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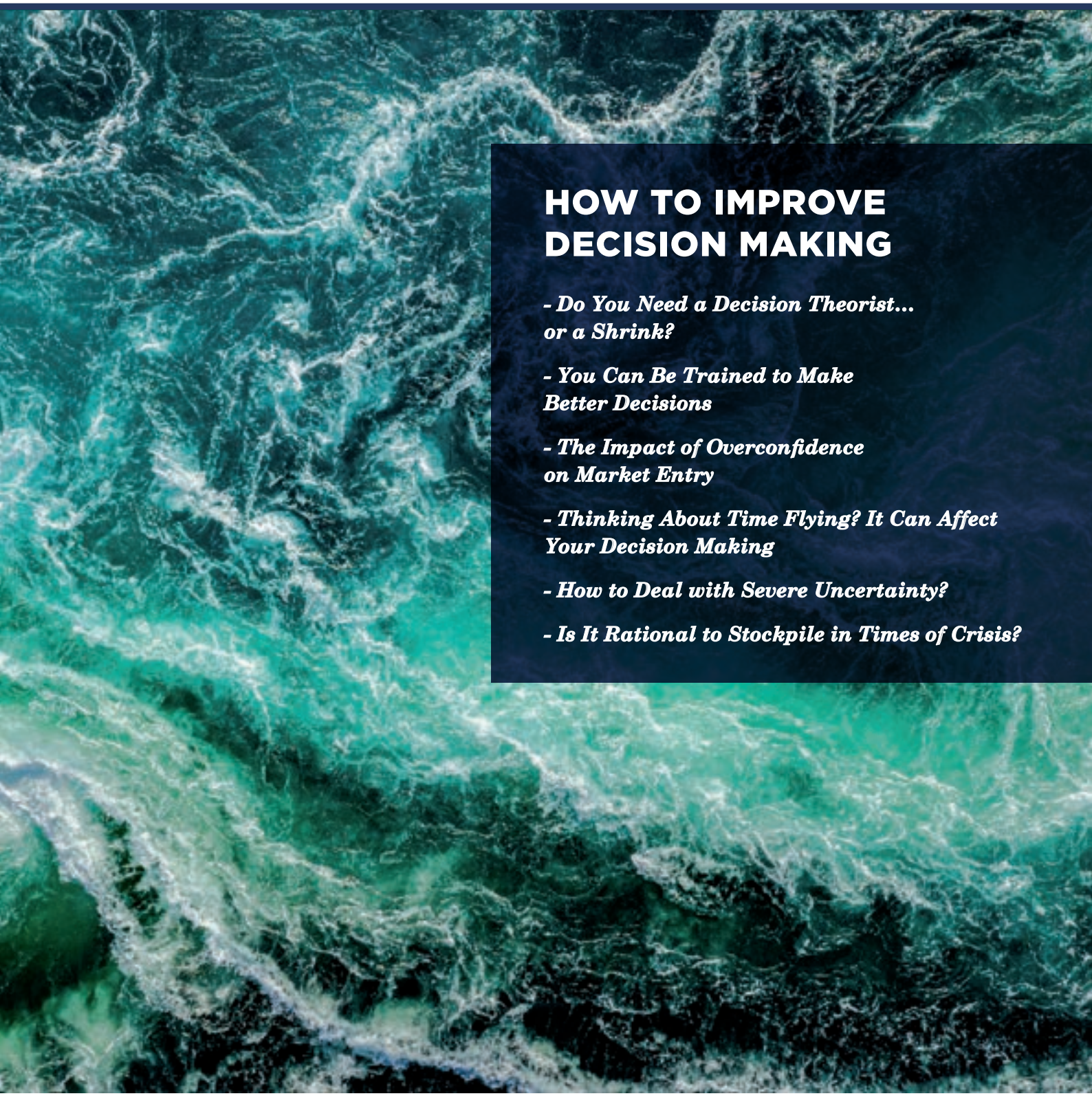

HOW TO IMPROVE DECISION MAKING

- *Do You Need a Decision Theorist... or a Shrink?*
- *You Can Be Trained to Make Better Decisions*
- *The Impact of Overconfidence on Market Entry*
- *Thinking About Time Flying? It Can Affect Your Decision Making*
- *How to Deal with Severe Uncertainty?*
- *Is It Rational to Stockpile in Times of Crisis?*

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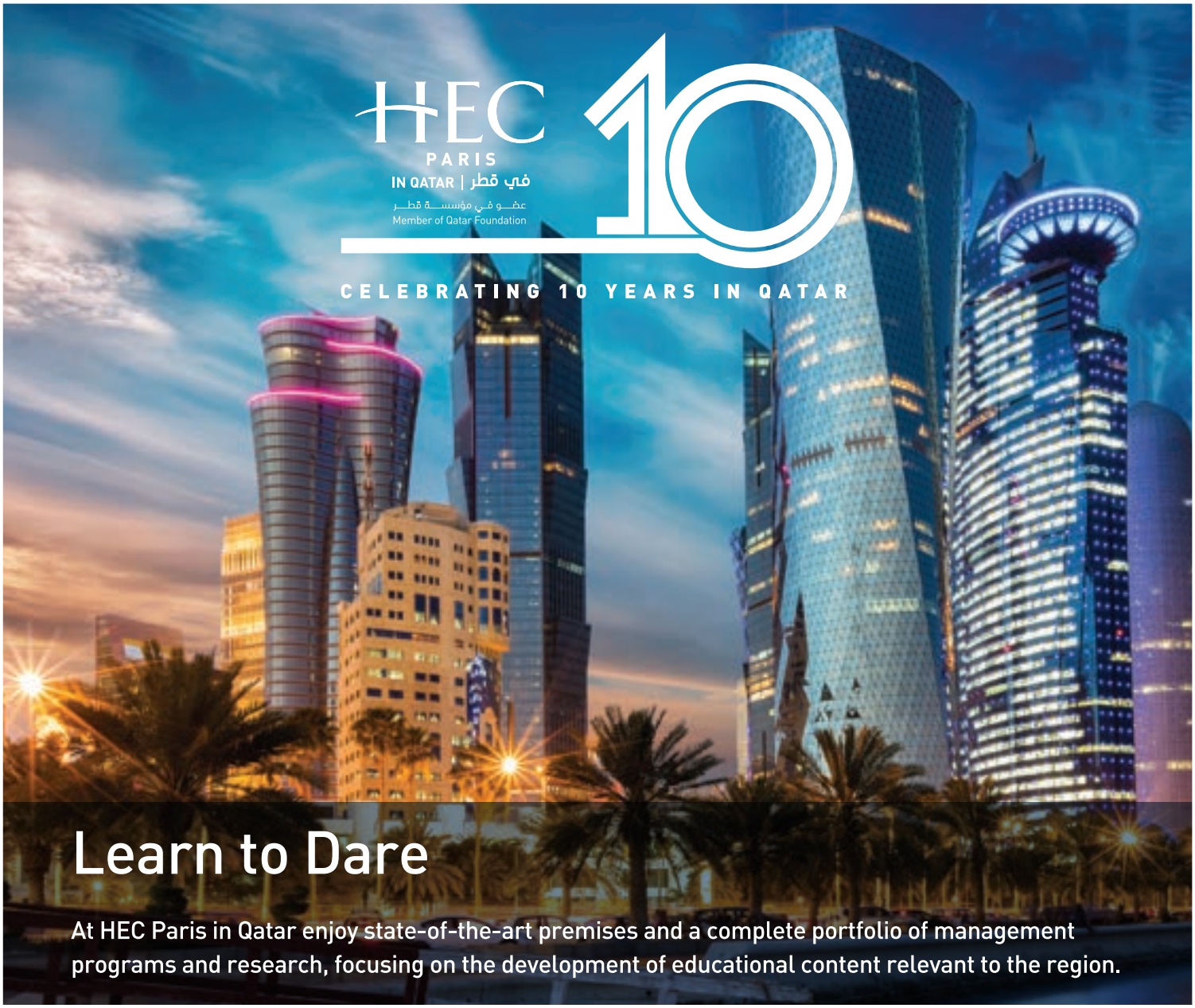

