” to science, even if their employers might skew or withhold clear scientific results which undermine their economic interests (2019, 67). There were and are many outstanding contributions to science by white, old, heterosexual men, even if they or their scientific institutions might have been (and in some cases still are) sexist and racist. But for us to advance in our understanding, the following applies to everyone, without exception:

“The processes of critical interrogation rely on an assumption of good faith: that participants are interested in learning and have a shared interest in truth. It assumes that the participants do not have an intellectually compromising conflict of interest.” (Oreskes 2019, 68)

I fully support Oreskes’ call for science as a collective enterprise. Indeed, it is one of the main tenets of this book. Diversity – in the form of

analogies or assertions (see Oreskes 2019, 137), and while she goes to great lengths to show a few extreme examples of science gone awry, she does not attempt to quantify and compare these negative examples with positive examples of successes in science. Clearly, both are part of the history of science, but as stated at the very beginning, it might not suffice to stress the disaster *or* the miracle.

different methods, approaches as well as in the form of different groups of researchers contributing (traditional scientists, citizens' science, experienced professionals) – can and indeed often does add to the advancement of scientific insight and understanding. In this sense, it is certainly a good thing that the “Intergovernmental Panel on Climate Change – now one of the world’s largest aggregations of scientists – makes a particular point of seeking geographical, national, racial, and gender diversity in its chapter-writing teams” (Oreskes 2019, 59). But diversity only yields real benefits for a better understanding of the world, if the diversity of the scientific community is based on scientific credentials and an open, tolerant, self-critical interest in truth, not with an eye to please ‘political correctness’. For, whatever the gender, race, age and origin of a scientist, only their interest “in learning” and “truth” (rather than political, economic or self-interest), their capacity to utilise a scientific approach, as outlined above, and their willingness to take into account their own cognitive limitations and psychological biases, to critically review their upbringing, their ideological and religious beliefs, will render them capable of trustworthy, reliable scientific work. There is every reason to assume that feminist, queer, black or indigenous researchers do have the same potential to go as wildly astray, if they allow their scientific work to be influenced by their political ideologies and moral convictions, as all the examples that Oreskes assembles of white, old men going awry (Oreskes 2019, 69-146).

Robson adds an interesting little twist to this: this propensity for self-illusion might be *even more prevalent* in people with a high IQ, good education and even astonishing expertise in a given field. The first step to a solution, says Robson, “is to acknowledge the problem”. What we all need is “intellectual humility”, as advocated in this book: “the capacity to accept the limits of our judgement and to try to compensate for our fallibility”, for example with “actively open-minded thinking”, i.e. “the deliberate pursuit of alternative viewpoints and evidence that may question our opinions” (Robson 2019, 268-269; see Oreskes 2019, 138-139). This “can help us see through our bias blind spot, form more rational opinions, avoid misinformation, learn more effectively, and work more productively with the people around us” (Robson 2019, 263).

2.3 Illusions of memory

These insights are even more disturbingly corroborated by research on memory illusions by Julia Shaw. Her research, and previous research she builds on, have shattered quite a number of dearly held myths about memory. Here are some of the main findings from her book *The Memory*

Illusion. Remembering, Forgetting, and the Science of False Memory (2016):

- Brains are physiologically not capable of storing early memories long-term – impossible before age 2, mostly not happening before age 4 or 5. So it is simply impossible to have memories of your birth or even from before (1-26). Our brains mature over a long time, increasing the capacity to memorise best between age 13 to 25 (15-18).
- A lot of brain activity in teenage years is pruning – getting rid of unhelpful memories and connections, strengthening useful and important ones (17, 102-105). This is why sleep is so essential: it prunes, strengthens, reorganises and transforms memories (116-119). Imperfect memory and forgetting are crucial for survival; people who have exceptional memories are severely impaired in life (83-105).
- Recalling a memory seems not to recreate and strengthen a memory but rebuild it from scratch, anew (64-65; see also Bjork et al. 2013).
- Since memory is mostly associations, it is very powerful. It is able to be inventive, to create new ideas, at the price of creating false memories, partially or totally fabricated (71-81).
- Another driver is our desire for coherence in our (life-) stories: if we have insufficient information, our mind fills in the gaps. But there are lots of traps waiting: We are not good at remembering times and order, we store individual memory parts at different locations, enabling wrong recall, wrong associations, with our mind filling in the gaps (as we have seen above) (18-22, 42-51, 71-75, 195-215).
- *No* memory is safe from corruption (186): Because of the way memory works it is relatively easy to implant totally manufactured memories in people and make them fervently believe in them – they will not be able to tell the difference between these false and real memories. Social pressure, leading questions, assumptions and expectations all ‘help’ (155-182, 195-239). For example, photos can severely mislead our memories: 50% of people ‘remember’ an event if they are shown Photoshop-edited photographs, ‘showing’ them as part of the event (182). There is also sound evidence that eyewitnesses can strongly influence each other (198) and that people ‘steal’ memories of others and claim them their own (199-200, 213). Furthermore, the majority of us can be influenced by peers to give obviously wrong answers – just to conform (201). Digital media and ‘online’ memories seem to make all this much worse – mixing up of images, creating personas for online ‘impression’... (187-216).
- Humans need to perceive things (via senses or in imaginary mode) in order to encode them to memory and we need to pay attention in the process. One can simulate this if one focuses people on imagining things vividly, even if they never happened (28-42).

