Exploring Biased Risk Decisions and (Re)searching for an Educational Remedy

A.G.E.M. (Ab) Bertholet*
*Lecturer and Researcher, Utrecht University of Applied Sciences, Department of Safety and Security Management Studies, P.O Box 85397, 3508 AJ Utrecht, The Netherlands, ab.bertholet@hu.nl. PhD Researcher, Maastricht University, Top Institute for Evidence Based Education Research, Maastricht, The Netherlands.

ABSTRACT

Why are risk decisions sometimes rather irrational and biased than rational and effective? Can we educate and train vocational students and professionals in safety and security management to let them make smarter risk decisions? This paper starts with a theoretical and practical analysis. From research literature and theory we develop a two-phase process model of biased risk decision making, focussing on two critical professional competences: risk intelligence and risk skill. Risk intelligence applies to risk analysis on a mainly cognitive level, whereas risk skill covers the application of risk intelligence in the ultimate phase of risk decision making: whether or not a professional risk manager decides to intervene, how and how well. According to both phases of risk analysis and risk decision making the main problems are described and illustrated with examples from safety and security practice. It seems to be all about systematically biased reckoning and reasoning.

Is there a remedy? Based on the process model this paper presents and discusses the design of two evidence based educational experiments to be conducted in 2016. The first experiment consists of a blended learning intervention with bachelor students of Safety and Security Management. The second one will be an experiment with airport security agents who are responsible for security checks of baggage and passengers. Visualization, heuristics, meta-cognition and blended instruction are some of the main variables of the effect studies to follow. The design of both the intervention and the evidence based experiment could be applicable for innovative competence-based learning in general.

INTRODUCTION

Safety and security risks can originate from various sources and must be controlled by risk managers in very differing domains. Traffic accidents, natural disasters, hazardous materials, polluted food, power outlet, terrorism, domestic violence, cyber-bullying, fraud, viral diseases and addiction are only a few random examples. Making risk decisions is surrounded by uncertainty. Determining adequately the probability that a specific risk will manifest itself in reality and with what effect is a difficult task in all kinds of professional contexts. In general professionals tend to overestimate certain risks and underestimate others (Kahneman, 2011). In the last decades a broad range of hardware and software aids was developed to support professionals in making risk decisions. Nevertheless risk management practice is not as satisfying as desirable, in spite of all models, procedures, norms, standards and checklists available.

This paper describes the main causes of problematic risk managing in the broad field of safety and security, including healthcare, traffic safety, welfare, crime fighting, construction industries, among others domains. With a generic process model we illustrate where the shoe pinches in the process of risk analysis and risk decision making. The model reduces common models of risk management to the two phases that are crucial for analysing problematic risk decisions (Bertholet, 2016). From research literature an overview of pressure points is disposed and illustrated with examples of practice. At that point the question arises if, when we know what is going wrong, we can develop an educational remedy for (future) professionals? A design for two training interventions, embedded in an evidence based experimental setting, will be presented in the last part of this paper.

DETERMINING, MEASURING AND CONTROLLING RISKS

Risk management is often visualized in process models with from three to six successive phases, for example COSO or ISO 31000[1]. Determining, measuring and controlling risks via interventions is the common denominator of these models. The focus of our process model is to point out where sub-optimal or even irrational risk decisions are made, where inadequate interventions may follow, instead of adequate ones. Therefore we distinguish the process of risk management into two constituent processes: risk analysis and risk decision making. Risk analysis consists of measuring by calculating or estimating a risk. A risk decision based on the analysis leads to a decision to intervene or not, in order to control the risk. (Figure 1).

---

[1] The COSO-model was developed by the Committee of Sponsoring Organizations of the Treadway Commission (coso.org), a network organisation in the field of risk management for businesses. The framework of ISO 31000 contains principles and guidelines for Risk mangement of Organisations, drawn up by the International Standardization Organization (iso.org).

Risk intelligence and Risk skill

We define risk intelligence as the ability of people in general and safety and security professionals in particular, to mobilise and operationalise, under uncertainty, knowledge and experience on risks, and to convert it into adequate risk analyses. As risk skill, we define the ability to make adequate risk decisions based on a risk analysis (Figure 1). Adequate in each case means that a risk is determined, controlled or reduced in a rational, effective and efficient way. And that, in other words, the probability that a risk manifests itself or the impact of such an undesirable event is reduced.