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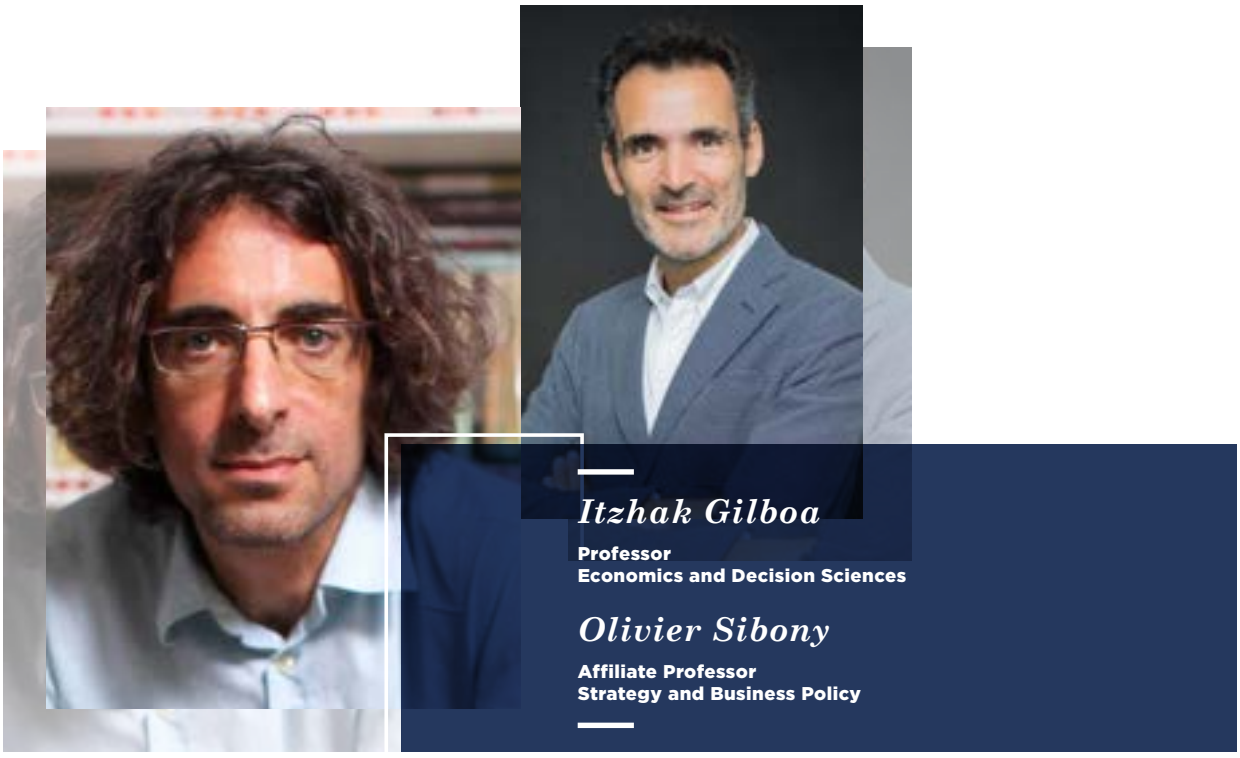
Summary

Decision Making: Do You Need a Decision Theorist… or a Shrink?

Human beings are notoriously bad at making rational decisions. Even theoretical models designed to help you find the "right" answer are limited in their applications. A trio of researchers calls for a re-appraisal of decision theory, arguing that basic tools can improve decision making by challenging underlying assumptions and uncovering psychological biases.



Itzhak Gilboa
Professor
Economics and Decision Sciences

Olivier Sibony
Affiliate Professor
Strategy and Business Policy

Is it worth insuring my house against hurricane damage? Which route will help me beat traffic? Should I invest in this stock? Latte, black, cappuccino, mocha or vanilla? Every day, we are faced with hundreds of decisions, some big, some small, some tough, some easy. Sometimes we follow our instinct, sometimes our intellect, sometimes we just go with habit. But more important than how we choose between various options, is the question, how *should* we choose?

Decision theory offers a formal approach, often seen as a rational way to handle managerial decisions. While this theoretical framework has not lived up to early expectations, failing to provide the "right" answer in every case, a trio of researchers says not to throw the baby out with the bathwater just yet.

METHODOLOGY

The paper first reviews the main principles and concepts of decision theory and explores its limitations to explain why it is not currently used in business decision making. The researchers then make a case for decision theory as a conceptual framework whose tools can be used to support and refine intuition, and give examples of applications through three imaginary dialogues with executives faced with three different business cases.

Based on an interview with Itzhak Gilboa and Olivier Sibony of HEC paris on their paper "Decision theory made relevant: Between the software and the shrink," co-authored by Maria Rouziou of Wilfrid Laurier University (formerly Ph.D. student at HEC Paris), published in Research in Economics, in 2018.

DECISION MAKING HAS BEEN FORMALIZED AND USEFUL, BUT...

Decision making has been formalized since the age of Enlightenment. Decision theory and its key concepts (utility, or desirability of an outcome, states of the world, or possible scenarios, etc.) culminated in the mid-20th century with the invention of game theory and the development of mathematical tools of analysis.

"In the 1950's there was the idea that mathematical models could automate decisions," says Itzhak Gilboa, professor of decision sciences at HEC Paris. "There has been a measure of success, with applications to logistics, or, for example, to route optimization with Google Maps."

And yet, today, decision theory is all but dismissed, including in business circles. Olivier Sibony, who worked as a management consultant for 25 years before joining HEC Paris to teach strategy, says he literally never encountered decision theory in those 25 years, either in words or practice, the exception being within a minority of financial institutions. "It's shocking," he muses, "because it is taught in business schools as a sensible way to make decisions."