- Change blindness: We can only pay attention to a small section of all the information our senses generate, because of limited short-term memory and the evolutionary necessity to have broad categories (so that we recognise friends in other clothes, with different haircut etc.). This means that we filter out a lot (113-116; see the famous *invisible gorilla* selective attention task by Chabris and Simons 2010).
- Hypnosis, sleep-teaching, subliminal messaging all do not work for memory: you need conscious attention (119-133).
- There are no universal symptoms of child abuse, but plenty of evidence that leading and suggesting interview techniques lead to fabricated memories (217-239). On a similar note, repressed memories simply do not exist – there is no evidence for them at all – so you cannot un-repress them (228-233; see below on Freud and his disastrous legacy).

Shaw summaries:

“If I have done my job, your memory should now seem hopelessly fragile, impossibly inaccurate. To bring you to an acceptance that all of us have critically flawed memories is the very reason I wrote this book. You hopefully now appreciate just how plagued memory is by biological flaws, perceptual errors, contamination, attentional biases, overconfidence and confabulation.” (Shaw 2016, 241)

Taken seriously, all this gives tremendous weight to use a scientific approach, rather than one that trusts subjective experiences:

“As the world’s single most influential false memory expert Elizabeth Loftus said in her fantastic TED talk in 2013 [Loftus 2013], ‘Most people cherish their memories, know that they represent their identity, who they are, where they come from. And I appreciate that. I feel that way too. But I know from my work how much fiction is already in there. If I’ve learned anything from these decades of working on these problems, it’s this: just because somebody tells you something and they say it with confidence, just because they say it with lots of detail, just because they express emotion when they say it, it doesn’t mean that it really happened.’ This knowledge has the power to revolutionise the legal system and to help prevent miscarriages of justice.” (Shaw 2016, 254-255; see Loftus 2019, 2020)

Shaw and others have analysed many legal cases, involving what appear to be perfectly coherent, conclusive and convincing memories (of abuse or other things). It turns out that often these memories are, in fact, manufactured along the way by questioning, suggestions, dubious psychological techniques and false assumptions of the people involved.

So, whether it is the Kavanaugh nomination for the Supreme Court or #MeToo-accusations: if we were to employ a rational rather than an emotional approach to all this, we would need to do the following. Based on the knowledge of how memory works and how false memories are constructed, all the parties involved would first need to step back and say: “I seem to have these memories, but I know – despite my deepest instincts – I cannot trust them. Nor can you. So let’s sit together and look for independent evidence to establish what really might have happened, as carefully and self-critically as we can, without jumping to conclusions before the very end.” Or in Shaw’s words: “Everyone has the right to a fair trial, and that trial is only fair if there are empirically based standards of evidence” (Shaw 2016, 238) – as opposed to subjective allegations based on flawed memories. But then again, this would ask for Flaßpöhler’s differentiation which so rarely happens in these cases.