Figure 1 Two critical competences applying to the process of risk management: Risk Intelligence and Risk Skill

In daily practice, three types of problems occur, when professionals have to determine risks and have to make risk decisions on the basis of this risk analysis. In the following sections we will describe these three types: calculation biases, estimation biases and decision making biases.

CALCULATION BIASES: ON THE COGNITVE LEVEL RECKONING WITH RISK IS HARD

Determining the probability that a certain risk will manifest itself is a very technical and often complicated task. Nevertheless it is important to quantify risks wherever possible. It enables the comparison of one risk with another and testing it against norms. Furthermore risks can be expressed then in financial or social costs, so priority setting in risk management and safety and security policy becomes possible.

Restricted numeracy, complexity and predictors

Quantifying risks means reckoning and gaining insight in figures, and that is not everyone's cup of tea. John Allen Paulos (1998) and Gerd Gigerenzer (2002) were the first of a long list of authors who have written about the human incompetence to cope with numbers and quantitative abstractions. Doctors and patients both draw wrong and rigid conclusions from positive and negative HIV-testing results (Gigerenzer, 2002). The same happens when a woman's first mammography is positive and the question is: does she really has breast cancer (ibid.). In jurisdiction professionals have to deal with risks when they have to calculate probabilities of guilt and evidence.

The issue of misleading intuition according to numbers was adopted by Daniel Kahneman (2011) as well. Kahneman describes how the human brain works and distinguishes between a fast and intuitive way of thinking (System I) and a more analytical, systematic way (System II). Reckoning with risks indeed is partly a technical matter, but the human intuition is unreliable when coping with acquired quantitative results in lots of cases. When we use technical instruments and methodologies, permanent critical reflection on the meaning of the outcomes is necessary. Technology needs psychology is Gigerenzer's conclusion (Gigerenzer, 2002).

Two other factors that make it difficult to calculate risks are their complexity and the restricted possibility to predict them. The complexity's basis is the fact that we often do not know what factors exactly are contributing in what way and to what extent to the manifestation of a risk. In traffic safety for example we can calculate to what speed limit car passengers are safe in case of a collision. But the combined factors that together lead to an accident cannot be taken into account, when we are making a calculation. When we use statistics to predict risks, another aspect of the limited human mind reveals, particularly in dealing with extremely small probabilities. Nassim Nicholas Taleb demonstrates this phenomenon in *The Black Swan* (2007). The impact of the most unlikable, which is what the black swan stands for, is systematically underestimated by the human mind. Taleb regards it as one of the causes of the recent global financial crisis. The attacks at the Twin Towers in New York on 9/11/2001 and the impact they had, Taleb regards as Black Swan as well. The statistical probability of event like that is extremely small, and therefore the

human mind is trivializing it. On the other side: once such an unlikable event has taken place anyway, its probability will be overestimated. This can lead to disproportional safety measures and law-making.

About risk calculation and management in general Taleb (2013) states that calculations can lead to a certain kind of illusory safety, for example in the construction industry. Stability norms are based on historical events and cannot be transferred unrestricted to all future events. The next earthquake might be stronger than all others before. Or a mere coincidence can occur that could not had been taken into account. The Fukushima nuclear power plant was designed 'earthquake proof', but the sequential appearance of an earthquake and a tsunami in 2011 lead to a nuclear disaster.

ESTIMATION: ASSESSING RISKS ADEQUATELY IS MENTALLY CHALLENGING

Risks and indicators which cannot be calculated, have to be estimated, in order to get a somewhat adequate risk determination. Just as with calculating, the aim of estimating is to assess and weigh risks based on the probability that they occur and the damage they might cause. Professionals as well as laymen and even experts not only make incidental, but also structural mistakes in the process of estimating: "systematic deviations from rationality, from optimal, logical, rational thinking and behaviour"(Dobelli, 2011). In the meantime in social science literature about one hundred and fifty of such, sometimes related biases are known, and there are still new ones getting discovered and described. Below we will discuss the most relevant biases in the safety and security domain.