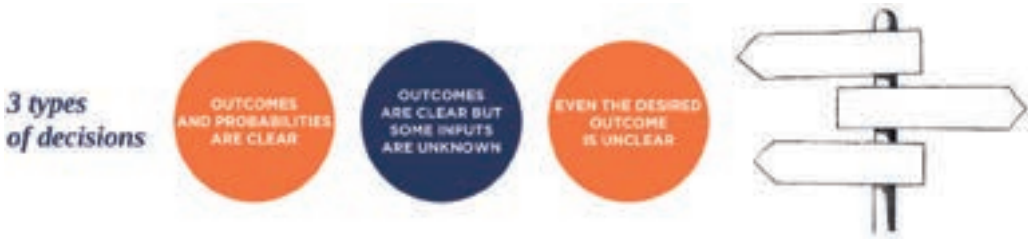
...DECISION THEORY HAS ITS LIMITS

The textbook model of decision theory, however enticing and elegant it may be, has a number of limitations that prevent it from being widely used by managers.

The theoretical model raises some very practical challenges. Probability is often hard to calculate due to lack of data about the same past problems. Similarly, the desirability of an outcome, such as career choice for example, is hard to quantify because of the wealth of criteria by which it is judged: income, prestige, work-life balance...

What's more, behavioral psychology has shown that human beings, far from being the rational agents assumed by economic theory, are hopelessly irrational. Confirmation bias makes us prone to disregard negative data about the option we are considering; overconfidence makes us consistently overestimate our chances of success; mental accounting makes us value equivalent outcomes differently depending on the way they are framed; and on and on. The list of psychological biases we suffer from is so long, it's a miracle that we haven't blundered ourselves into extinction, as a race. "But we are teetering on the brink of just that!" counters Olivier Sibony.

And just because the world functions relatively well doesn't mean we have been good at making decisions, including in business, where success often boils down to sheer luck. "Even a billionaire like Warren Buffet acknowledges the role of luck in his success," adds Sibony. "We do observe a lot of failures; after all, millions of years of evolution have prepared us to recognize rotten food, but not rotten counterparties," joke both HEC professors.



FOR A REHABILITATION OF THE BASIC TOOLS OF DECISION THEORY

Recognizing all the limitations of decision theory, the specialists nonetheless believe that certain tools can be helpful.

The axioms of rational decision-making are especially important in the context of strategic decisions made by managers and executives, who might need to present and justify decisions to their superiors or boards.

Decision theory is not a magic wand for a final answer. It should be used as a conceptual framework, or tool, rather than as a theory that is directly applicable. The researchers outline 3 different types of decisions and how decision theory can potentially serve in each of those cases:

1. In the first type of decision, outcomes and probabilities are clear and all relevant inputs are known or knowable, which means that finding the best solution is simply a matter of using mathematical analysis based on classical decision theory. Simple computing power can find the single best solution (optimize a route or, in the case developed in the research article, allocate sales reps to territories according to travel costs). The decision-maker need not even know the details of the algorithm that the software uses.

2. In the second type of decision, the desired outcome is clear but not all of the relevant inputs are known or knowable. In this case, decision theory cannot provide a single best answer but can test the consistency of the reasoning by formulating the decision-maker's goals, constraints, and so on, to check whether the reasoning makes sense.

3. In the third type of decision, either because data is missing or because the logic of the proposed decision cannot be articulated, even the desired outcome is unclear. In such a case, the problem cannot be described in the language of decision theory. But, while theory cannot provide a "correct" answer, it can still serve to test the intuition and logic of the decision-maker. There may be no objective way to assign precise probabilities to different scenarios, or even to identify all the possibilities, but the theory can still potentially challenge underlying assumptions or processes.

"If you want to be in a certain market just for your ego, fine, but it's my job to uncover it!" says Itzhak Gilboa, comparing the process to "sitting down with a shrink before you press the button". The idea is simply to understand one's own motivations for a decision and to be comfortable enough with them to explain the rationale to one's own boss. The researcher likes to think of the approach as a "humanistic project", improving decisions in a way that will ultimately be useful to society – "even if business decisions are rarely life and death matters!"

APPLICATIONS

The researchers say the most important idea to retain is that of challenging decision-making. When it comes to the second and third type of decisions, where an algorithm cannot simply identify the best solution for you, the researchers recommend collaborating with someone who has a firm grasp of decision theory – someone who knows, for example, what a utility function is, or desirability of outcome, and so on – to challenge your decision-making process. "The best thing you can do to improve the quality of a decision is to ask an outsider to challenge not the decision itself but the process and its logic," says Olivier Sibony. "There are very practical ways of getting theory and practice to dialogue, by setting up routines and methods."

Yes, You Can Be Trained to Make Better Decisions

Mental distortions known as cognitive biases often shifts our judgement away from rational prescriptions. While such biases are normal – it's just the way our brains are wired – they can lead to poor choices, sometimes with disastrous consequences. But new evidence shows how simple training can help us identify these biases and tremendously improve decision making.

" WITHOUT CONFIRMATION BIAS, THE U.S.A. MAY NOT HAVE (...) DECIDED TO INVADE IRAQ IN 2003 "

Anne Laure Sellier

Associate Professor
Marketing

WHAT IS COGNITIVE BIAS?

Despite its incredible abilities, our brain is often fooled into making seemingly irrational decisions because of certain biases in the way it processes information. Decision making is complex, so we take mental shortcuts based on our emotions, experience or just the way information is framed. We tend to see patterns where there aren't any (clustering illusion), be overly optimistic about our own abilities (overconfidence bias), follow the judgement of others (bandwagon effect) and so on. Scientists regularly remind us of the many ways cognitive biases interfere with the choices we make.

HOW DOES COGNITIVE BIAS AFFECT DECISION MAKING?

It can cloud our judgement and lead to disastrous choices. Cognitive bias has practical ramifications beyond private life, extending to professional domains including business, military operations, political policy, and medicine. Some of the clearest examples of the effects of bias on consequential decisions feature the influence of confirmation bias on military operations. Confirmation bias - that is, the tendency to conduct a biased search for and interpretation of evidence in support of our hypotheses and beliefs - has contributed to the downing of Iran Air Flight 655 in 1988 and the decision to invade Iraq in 2003.

SO ARE WE DOOMED TO MAKE TERRIBLE DECISIONS?

Ever since Daniel Kahneman and Amos Tversky formalized the concept of cognitive bias in 1972, most empirical evidence has given credence to the claim that our brain is incapable of improving our decision-making abilities. However, our latest field study, published by *Psychological Science* in September 2019, suggests that a one-shot de-biasing training can significantly reduce the deleterious influence of cognitive bias on decision making. We conducted our experiment in a field setting that involved 290 graduate business students at HEC Paris. In our experiment, a single training intervention reduced biased decision making by almost a third.

Article based on an interview with Anne Laure Sellier of HEC Paris and on her paper, "Debiasing Training Improves Decision Making in the Field", co-authored by Irene Scopelliti, of City University of London and Carey K. Morewedge of Boston University.

WHICH PARTICULAR BIASES CAN BE ATTENUATED AND HOW?