2.4 Claims or insights?

I give you another, very important reason, why trust in carefully corroborated science should be very high up your agenda. There are theories out there, which have no scientific merit whatsoever, yet they are influential beyond imagination, shaping the conception of how we talk about things like power or memory in philosophy, the arts, literature and popular culture. I am talking in particular about Sigmund Freud and psychoanalysis. The literature to prove the unscientific nature of Freud’s claims has been out there for a while (Gellner 1985; Webster 1995; Crews 1997), yet despite Webster’s well-founded claim that Freud’s concept of psychoanalysis is perhaps the most complex and successful pseudo-scientific theory in history, none of this has transferred to the public imagination. Shaw summarises:

“Freud based most of his published theories exclusively on interviews with his patients [i.e. subjective material highly prone to totally arbitrary interpretation], not on science. Indeed, it is tempting to say that Freud was not a scientist at all. If you don’t believe me, ask the Nobel Prize committee. After 12 years of Freud being nominated for the Nobel Prize, the committee actually hired an expert to inquire into his work. The expert came to the conclusion that Freud’s work was of no proven scientific value.” (Shaw 2016, 230)

We could say that this is sad, but long gone. However, worldwide millions of people are still subjected to these pseudo-scientific ideas, with direct, negative consequences for their health and their memories: “(...),

unfortunately, although they have all been discredited, Freud's assumptions about memory repression, the subconscious and retrieval therapy are all still represented in a subset of the therapeutic population." (Shaw 2016, 232)

In view of this frightening instance of an influential hoax in science I think it is a good moment to pause and draw some preliminary conclusions. We started this chapter with an invitation to use a scientific approach in order to accurately understand reality and base one's actions on these understandings. Along the way, we could corroborate two important insights:

1. We can explain the world in purely materialistic, scientific terms (Mario Bunge, see Droste 2015, 73-75). There is no need to evoke a Kantian or Cartesian dualism or some kind of mystery to explain what is going on. There is no separation between body and mind and there is no separation between instinct and consciousness: they are all phenomena of the same bodily world:

"These are hard times for anyone who wishes to defend Cartesian dualism – the idea that our minds are somehow separate from the workings of the material world, that our thinking is not done in our brain. There is evidence from neuroscience (...) making it abundantly clear that the brain really is the source of mental life." (Bloom 2018, 217; Mario Bunge, see Droste 2015, 79)

As the history of science has shown time and time again, there is no need to evoke magic or the supernatural: "What at first appears to be supernatural is shown in the end to have a rational, physical explanation." (Frith 2007, 39, Footnote 24; Dennett 2017, 28) Or in Rovelli's down-to-earth version: "In the course of the centuries we have come to realize just how very many wrong ideas we had." (Rovelli 2016b, xi) This is, for example, also true of intuition, another favourite of many people to cast into doubt a rational approach to understanding the world:

"The psychology of accurate intuition involves no magic. Perhaps the best short statement of it is by the great Herbert Simon, who studied chess masters and showed that after thousands of hours of practice they come to see the pieces on the board differently from the rest of us. You can feel Simon's impatience with the mythologizing of expert intuition when he writes: 'The situation has provided a cue; this cue has given the expert access to information stored in memory, and the information

provides the answer. Intuition is nothing more and nothing less than recognition.” (Kahneman 2012, 11)

Linden makes an even broader point, when confronted with attempts to understand touch:

“When confronted with experiences that are deeply emotional, transporting, or counter-intuitive, it is a fundamentally human response to seek explanations beyond the natural world. Touch is intrinsically emotional, and so the experience of touch is often subject to such inclinations. Yet the supernatural is not required to explain mysterious or transcendent touch sensations.” (Linden 2016, 208)

2. Because of the limitations of our cognition and perception, both conscious and unconscious;²⁶ because ‘common sense’ does not make sense; and also because we are severely hampered in our understanding of the world due to our culturally shaped experiences, traditions, unreflected belief systems (such as those handed down to us by our parents); because of myths, and the structure of our social and economic reality; because of all this we need the triangulation of science to understand reality: “By putting together the models of many people, we can construct a new model that is better than any model produced by a single individual.” (Frith 2007, 181) Reality and the best theories about reality are counter-intuitive,²⁷ complex and in the final account not readable by fast-track System 1-assumptions. Most of the important advances in science in the last hundred years, for example in quantum physics – the one theory with the most accurate predictive quality humankind has ever developed²⁸ –, have shown that intuition is a very poor guide to understanding the world:

²⁶ These limitations are, of course, since millennia exploited and abused by con artists (Konnikova 2016).