Confirmation bias

According to researchers in the field of rationality and irrationality the confirmation bias is also known as 'the mother of all biases'. On the individual level this 'thinking mistake' is hard to prevent. Intuitively we accept the information that fits to an existing risk profile and reject the information that doesn't fit in (confirming versus disconfirming evidence). 'Profilers', who for example observe football supporters, museum visitors or travellers on airports have to be aware that they should not only focus on physical appearance that matches with an explicit or implicit offender profile or suspicious signs they have already in their heads. To come to a good estimation of risks and to prevent tunnel vision, there is room required for independent, creative and out-of-the-box thinking. Later on we will be talking about dealing with risks after they have already been calculated or estimated and this bias will be discussed again. At this point the role of the confirmation bias in estimating risks and confirming or debunking existing visions, paradigms, patterns and analyses, is relevant. The authority bias goes along with the confirmation bias

When a professional is regarded as an authority or when he or she is placed on a higher position, the professionals around hem tend to recklessly except his estimations instead of evaluating them critically and professionally.

Overconfidence

The tendency to overestimate one's own (assessment) capacities is a universal, inbred and 'incurable' phenomenon. With men the tendency in general is a bit stronger than with women, with expert extremely stronger than with laymen. (Dobelli, 2011; Kahneman, Slovic & Tversky, 1982). When you ask a random group of professionals at a conference, risk analysts or professors for example, who thinks their professionalism is above average, there will likely be much more than 50% of self-declared outstanding experts. Statistically this cannot be possible, of course. This overestimation of one's abilities by experts leads often to substantially underestimation of safety, security and other risks. In financial and insurance markets, and in big infrastructure projects, this can cause enormous financial losses. In for example industry and the medical world this can lead to accidents, in the worst case with a fatal ending.

Availability bias

Numerous experiments have shown how hard it is to estimate what risks on a certain moment are most threatening to an individual, a community, a nation or the whole world. What is known in literature as the availability bias makes those risks which came in mind most recently, or the ones which are most spectacular, appear as most dangerous (Dobelli, 2011). When smokers accept one old heavy smoking uncle or neighbour as proof of the 'fact' that smoking isn't that unhealthy, this is an example of an availability bias. The availability of one example of incurable smoker who has been smoking for years, seems enough reason not to quit. This goes for climate critics as well, when they accept one strong winter as proof that there is no climate change (Mommers 2015). The role of imagination in this bias is shown when the probability of dying by a bomb attack or an accident in traffic is considered more likely than dying by suicide or diabetes, while the evidence proves exactly the opposite (Dobelli, 2011).

Risks that were in the news recently are considered to be relatively hazardous and to be more dangerous and threatening in the future. Most people in 2014 regarded the risks of Ebola and the marching Islamic State to be bigger than the risks of malaria or the drug gang wars in Mexico, while the numbers of victims showed it was the contrary (Sitalsing, 2014). Research of Philip Tetlock on how adequate the expert judgements of advisors to the yearly World Economic Forum were, demonstrates that professionals suffer from the same bias (Tetlock, 2005).

RISK DECISION MAKING: REGARDING RISKS RATIONALLY IS MENTALLY DIFFICULT

The problems regarding calculating and estimating risks that have been described above, only represent the restrictions of coping with risks adequately and rationally in practice partly. The concept of bounded rationality presented by Herbert Simon (1984) explains why risk decision making under uncertainty is that difficult: time pressure, lack of reliable information and the restricted capacities of the human brain. Lack of reliable information can explain the problems for at least a part. Besides that the human brain processes available risk information with difficulty, new biases occur and inadequate risk decisions come along.

Confirmation bias

As mentioned before, the confirmation bias is regarded as the most important bias by many experts. With all risk management systems, protocols, checklists, risk profiles and other risk management instruments this bias is on the lurk. This means not necessarily, or certainly not only, with the systems themselves, but with the thinking of the professionals using them. The focus often lies on finding confirming information, what can easily lead to a tunnel vision. One of the six principles of persuasion distracted by social psychologist Robert Cialdini from his experiments closely connects to this bias. The so called 'social proof' leads people in a group or team to a joint perception of reality and makes them confirm each other's perception and assessment of reality and social norms (Cialdini, 2009). The phenomenon of belief perseverance is strongly connected to the confirmation bias. Accepting the earlier mentioned disproof (disconfirming evidence) often turns out to be a mental hurdle, which is strengthening tunnel vision and group think.