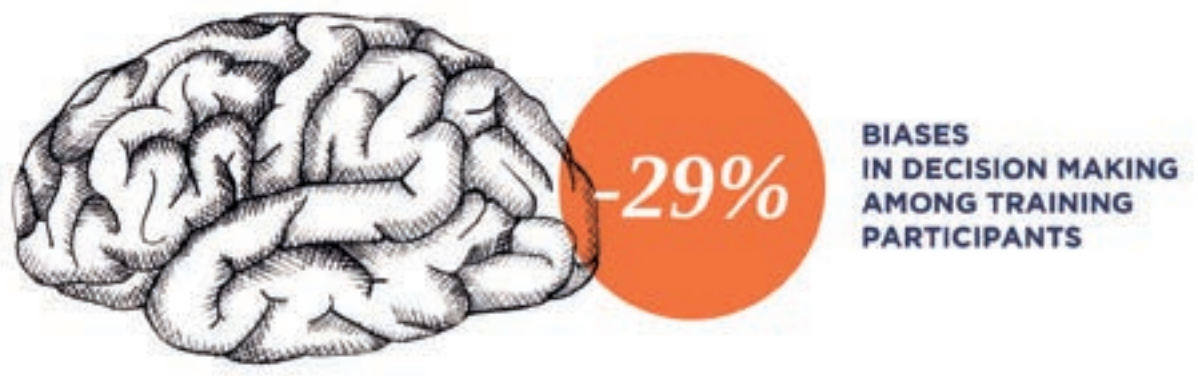
Our research focuses on one particular training intervention, which had produced large and long-lasting reductions of confirmation bias, correspondence bias, and the bias blind spot in the laboratory. As American educator Ben Yagoda pointed out in his compelling article in *The Atlantic* last year, without confirmation bias, the US may not have believed Iraq possessed weapons of mass destruction and decided to invade Iraq in 2003. Our intervention was originally created for the Office of the Director of National Intelligence and was designed to reduce bias in US government intelligence analysts.

The intervention involved playing a serious game that gives players personalized feedback and coaching on their susceptibility to cognitive biases. The training elicited biases from players during game play, and then defined each bias. It gave examples of how each bias influenced decision making in professional contexts (e.g., intelligence and medicine), explained to participants how their choices may have been influenced by the biases, and provided participants with strategies to avoid bias and practice opportunities to apply their learning to new problems.

CAN SUCH TRAINING TRULY IMPROVE JUDGEMENT?

The results were promising. Participants trained before completing the case were 29% less likely to choose the inferior hypothesis-confirming solution (i.e., to race) than participants trained after completing the case. This result held when we controlled for individual differences including gender, work experience, GMAT scores, GPA, and even participants propensity for cognitive reflection (i.e., their tendency to override an incorrect "gut" response and engage in further reflection leading up to a correct answer). Our analyses of participants' justifications for their decisions suggest that their improved decision making was driven by a reduction in confirmatory hypothesis testing. Trained participants generated fewer arguments in support of racing – the inferior case solution – than did untrained participants.

Our results provide encouraging evidence that training can improve decision making in the field, generalizing to consequential decisions in professional and personal life. Trained participants were more likely to choose the optimal case solution, so training improved rather than impaired decision making.



HOW APPLICABLE ARE YOUR (LAB-TESTED) RESULTS IN THE WIDER WORLD?

Of course, our findings are limited to a single field experiment. More research is needed to replicate the effect in other domains and to explain why this game-based training intervention transferred more effectively than have other forms of training tested in past research. Games may be more engaging than lectures or written summaries of research findings. The game also provided intensive practice and personalized feedback, which is another possibility. A third possibility is the way the intervention taught players about biases. Training may be more effective when it describes cognitive biases and how to mitigate them at an abstract level, and then gives trainees immediate practice testing out their new knowledge on different problems and contexts.

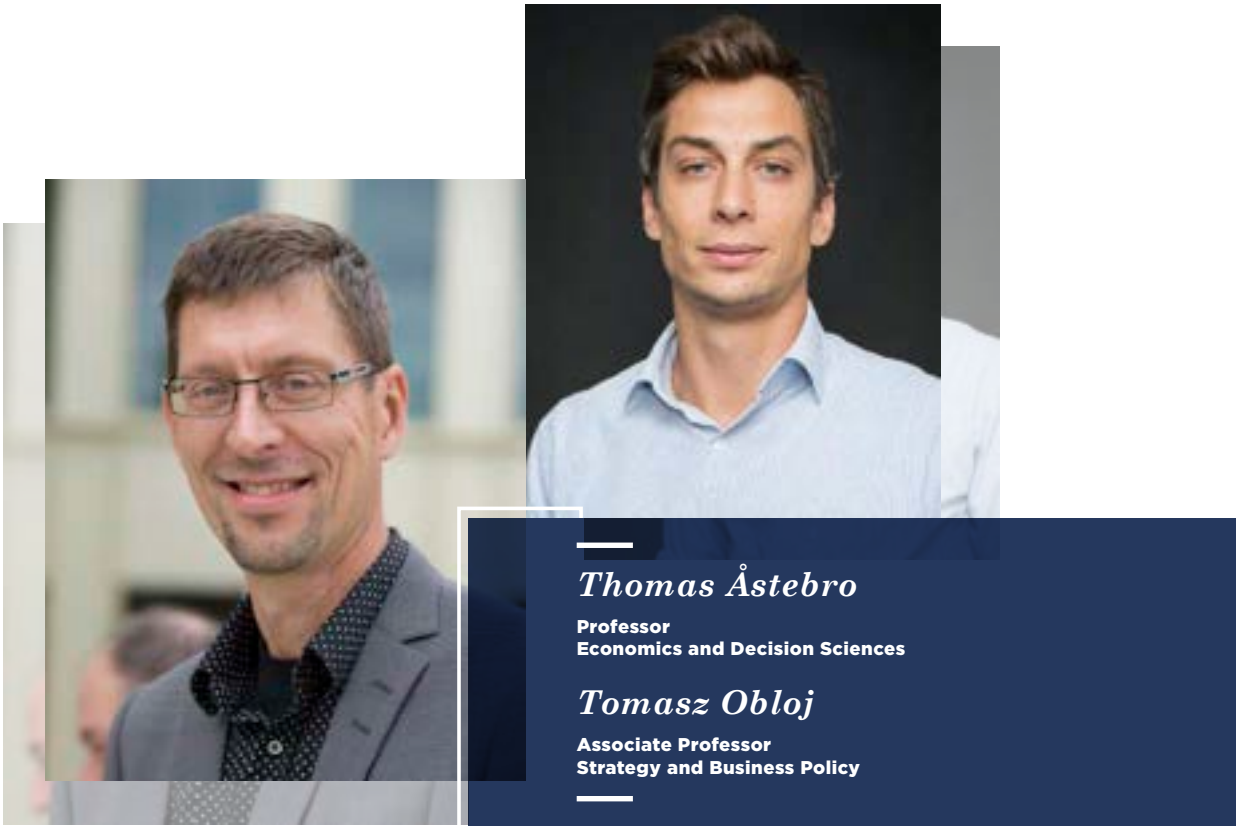
People have been debating how to overcome the many ways in which we deviate from rationality well before the concept of cognitive bias was first coined over six decades ago. The general conclusion has been that decision making cannot be improved within persons, and the only way to reduce bias is through changes to the environment like nudges. In September 2018, Nobel laureate Daniel Kahneman said, "*You can't improve intuition. Perhaps, with very long-term training, lots of talk, and exposure to behavioral economics, what you can do is cue reasoning…. Unfortunately, the world doesn't provide cues. And for most people, in the heat of argument, the rules go out the window.*"

We believe our results show, fortunately, that this conclusion may be premature. Training appears to be a scalable and effective intervention that can improve decisions in professional and personal life.