²⁷ “Each of these theories [General Theory of Relativity, quantum theory, etc.] has, when it is taken seriously, very counter-intuitive implications. Consequently, all sorts of attempts have been made to avoid facing those implications, by making *ad hoc* modifications or reinterpretations of the theories, or by arbitrarily narrowing their domain of applicability or simply by using them in practice but drawing no wider conclusions from them.” (Deutsch 1998, ix; see also Rovelli 2016b, 223)

²⁸ Contrary to popular belief and based on a misunderstanding of Heisenberg’s Uncertainty Principle, quantum theory does not mean anarchy, imprecisions or indeterminacy. It just means that we are not dealing with causal determinacy, but statistically determined probability: “Intellectual gurus of all kinds ignore the fact that for almost 100 years physics has been able to prove experimentally that

“Physics opens windows through which we see far into the distance. What we see does not cease to astonish us. We realize that we are full of prejudices and that our intuitive image of the world is partial, parochial, inadequate. Earth is not flat; it is not stationary. The world continues to change before our eyes as we gradually see it more extensively and more clearly. If we try to put together what we have learned in the twentieth century about the physical world, the clues point toward something profoundly different from our instinctive understanding of matter, space, and time.” (Rovelli 2016a, 49; see also Rovelli 2018)

Just think of Einstein’s General Theory of Relativity (which, incidentally, has nothing whatever to do with postmodernist, cultural relativism), which showed us that our ‘intuitive’, everyday assumption that mass, time and gravity is constant, is far from true; or consider our notion that matter is solid when it rather is empty space; or the fact that what we see with our eyes when we gaze into space is rendering only a very limited picture of what is really out there since there are a number of well-explained phenomena which make it impossible that our human vision ‘sees’ all there is (Crockett 2016). Werner Obrecht has very clearly stated this:

“Everyday thinking does not understand itself, is therefore uncritical and, if at all, only partially able to come to true statements. (...) Without a critical theory of itself and without a theory of the nervous system, everyday thinking (...) believes that it understands the material things in the world directly as they are (naïve realism). (...) Its implicit meta-theory is equal to the one in magical and religious world-views and is the source of resistance against the scientific world-view of adults.” (Obrecht 2009, 56; my translation)

Or in the words of Cox and Forshaw:

“Fortunately, Nature is not restricted to things that human beings can picture: Nature is richer than that. And, also fortunately, human beings have discovered mathematics, which allows them to deduce things that they cannot picture.” (Cox and Forshaw 2016, 123)

Frith, Kahneman and Shaw all urge us to be cautiously optimistic: since we cannot change our evolutionary gear, we have no option but

quantum physics is the most precise of all physical theories.” (Droste 2015, 69; my translation)

to develop approaches and strategies which keep these inbuilt error-prone systems in check:

“Because System 1 operates automatically and cannot be turned off at will, errors of intuitive thought are often difficult to prevent. (...) The best we can do is a compromise: learn to recognize situations in which mistakes are likely and try harder to avoid significant mistakes when the stakes are high. The premise of the book is that it is easier to recognize other people’s mistakes than our own.” (Kahneman 2012, 28)

“Can we be happy knowing that our memories are highly questionable? Absolutely. Happier, I would argue. We are now less likely to be a victim of our own memories, and can assume at least some control over this elusive process.” (Shaw 2016, 253)

“But I am optimistic. (...) Our beliefs are models of the world, and the real world out there is a gold standard for our models. In the end false beliefs can always be discarded because they make bad predictions. I believe that the truth is out there. As long as we have ways of showing that one model of the physical world works better than another, then we can aspire to developing a series of better and better models. At the end of this series, although it is infinite in the mathematical sense, lies the truth – the truth of how the world really is.” (Frith 2007, 182-183)

One thing is clear: understanding reality is not easy and it will demand considerable effort and self-discipline:

“Questioning what we believe and want is difficult at the best of times, and especially difficult when we most need to do it, but we can benefit from the informed opinions of others.” (Kahneman 2012, 3)

“So, overconfidence has far-reaching implications, from bias in our everyday internal dialogue when evaluating relationship fairness, to our inability to give our failures equal weight and acknowledgement to our successes, and our problematic assumptions about the knowledge other people have of us and we of them. It touches every aspect of our lives. Even if we wish to be humble and take pains to avoid overconfidence illusions, we may not be able to – they are largely the by-product of selective memory processes we cannot control.” (Shaw 2016, 143)

Knowing all this should make us approach everything we do, but especially educational undertakings, far more carefully. We have to look for scientific evidence for the educational theories we use, we have to look

for evidence for the effects of what we do, and we have to, more than anything else, avoid being guided by our subjective feelings, ideas, and intuitions. We need to construct education for a viable future as a co-creative, transdisciplinary, multi-people endeavour, and never as a one-(hu)man show.