Another, earlier mentioned bias that is significant for risk decision making is the availability bias. Professionals in all kinds of disciplines choose the interventions that are provided by their brain and which they already know. Doctors for example tend to prescribe those therapies they are most familiar with. In all sectors this could be empirical proven interventions, which nevertheless need reflection. Not the best or the most rational risk decision of is chosen, but the available one.

Hindsight bias

"This had to go wrong." This at least is what one often might think after media reports on reconstructions of incidents with so called lone wolfs. Personal and other circumstances of the perpetrator are dug up by the media and presented as a compelling context for the event that happened. The question to follow often is why the professionals on duty didn't intervene before the dramatic climax took place, as in the case of Tarik Z., who disordered the Dutch NOS News show at prime time on 29 January 2015. With a fake weapon and a simple written message on a piece of paper he held a doorkeeper as a hostage and was live on screen for minutes.

(Wierenga, 2015). The story bias and the outcome bias are relevant in this context as well. Both biases allow a logical and even compelling connection between independent events afterwards, whereas this relation does not exist in a causal way, or at least not had been caused by (omitted) interventions or risk decisions that had been made. Media and the general public both want to know who was responsible for or guilty of the incident. Analyses of accidents often show that it isn't mainly because norms, procedures and protocols are insufficient, but the fact that in daily practice it is the human factor that is to blame for this kind of problems. In other words, it is the way professionals deal with rules and how they maintain them.

The effect of this bias is that one gets the idea of a negative risk scenario that has manifested itself in real life, and that would have been easily to prevent. And in the future it must be prevented, naturally. This approach disregards the prevention's price. Assets available to risk control are not only rare in an economic sense: it is impossible to monitor and control everything to the maximum. Studies in theory and practice of risk management showed that in most of the cases there is no such thing as a zero risk scenario.

RISK MANAGEMENT AS AN OBSTACLE RACE

Coping with risks in a rational way is hindered by mental processes and what is more, it makes us rely on insufficient risk analysis. Even when it is someone's sincere intention to reduce a certain risk and he or she is fully convinced to really do so, the actual risk decision can be suboptimal or even contra productive. With all rationalisation that took place in the past decades, men appear to be the weak link in the chain of risk management. The big number of systematic, partly unconscious biases that occur during the risk management process, makes way for the conclusion that risk management itself is kind of an obstacle race. Figure 2 visualises the obstacle track across three types of biases.

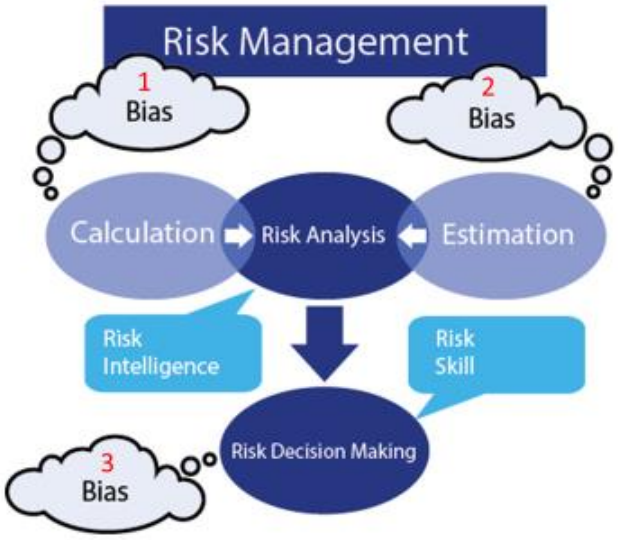

Figure 2 Three types of biases occurring in different stages of the risk management process: 1 calculation biases, 2 estimation biases, and 3 decision making biases

(RE)SEARCHING FOR A REMEDY

After exploring the most relevant biases applying to the risk decision making process, the next question is if there is some kind of solution possible. Can we remove obstacles or would a hurdling training be a better strategy?