Find the longer version and the research article online on Knowledge@HEC

The Impact of Overconfidence and Attitudes towards Ambiguity on Market Entry

For many people who have started their entrepreneurial adventure, the biggest challenge is to believe in yourself. Yet, for those who choose this path, confidence can also make the entrepreneur underestimate actual business risks, leading to fatal decisions. Researchers of HEC Paris and Bocconi University offer a new explanation for why decision makers often appear too confident, and shed light on the consequences of this characteristic.



Thomas Åstebro

Professor
Economics and Decision Sciences

Tomasz Obloj

Associate Professor
Strategy and Business Policy

Many of the key strategic decisions made in businesses may result in wasteful allocation of resources or excess market entry. For example, close to 75% of those who choose careers in entrepreneurship would have been better off as wage workers, and almost 80% of angel investors never recoup their money, both indicating that too many (unskilled) people enter into these activities. Similarly, an average corporate acquisition is more likely to destroy value than to add value.

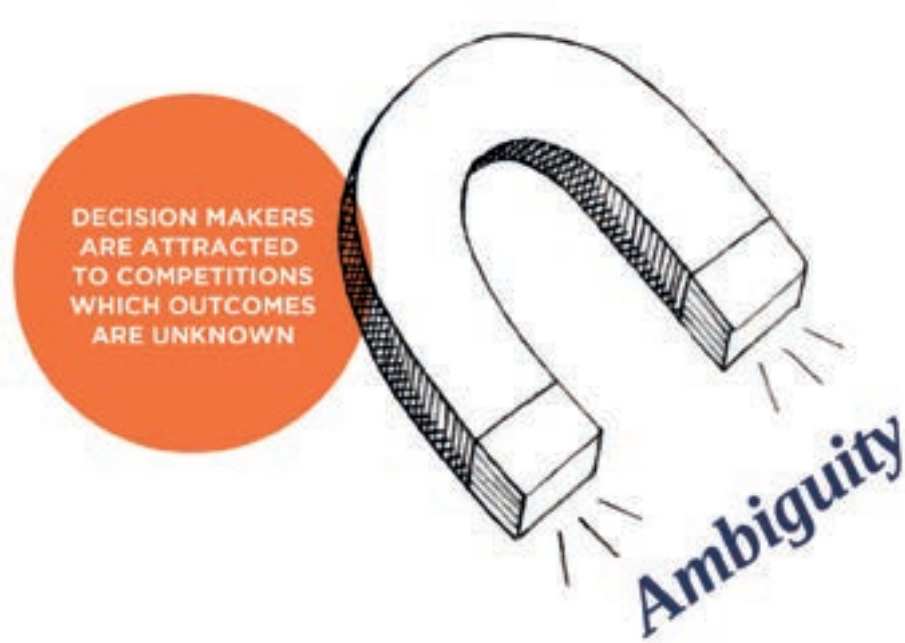
Article by Thomas Astebro, L'Oreal Professor of Entrepreneurship at the Economics and Decision Sciences Department at HEC Paris, based on his research paper co-authored by Cédric Gutierrez of Bocconi University and Tomasz Obloj of HEC Paris. Published in Organization Science.

Many of the key strategic decisions made in businesses may result in wasteful allocation of resources or excess market entry.

Why does this happen? One possible answer may be systematic biases that decision makers exhibit when making entry choices. We focus on market entry in strategic business contexts with two characteristics that are virtually omnipresent. First, these settings are inherently ambiguous. That is, we know what might happen, but we don't know the chances that they might happen. Ambiguous situations can be contrasted with risky ones when we know the chances of what will happen, for example when playing roulette. Second, the ambiguity in such settings, and the associated payoff, is likely to be perceived by decision makers as related to their own skills, often in comparison to rivals.

These characteristics imply that at least two distinct behavioral mechanisms could explain entry: overconfidence – believing that one's chances of success are higher than what they really are – and having a positive attitude toward ambiguity.

Like many before us we use a laboratory setting to make more precise claims about causality. We rely on a novel experimental treatment where we change the level of confidence that individuals have about their own skills, and the level of ambiguity.



Decision makers are ambiguity seeking when the result of the competition depends on their own and others' skills.

We find that decision makers are ambiguity seeking when the result of the competition depends on their own and others' skills. That is, decision makers are more willing to gamble with their money on competitions where the distribution of outcomes is shrouded by a lack of knowledge about what will happen, rather than when they have precise data on the chances of success. When outcomes of competitions are more unknown, having the opportunity to believe that your own ability affects results appears to make them more attractive.

Similarly, we also show that overconfidence only affects entry in skill-based competitions and does not appear in games that are chance based.

Both overconfidence and ambiguity seeking can therefore explain why individuals enter into entrepreneurship taking huge risks with their savings, or why mergers and acquisitions often do not pay off.

Thinking About Time Flying? It Can Affect Your Decision Making

When the clock in our minds ticks loudly, it changes not only our perspective of the time remaining in our lives, but also how we process information. A trio of researchers investigated how thinking about the concept of time can affect our decision making. This unique piece of research could explain biases in hiring, voting, and many other contexts.

> **"INFORMATION DISTORTION IS THE IDEA THAT PEOPLE TEND TO BE BIASED TOWARDS THEIR PRE-EXISTING BELIEFS WHEN THEY HEAR NEW FACTS."**

Anne-Sophie Chaxel

Associate Professor
Marketing

WHAT HAPPENS IN OUR MINDS WHEN TIME SEEMS TO PASS BY QUICKLY?

Do you ever get the feeling that your time is running out? Perhaps you've been dwelling about the fact that we've reached the end of another decade and you've still not got life quite figured out. Maybe you're questioning your life choices after seeing that your friends are all getting married, having children and buying houses, and you're still stuck in the same job you had five years ago. We all get the feeling that the clock is ticking every now and then, but does this feeling change the way that we interpret new information? This is what we set out to investigate, specifically; we wanted to see how this feeling that the clock is ticking impacts a phenomenon known as "information distortion".