2.5 The scientific approach: criticism, predictive power, reliability and distrust of certainty

I promised you a further reason for trusting only a scientific approach:

“Science is not reliable because it provides certainty. It is reliable because it provides us with the best answers we have at present. Science is the most we know so far about the problems confronting us. It is precisely its openness, the fact that it constantly calls current knowledge into question, which guarantees that the answers it offers are the best so far available: if you find better answers, these new answers become science. (...) The answers given by science, then, are not reliable because they are definitive. They are reliable because they are not definitive. They are reliable because they are the best available today. And they are the best we have because we don’t consider them to be definitive, but see them as open to improvement. It’s the awareness of our ignorance that gives science its reliability. And it is reliability that we need, not certainty. (...) The nature of scientific thinking is critical, rebellious and dissatisfied with a priori conceptions, with reverence and sacred or untouchable truth. The search for knowledge is not nourished by certainty: it is nourished by a radical distrust in certainty.” (Rovelli 2016b, 230-231)

There is no other way to make powerful and reliable predictions. Our most successful scientific theories, such as Einstein’s General Theory of Relativity or the other great discovery of the 20th century, quantum theory, are by far the most reliable and exact predictive theories. This is not just an academic issue. It means that most of what you encounter in everyday life works, not because of chance, but because we know that it does work. Otherwise, skyscrapers and bridges would fall down (Agrawal 2018), planes couldn’t fly, your GPS couldn’t calculate where you are, we wouldn’t have an accurate and reliable account of time, antibiotics and other medicines wouldn’t work, your surgeon couldn’t transplant your heart or replace your hip, etc. There is nothing that reliably, predictably and accurately works which is not underpinned by detailed, tried, contested and experimentally corroborated science.²⁹

²⁹ Sagan gives two good examples for this predictive power: “[Science] can tell

There is a good reason for this predictive power, and it is again something which sets science apart from any other endeavour to understand reality. Or as Linden says, when contemplating an accurate understanding of things like touch or itch: “That’s the fundamental power of biology: No amount of philosophical reasoning, linguistic analysis, or introspection could ever have resolved such matters.” (Linden 2016, 194-195) As opposed to dogma or any other ‘theories’ which rely exclusively on claims and opinions (such as Freud’s, see above), the scientific process is by design geared to falsification, detection of errors, rejection of false theories, and development of ever more accurate explanations, corroborated by independently replicable evidence. Karl Popper, whom I despised for many years on ideological grounds, Carl Sagan, and, more recently, Chris Frith have described these fundamental elements of the scientific approach as follows:

“But science is one of the very few human activities – perhaps the only one – in which errors are systematically criticized and fairly often, in time, corrected. This is why we can say that, in science, we often learn from our mistakes, and why we can speak clearly and sensibly about making progress there.” (Popper 1962, 216)

“When I speak of reason or rationalism, all I mean is the conviction that we can *learn* through criticism of our mistakes and errors, especially through criticism by others, and eventually also through self-criticism.” (Popper 1999, 84; italics in the original)³⁰

“The game of science is, in principle, without end. He who decides one day that scientific statements do not call for any further test, and that they can be regarded as finally verified, retires from the game.” (Popper 2002, 32)

“Science is a way of thinking much more than it is a body of knowledge. Its goal is to find out how the world works, to seek what regularities there

you a century in advance where the eclipse is going to be on Earth and when, say, totality will be, to the second. Think of the predictive power this implies. Think of how much you must understand to be able to say when and where there’s going to be an eclipse so far in the future. Or (the same physics exactly) imagine launching a spacecraft from Earth, like the Voyager spacecraft in 1977; 12 years later Voyager 1 arrives at Neptune within 100 kilometers or something of where it was supposed to be – not having to use some of the mid-course corrections that were available; 12 years, 5 billion kilometers, on target!” (Sagan 1995, 26)