In order to optimise the process of risk management in the field of safety and security, it is important to get to the bottom of risk analysis and risk decision making, and to understand the problems that occur during the process. The empirical literature of social psychology and behavioural economics doesn't give us much hope of removing hurdles from the track. We should rather try to strengthen the critical competences of risk intelligence and risk skill where possible. With risk intelligence this could mean training the ability to analyse risks on a (meta) cognitive level. Can we improve the crucial skills of numeracy and risk literacy: calculating, estimating and evaluating? With risk skill, training the practical ability to make adequate risk decisions on the basis of a risk analysis might be functional.

The question how far the critical competences mentioned above can be trained or improved is not clearly answered in research literature. On the one hand Gigerenzer

(2001; 2002) showed that clear and critical thinking can be stimulated by what he calls 'teaching clear thinking', and certain complex reckoning tasks as well. On the other hand Kahneman (1982; 2011) has apparently become less optimistic about the possibility of correcting biases of the intuitive brain system I, by training heuristics via the (meta) cognitive system II. In a small experimental study with Safety and Security Management students of Utrecht University of Applied Sciences, we found a small positive effect of a training in numeracy and risk literacy (Bertholet, 2013). A larger scale study on the effectiveness of professionalization interventions has started in February 2014. In 2016 two pilot projects will be conducted, one of them with airport security agents and one with bachelor students in safety and security management (BPM). The pilot studies will have an experimental design founded on evidence based research methodology for innovation of teaching. Results of both experiments will lead to conclusions about the effectiveness of the interventions and the various instructional strategies used. Lessons learned in these pilots can be applied in up scaled follow-up experiments.

INTERVENTION 1: AIRPORT SECURITY

Security agents on Amsterdam International Airport Schiphol are, among other tasks, responsible for security checks of passengers and baggage. In a quite hectic atmosphere they have to assess passengers and their hand luggage, respecting strict security procedures and looking for suspicious signs and behaviour. Airport security agents are well trained and equipped with state of the art hardware and software, such as X-Ray for baggage and security scanners for passengers. Nevertheless, security threats are dynamic and the airport's quality assurance management wishes to keep the human assets up with the latest standards. With a pilot experiment we will search for an answer to their question: to what extent do biased risk decisions by security agents occur and what kind of training could be a remedy for that problem? In the first half of 2016 an intervention group of 60 randomly selected agents will be trained in two intensive workshop sessions per 12 agents and afterwards in an extensive individual training.

Intervention

The two workshop sessions will focus on the most relevant biases. The theoretical concept will be presented briefly and in a way that is appropriate for the intermediate vocational education level of the agents. In this way awareness of biases will be created. With the use of cartoons, a visual transfer tool will be introduced to help the agents remember the pitfalls of the various biases and to automate strategies to avoid them. The training materials to be used will apply the theory to the working practice by visualizing, reflection and metacognition. After the training sessions the agents in the intervention group will receive a 1-item test on every working day for one month, with a realistic risk decision task from practice and immediate response to

their decision on that case. This extensive form of training will help the agents to build heuristics in rational, non- or less-biased risk decision making.

Experiment
The experimental setting of the first intervention is shown in Figure 3 below. Cases with critical decision moments will be collected first, to develop the training content for the workshop sessions, the extensive training and the tests.