Information distortion is the idea that people tend to be biased towards their pre-existing beliefs when they hear new facts. For example, imagine you are a hiring manager at an accountancy firm and you must choose between two job applicants, Adam and Mark. You hear a series of pieces of information about them in sequence. The first piece of information you look at just so happens to be education. Adam has a first-class university degree but Mark only received a second-class degree. Next you learn that Adam has already received some experience working in another similar firm while Mark is fresh out of university. Information distortion occurs if you were to evaluate this second piece of information, the job experience Adam received, as favoring him more than you would have done if you hadn't already seen that he received a first-class degree. This phenomenon has been shown to occur everywhere from legal decisions to medical diagnoses.

METHODOLOGY

We used Amazon's Mechanical Turk to recruit participants, then we manipulated them to have a limited time perspective. After that we had them complete a decision task involving imagining investing in a new business venture, in order to assess the impact of limited time perspective on information distortion.

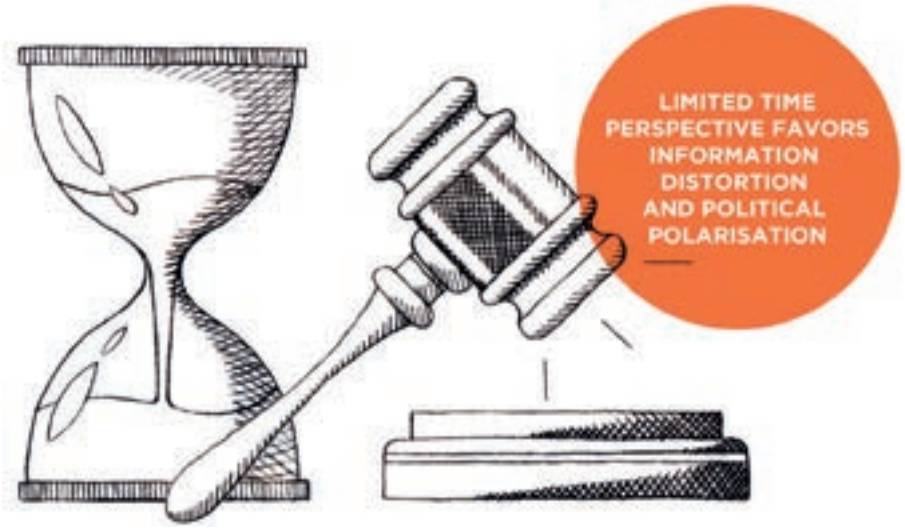
Based on an interview with Anne-Sophie Chaxel and on her article "The impact of a limited time perspective on information distortion", co-written with Catherine Wiggins of Cornell University and Jieru Xie of Virginia Polytechnic Institute and State University, Organizational Behavior and Human Decision Processes, 149 (2018).

MANIPULATING PEOPLE'S TIME PERSPECTIVE

In order to test experimentally whether the feeling that time is running out, known as "limited time perspective", impacts information distortion; we asked participants to describe a milestone in their life which they felt they had limited time left to achieve. They were given examples such as getting married or achieving their dream career. Participants in the control group were instead asked to report how long they spent each week completing surveys on Amazon Mechanical Turk, the platform where they were recruited. Next, we asked them how likely they would be to invest in a new business venture, producing a new type of material for making furniture. We then presented four attributes of the furniture in sequence. After each feature of the material was presented, we asked the participants to rate whether the new information made them more likely to invest in the product.

As we predicted, we found that leading participants to have a limited time perspective made them more likely to distort information. In other words, thinking about the limited time left in their lives made them more likely to hold on to the beliefs they had before having new information.

Our finding could help us understand why in the world today facts seem to be becoming more and more distorted and political polarization appears to be increasing. As facts become distorted such as in the case of "fake news" websites that spread ideology-fueled misinformation, people become more polarized, ebbing towards opposing ends of the political spectrum and rejecting evidence that doesn't confirm their beliefs. Our results suggest that this could be linked to the fact that we are living in a society where we often feel we don't have enough time, it's possible that this may be increasing political polarization.



WHEN AGE INCREASES BIAS

Another aspect of the recent phenomenon of increasing political polarization that is touched upon by our research is ageing. It's well known that the elderly tend to vote differently from young people and in recent times there has been much speculation that the gap is widening. In recent years, this gap in voting behaviour has been blamed on everything from Brexit to the election of Donald Trump.

In order to assess whether age has an impact on information distortion, we repeated our study but instead of artificially leading participants to have a limited time perspective we looked at age. To make our participants think about their age, we asked them to categorize themselves as 18-29, 30-50, or over 50 years of age. We then conducted our study as before and compared the different results based on the various age groupings. As we expected, we found that ageing had the same impact as having a limited time perspective, our older participants were more likely to show biased towards their own pre-existing beliefs.

Ultimately our work shows that the age-old phenomenon of age impacting information distortion can be artificially manipulated very easily in people of all ages by making them think about the time they have left in their lives. Our research provides the first evidence of such a phenomenon so it should be treated with a healthy level of scepticism until it is supported by further studies, however it may provide a fruitful avenue for further research..

APPLICATIONS

Our research has implications for political scientists studying the causes of information distortion. It may also prove valuable for marketers as our work could have implications for subjects such as brand loyalty and consumer confidence. It could also benefit human resources professionals due to the implications our work has for understanding the decision process of older managers.

How to Deal with Severe Uncertainty?

Severe uncertainty, deep uncertainty, radical uncertainty, ambiguity… different actors in a range of fields – decision scientists, risk analysts, climate scientists, central bankers – use a variety of phrases to talk of some extreme, important yet too often ignored form of uncertainty. But what is it? And how should we deal with this particular species of uncertainty: how should we characterize it, communicate it, and decide in the face of it? In this interview, CNRS Research Director and HEC Paris Research Professor Brian Hill explains the concept and unveils applicable tools based on theoretical models for guiding decisions in situations of severe uncertainty.

"SEVERE UNCERTAINTY POSES A DOUBLE CHALLENGE: TO WORK OUT WHAT WE KNOW, FULLY RECOGNIZING WHAT WE DON'T, AND TO HARNESS THAT KNOWLEDGE EFFECTIVELY IN DECISION MAKING "

Brian Hill

CNRS Research Director and Professor at HEC Paris Economics and Decision Sciences

WHAT IS SEVERE UNCERTAINTY?

A central characteristic of severe uncertainty is the lack of justified probabilities. When tossing a coin, we know precisely the probability of heads. Economists standardly assume that all uncertainties are glorified coin tosses: we can come up with a precise probability for whatever might happen (even if we might not always be right about it). But clearly many real-life situations are just not like that. There are many cases where we don't know something for sure, and, though that doesn't necessarily mean that we know nothing at all, what we do know is not enough to justify a solid, precise probability.

What's the Coronavirus mortality rate? We know that it's worse than the flu, and below 15%, but beyond that? Can we give a number we are 90% sure about? How fast will the global economy recover to turn-of-the-year GDP levels, or the Dow Jones to its pre-Covid-19 levels? They will almost surely not be there by September, but beyond that? Can we put precise probabilities? What will happen to sea level in, say, New York over the next 30 years? Given our understanding of climate change, we know it will rise, and almost certainly by less than 4m, but beyond that?

WHY IS SEVERE UNCERTAINTY RELEVANT NOW?