³⁰ See Dawkins: “It is an essential part of the scientific enterprise to admit ignorance, even to exult in ignorance as a challenge to future conquests.” (2007, 151)

may be, to penetrate to the connections of things – from subnuclear particles, which may be the constituents of all matter, to living organisms, the human social community, and thence to the cosmos as a whole.” (Sagan 2011, 344)

“Science has built-in error-correcting mechanisms – because science recognizes that scientists, like everybody else, are fallible, that we make mistakes, that we’re driven by the same prejudices as everybody else. [In science] there are no forbidden questions. Arguments from authority are worthless. Claims must be demonstrated. Ad hominem arguments – arguments about the personality of somebody who disagrees with you – are irrelevant; (...).” (Sagan 1995, 27)

“Science involves a seemingly self-contradictory mix of attitudes: On the one hand, it requires an almost complete openness to all ideas, no matter how bizarre and weird they sound, a propensity to wonder. (...) But at the same time, science requires the most vigorous and uncompromising skepticism, because the vast majority of ideas are simply wrong, and the only way you can distinguish the right from the wrong, die wheat from the chaff, is by critical experiment and analysis.” (Sagan 1995, 30)

“Reaching [the] truth is the program of science. Science progresses by making models of the world, making predictions on the basis of these models, and using the errors in these predictions to construct better models.” (Frith 2007, 183; see Rovelli 2018, 132)

This is the challenge we have to master. An adequate, complex approach to reality necessitates that we come to accept the following as simultaneously true: we should rely on the best available answers today, and not settle for anything less. Yet at the same time, we have to be open to new evidence and novel explanations, if they provide better, more reliable models.

When I talk about the scientific approach I talk about this open mindset which will never accept any dogma, any claim by the powerful, the elites, tradition or anybody else at face value. It always wants proof, explanation, evidence, and always independent of the person that tries to impose a certain truth.³¹ Only if insights are replicable independently, if they work

³¹ We are, again, talking about differentiation. ‘One size fits all’ claims are hardly ever valid. Truth may indeed be different at different scales, what holds true at the sub-atomic level might be different at the atomic level. So we are forced to look carefully and closely, not to fall for generalisations and metaphors, which transpose findings from one level to another. I owe this qualification to Henry Liebling (Email to the author, November 5, 2019).

outside a specific community is there a chance that we are onto something which is beyond the illusions, the traditional ‘this is what we always believed’ and the self-justifications of individuals, communities and groups with vested interests: “It’s this demonstrability and repeatability that makes science unique: it requires no indoctrination to accept.” (Spadafino 2016) This approach is the only one, which allows us to liberate ourselves from the crutches of fear, of ignorance, of ‘eternal truth’ being forced upon us. Or to quote Kant again: we need to emerge “from [our] self-imposed immaturity” (Kant 1784). True to its enlightenment origins, we should not underestimate or wilfully neglect the liberating power of this approach:

“Science flings open the narrow window through which we are accustomed to viewing the spectrum of possibilities. We are liberated by calculation and reason to visit regions of possibility that had once seemed out of bounds or inhabited by dragons.” (Dawkins 2007, 418)

Of course, we need to add a word of caution here. Let us be as differentiated as we can also with a view to science, its theoretical and practical powers, but also its potential for abuse and destruction. We clearly have to acknowledge that the scientific approach as described by Popper, Sagan and Frith is not always followed by scientists and scientific institutions. In a capitalist world, where power, wealth, greed, prestige and social status have a formidable impact on shaping our lives, it would be foolish to assume that scientists would somehow be immune and better human beings than the rest of the earthlings. As we know from long-suppressed and manipulated scientific proof that smoking causes lung cancer (because this proof interfered with the profit interests of the tobacco industry), via a long story of suppressed negative findings on various toxic substances, foods, and medical drugs (Michaels 2008, 2020; Nestle 2015, 2018), via the abuse of science in Nazism and Stalinism (to name but two), to the distortion and abuse of the scientific evidence for human-induced climate change (Conway and Oreskes 2010), there is a long history of an arrogant and destructive side to science and knowledge. It arises when science forgets Popper’s humble insight that “the game of science is, in principle, without end”, when it abuses knowledge for the gain of economic and political power. In short, if science is not practised and used in its own spirit of openness, preparedness to correct errors, to learn in view of better evidence, if it is not employed for the sake of a better, fairer, more open, more democratic, more transparent, more equitable future, it can be equally or even more destructive than anything else. This is why we always have to think the two projects together,