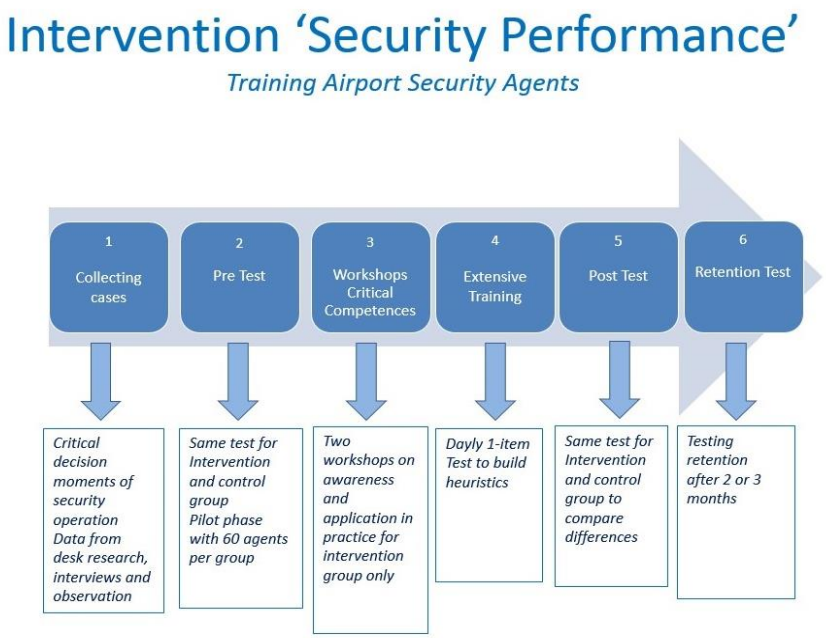

Figure 3 Experimental design of intervention 1: Equal, randomly selected intervention and control groups will get the same pretest and post-test. Only the intervention group will get the two phases training intervention and a retention test after 2 or 3 months.

INTERVENTION 2: TEACHING CLEAR THINKING TO BACHELORSTUDENTS

Bachelor students in Safety and Security Management are preparing themselves for a professional role as coordinators or liaison officers in an extremely broad working field. However, risk management always is one of their core tasks. At the Department of Safety and Security Management Studies, teaching staff members were realizing since a long time how important competences like analysing and critical thinking would be for the 'reflective professionals' we are educating for practice. So as we started to redesign our curriculum in 2014, we assigned 15 ECT's (420 hours) to Analysis & Interpretation and Intervention Strategy, as new subjects

for our second year students. Analysis & Interpretation fits to a phase of Risk Analysis of the process model. Intervention Strategy covers the phase of Risk Decision Making. In the current academic year (2015-2016), the new modules are offered to the students for the first time. A dedicated training in 'debiased Risk Decision Making' will be added in the next academic year, in an experimental effect study.

Intervention

On the cognitive level students are provided with theoretical background knowledge on decision making and biases from social psychology and behavioural economics, as Figure 4 shows. On the basis of the process model we will collect cases from about ten subdomains of safety and security practice, where risk decision biases occur. For each subdomain, for example domestic violence, health care, outdoor sports, traffic, we will produce an instruction video, explaining how the pitfalls of biased decisions apply to it in a specific way. The videos can be used in a blended learning setting, where also face-to-face trainings sessions and (online) training and testing modules will be part of. Visualization will be a leading principle of instruction strategy, as well as student achievement (Hattie, 2009; Valcke, 2010).

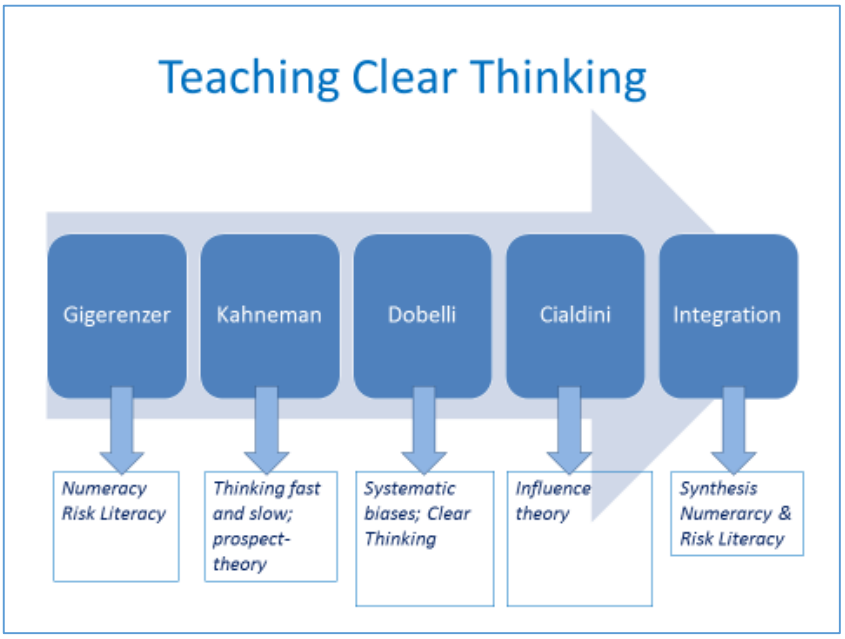

Figure 4 Design of intervention 2: Core conceptual knowledge of biases to be transferred on a theoretical basis and in applications like instructional videos and cartoons

Experiment
The experimental setting of the second intervention will be similar to the first. Half of the student groups will be in intervention and the other half in control groups. Pretest and post-test are based on the standardised Berlin Numeracy Test (Cokely, 2012) and a risk literacy test we used in earlier experiments. The test results will be evaluated with statistical regression analysis and compared with results of the preadmission test the students have made in 2015.