Severe uncertainty is especially relevant now because we increasingly face situations involving it. Examples abound, including climate mitigation policy, Coronavirus reaction, economic policy, and of course business decisions. I should also add that this is being increasingly recognized, with the ex-governor of the Bank of England, Lord King, having just published a book on Radical Uncertainty with John Kay.

Brian Hill is Research Director at the French National Centre for Scientific Research (CNRS), member of the GREGHEC laboratory (CNRS-HEC Paris), and CNRS Research Professor in the Economics and Decision Sciences Department at HEC Paris.

Learn more on Brian Hill's "Decision Making under Severe Uncertainty" website www.desevun.org, including filmed interviews of experts on the "Uncertainty Across Disciplines" project here: scan the QR code»

What do all these examples have in common? Urgency. Since the problem is lack of knowledge, one instinctual response would be to go out and do (more) research. But these decisions don't allow us the time to do that: we have to respond to the Coronavirus before fully understanding it; by the time we know the sea level in New York in 2050 it might be too late to save it from flooding; and so on.

WHY DO MOST PEOPLE IN ECONOMICS, FINANCE AND RISK ANALYSIS CONTINUE TO DISCOUNT SEVERE UNCERTAINTY, BY ASSUMING THAT ALL UNCERTAINTY CAN BE FULLY CAPTURED BY PROBABILITIES?

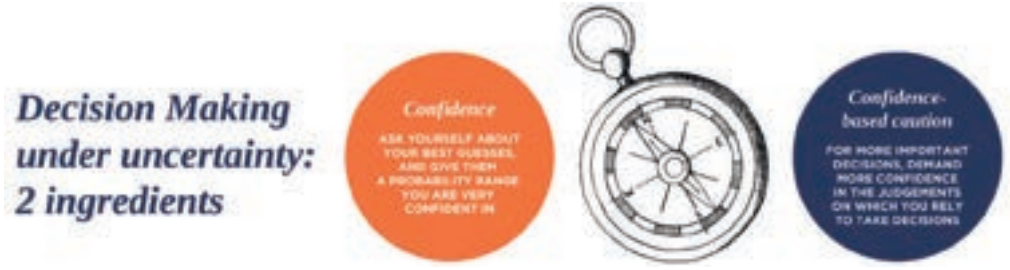
There are basically two reasons: one pragmatic and the other principled. First, it's easier to work with precise probabilities, and the mathematical methods are familiar. Second, a bunch of philosophical, "axiom-based" arguments purport to show that, if you stray from precise probabilities, your decision making will violate some seemingly "rational" dynamic principles. These arguments have persuaded many over the years. If they were right, then these rationality principles would justify pretending that we always had precise probabilities (despite the egregiousness of the pretence).

In sum, beyond these arguments, the only barrier to a more refined, richer approach to uncertainty is inertia. In my research[1], I show that these arguments rest on a mistake: you can satisfy (properly formalized versions of) the rationality principles, even if you do not stick to precise probabilities. It thus removes the main hurdle to building an account of rational or sensible decision making that doesn't need to assume precise probabilities.

HOW SHOULD WE DECIDE IN THE FACE OF SEVERE UNCERTAINTY, THEN?

As I see it, severe uncertainty poses a double challenge. The first is to work out what we do know and how solid that knowledge is, avoiding two pitfalls: nihilism – assuming that because we can't put probabilities, we don't know anything at all – and self-deception – pretending or assuming that we know more or have more precise knowledge than we in fact do. The second is to work out how to harness what we know – and more importantly recognize what we don't – in decision making. Good, responsible, and informed but not self-deceptive decision making.

In my research[2], I have developed an approach to decision under uncertainty that meets each of these challenges. It combines two ingredients:



1. Confidence.
Forget pretending that you can always give a probability and:
a. Ask for your best guess. Then ask how confident you are of it. That might not be very confident at all (if so: don't rely on it!)
b. Then ask: if you had to give a probability range that you were very confident in, what would it be. (For difficult cases, this range could be very large: that's what makes the case difficult!)
c. Repeat, asking for ranges that more or less confident in, or sure of.

2. Confidence-based caution:
a. For more important decisions, demand more confidence in the judgements on which you rely to take the decision. If you have lots of confidence in a judgement or an assessment, by all means base your decision on it. If not, perhaps you should fall back on the (weaker, more imprecise) judgements of which you are more sure – especially if the decision is very important.
b. Now these judgements may be so weak as not to support any option as best: you don't know enough to categorically justify a single course of action. In such cases, acknowledging this is a crucial first step. In the face of it, it's best to show caution and take an alternative that won't lead to too bad a result, no matter which of the values in the range (of which you are sufficiently confident) turns out to be right.

Basically, this advice amounts to applying precaution when you are not confident enough for the importance of the decision, and choosing boldly when you are.

This approach is not just common sense: in my research (2) I have shown that it can be defended by the sort of principled, "rationality" arguments used by some to defend the reducibility of all uncertainty to probabilities.

WHAT ABOUT MODELS?

You often find criticism of, say, economic models with a tendency, when attacking the use of probabilities to represent uncertainty, of throwing the baby out with the bathwater. This is a case of what I previously called the pitfall of nihilism. By contrast, climate scientists have a relatively sophisticated use of models, which can serve as an example. They realize that models are the input to an assessment or judgement about the question of interest (e.g. temperature in 2050, etc.), but no model – nor even all models – provides the whole picture. Climate scientists (e.g. in IPCC reports) have to make a judgement, drawing on models, but also on other evidence, their experience and common sense. And these judgements do not generally come in the form of precise probabilities, although that's what models produce. Rather, as I have discussed in my research with co-authors on climate uncertainty[3 and 4], they rightly report uncertainty in the form of confidence judgements on the probability assessments that come out, or could have come out, of the models.

In other words, they adopt as reporting practice the approach I set out above.

1. Dynamic consistency and ambiguity: A reappraisal, *Games and Economic Behavior*, 120: 289-310, 2020.
2. Confidence in Beliefs and Rational Decision Making, *Economics and Philosophy*, 35(2): 223-258, 2019
3. Climate Change Assessments: Confidence, Probability and Decision, *Philosophy of Science 84* (3): 500-522, 2017 (with R. Bradley, C. Helgeson)
4. Combining probability with qualitative degree-of-certainty metrics in assessment, *Climatic Change 149* (3-4): 517-525, 2018 (with R. Bradley, C. Helgeson)

Is It Rational to Stockpile in Times of Crisis?

The health crisis caused by COVID-19 has triggered an economic one. We observe a significant portion of the population fearing shortage of primary consumption goods and marked stockpiling behavior. Because such behavior increases the risk of shortage, several stores have decided to ration some goods, and governments have had to make public announcements to reassure consumers that there would be no shortage. Avoiding consumer stockpiling is hence one of the key aspects of the management of this crisis. But is it rational to stockpile in times of crisis? We review and discuss the rational and irrational aspects of such behavior.

"STOCKPILING CAN BE RATIONAL BUT PEOPLE MAY NOT STOCKPILE OPTIMALLY BECAUSE OF BEHAVIORAL BIASES"

Emmanuel Kemel

CNRS Research Professor at HEC Paris Economics and Decision Sciences

Although over-purchasing in times of crisis might be considered as irrational, scholars in economics, operations research and marketing have proposed theoretical models explaining when and how individuals rationally decide to stockpile. Besides rational motives, many behavioral aspects can also motivate over-purchase decisions.

STOCKPILING AS A RATIONAL DECISION INVOLVING RISK AND TIME

Decisions to purchase and store quantities in prevision of future hazards are not infrequent, and may concern not only individuals, but also states and companies. At the State level, decisions to stockpile goods such as oil, weapons, medical masks and drugs are highly strategic. It can also be in the interest of the companies and consumers to stockpile primary or consumption goods, as an insurance against variations of future prices (as in the case of shortage risks).

In all these contexts, the decision can be analyzed using the same framework. Stockpiling is a safe but costly option: the costs relate to purchasing additional quantity at the present time rather than smoothing the expense across time, as well as to storagoptimae costs (e.g. warehouse space and guarding). Not stockpiling is a risky option that exposes the decision maker to future price variations.

The best option, or optimal amount of stockpiling is therefore a decision involving risk and time and as such involves many factors: the perceived risk of price variations, the attitude towards time (how the decision maker values future consequences) and the risk attitudes (how the decision maker values risky consequences). In rational decision making these factors are combined using a model called "discounted expected utility". For example, under this model, a consequence received at a future time period t with a perceived probability p is valued $p\ exp(-rt)u(x)$, where r is the discount rate that captures attitudes towards the future, and u is a utility function that characterizes risk attitudes. Assuming that the decision maker has well-defined risk perception, discount rate and risk attitudes, the model makes recommendations about how much to stockpile.

Decision to stockpile depends on the perceived probability of shortage, risk aversion, discount rate and storage costs.

As one could expect, recommended stockpiling will increase with the perceived probability of shortage and risk aversion; it will decrease with the discount rate and storage costs.

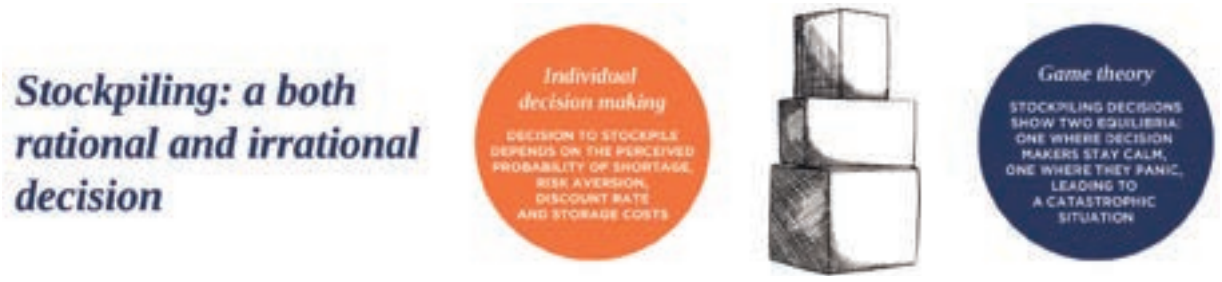
The discounted expected utility model can be used to study many other decisions involving risk and time in various domains such as strategy, finance, marketing and industrial organization.

DEVIATIONS FROM THE RATIONAL DECISION MAKING MODEL

Beyond its normative appeal, the model underlying such recommendations cannot satisfactorily describe observed behavior. See Machina (1987) for violations of this model in the context of risk, and Loewenstein and Prelec (1992) for the context of time. We have investigated several of these anomalies in a recent laboratory experiment where subjects had to make decisions involving both risk and time with real possible gains. We observed systemic deviations from the predictions of the rational model. As previously observed, subjects did not exhibit stable risk attitudes. They took more risks in decisions involving small probabilities than in decisions involving medium or large probabilities. Another result regards the impact of time. Here again, time preferences were not constant. More impatience was observed towards the near future than concerning periods further away in time. This pattern is responsible for several anomalies in decisions involving time, such as reversal of preferences over time or procrastination. Though well documented in the literature, several scholars have hypothesized that this pattern would disappear in decisions involving both risk and time. Our results, recently published in Games and Economic Behavior (1), show that this pattern holds even in these more general contexts.

Another source of irrational decisions regards the way people perceive risks when probabilities are not available (e.g. Tversky and Kahneman 1974). For example, in their evaluation of the likelihoods of uncertain future events, people generally tend to overestimate rare events and underestimate frequent ones. In another recently published paper, we propose a method for measuring people's beliefs about uncertain events (2) from simple choices. The method allows to put beliefs into numbers and to test if peoples' perception is accurate.

Another important research question in the decision sciences relates to how people formulate and update their beliefs in the light of available evidence. In the context of stockpiling, decision makers can also be influenced by the behavior of their peers.



THE SOCIAL DIMENSION OF STOCKPILING: AN ANALOGY WITH BANK RUNS

Stockpiling is an individual decision that can have dire social consequences. Indeed, in the context of shortage risk, individuals deciding to overpurchase effectively contribute to the risk. This kind of situation is called "self-fulfilling prophecy".

Like bank runs, stockpiling decisions show two equilibria: one where decision makers stay calm, one where they panic, leading to a catastrophic situation.

When considered as a game involving many players, the decision to stockpile can be studied in game theory and is analogous to bank run games. These games have two equilibria: one where decision makers stay calm and do not overpurchase; another where decision makers panic and decide to overpurchase, leading to a catastrophic situation of real shortage. The first equilibrium is obviously better than the second one. Nevertheless, regarding individual rationality, both are "Nash equilibria", meaning that when one sees that other people start to stockpile, individual rationality recommends you to stockpile too! In a social context, stockpiling can therefore be considered as a rational but selfish decision.

THE ROLE OF HERDING BEHAVIOR

Considering stockpiling as a social game introduces the fact that the beliefs and actions of each decision maker can be influenced by the actions of the other decision makers. Updating beliefs after observing the behavior of the others can be rational. Such situations are called information cascades. But behavioral studies reveal that people are sensitive to the behavior of others, even when it is uninformative or even misleading! In particular, people tend to conform to the dominant behavior, even in the absence of rational reasons to do so. In the present case of COVID 19, we can speculate that the sudden but notable stockpiling of toilet paper was due to herding.

People can probably easily convince themselves that, even if there were a major economic collapse, toilet paper is not the good that need be given the highest priority. However, observing that other people stockpile creates a social pressure: "it is not possible that so many people behave so irrationally: there must be a good reason for them to do so".

Decision science suggests that stockpiling can be rational from an individual perspective. But in practice, people do not stockpile optimally because of individual and group irrationality.

Overall, decision science focusing on both individual decision making and game theory suggests that stockpiling can be rational from an individual perspective. However, in practice, there are many reasons to think that people do not stockpile optimally because they violate the rules of individual decision rationality or are irrationally influenced by the behavior of others.

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