CONCLUSION

Both effect studies will already show in the pilot phase to what extend 'debiasing by training' in education as well as in practice might be possible. First experimental data may be presented to the EAPRIL Conference 2016 in November.

An early pilot study to this research project was presented at the EAPRIL 2012 Conference in Finland. At the EAPRIL 2015 Conference in Luxembourg we presented the actual design of both the two experiments and the educational interventions.

REFERENCES

Ariely, D. (2008). Predictable Irrational. The hidden forces that Shape Our Decisions. New York: HarperCollins.

Bertholet, A.G.E.M. (2013). Teaching Clear Thinking. Het verbeteren van gecijferdheid en risicogeletterdheid als bijdrage aan adequatere risicocommunicatie: een onderwijsexperiment in het hbo. In: Evidence based verbeteren van het onderwijs 4. Maastricht: Dutch Teachers and Policymakers Academy, p. 140-153.

Bertholet, A.G.E.M. (reviewed, to be published in 2016). Risico-intelligentie en risicovaardigheid van professionals in het veiligheidsdomein. Problemen bij het nemen van risicobeslissingen door denkfouten en beperkte gecijferdheid.

Cialdini, R.B. (2009). Influence. The Psychology of Persuasion. New York: Harper Collins.

Cokely, E.T., Galesic, M., Schulz, E., Ghazal, S. & Garcia-Retamero, R. (2012). "Measuring Risk Literacy: The Berlin Numeracy Test." Judgement and Decision Making 7(1): 25-47.

Dobelli, R. (2011). Die Kunst des klaren Denkens. 52 Denkfehler, die Sie besser anderen überlassen. München: Carl Hanser Verlag.

Gigerenzer, G. (2002). Reckoning with Risk. Learning to live with uncertainty. London: Pinguin Books.

Gigerenzer, G., Sedlmeier, P. (2001). Teaching Bayesian Reasoning in Less Than Two Hours. Journal of Experimental Psychology Vol. 130, No. 3, p. 380-400.

Hattie, J.A.C. (2009). Visable Learning. A synthesis of over 800 meta-analyses relating to achievement. New York: Routledge.

Kahneman, D. (2011). Thinking fast and slow. London: Penguin UK.

Kahneman, D., Slovic, P., Tversky, A. (1982). Judgement under uncertainty: Heuristics and biases. Cambridge: Cambridge University Press.

Mommers, J. (2015). Zo breng je de wereld aan het twijfelen over klimaatverandering. Retrieved on 13 March 2015 from https://decorrespondent.nl/2532/Zo-breng-je-de-wereld-aan-het-twijfelen-over-klimaatverandering/13757773920-6fcb4587.

Paulos, J.A. (1998). Innumeracy. Mathematical illiteracy and its consequences. New York: Vintage Books.

Simon, H.A. (1984). Models of Bounded Rationality and Other Topics in Economics. Cambridge MA: MIT Press.

Sitalsing, S. (22 September 2014). Risico. De Volkskrant, p. 2.

Taleb, N.N. (2007). The Black Swan. The Impact of the Highly Improbable. New York: Random House.

Taleb, N.N. (2013). Antifragiel. Dingen die baat hebben bij wanorde. Amsterdam: Uitgeverij Nieuwezijds.

Tetlock, P. E. (2005) Expert Political Judgment: How Good Is It? How Can We Know? Princeton, N.J: Princeton University Press.

Valcke, M. (2010). Onderwijskunde als ontwerpwetenschap. Gent: Academia Press.

Wierenga, P. (31 January 2015). De lone wolf bestaat niet. De Volkskrant.