

COMENIUS UNIVERSITY IN BRATISLAVA

FACULTY OF MATHEMATICS, PHYSICS AND INFORMATICS

**TESTING THE CULTURAL COGNITION THEORY
OF RISK PERCEPTION**

DIPLOMA THESIS

2016

Lenka Kostovičová

COMENIUS UNIVERSITY IN BRATISLAVA

FACULTY OF MATHEMATICS, PHYSICS AND INFORMATICS

**TESTING THE CULTURAL COGNITION THEORY
OF RISK PERCEPTION**

DIPLOMA THESIS

Study program: Cognitive Science

Study discipline: 2503 Cognitive Science

Institution: Department of Applied Informatics

Supervisor: Prof. PhDr. Viera Bačová, DrSc.

Bratislava 2016

Lenka Kostovičová



Univerzita Komenského v Bratislave
Fakulta matematiky, fyziky a informatiky

ZADANIE ZÁVEREČNEJ PRÁCE

Meno a priezvisko študenta: Mgr. Lenka Kostovičová, PhD.
Študijný program: kognitívna veda (Jednoodborové štúdium, magisterský II. st., denná forma)
Študijný odbor: 9.2.11. kognitívna veda
Typ záverečnej práce: diplomová
Jazyk záverečnej práce: anglický
Sekundárny jazyk: slovenský

Názov: Testing the cultural cognition theory of risk perception
Testovanie kultúrno-kognitívnej teórie vnímania rizika

Cieľ: Je vnímanie rizika determinované kultúrnymi svetonázormi? A ak áno, aké psychologické procesy by mohli vysvetliť dané zistenia? Pre účel zodpovedania týchto kľúčových otázok budeme testovať špecifické kognitívne mechanizmy, prostredníctvom ktorých by kultúra mohla ovplyvňovať posudzovanie rizika (a benefitov).

Literatúra: Hayes, A. F. (2013). An introduction to mediation, moderation, and conditional process analysis: A regression-based approach. New York: Guilford Press.
Kahan, D. M. (2012). Cultural cognition as a conception of the cultural theory of risk. In S. Roeser, R. Hillerbrand, P. Sandin, & M. Peterson (Eds.), Handbook of risk theory: Epistemology, decision theory, ethics, and social implications of risk (pp. 725-759). New York: Springer.
Kahan, D. M., Braman, D., Cohen, G. L., Gastil, J., & Slovic, P. (2010). Who fears the HPV vaccine, who doesn't, and why? An experimental study of the mechanisms of cultural cognition. Law and Human Behavior, 34, 501-516.

Anotácia: Kultúrno-kognitívna teória postuluje, že jednotlivci selektívne vnímajú a interpretujú riziká a s nimi súvisiace fakty spôsobom, ktorý reflektuje a podporuje ich kultúrne svetonázory alebo preferovaný pohľad na organizáciu spoločnosti. Cieľom práce je overiť tento predpoklad v rámci slovenskej populácie, a zároveň nájsť možné vysvetlenia daného fenoménu.

Vedúci: prof. PhDr. Viera Bačová, DrSc.
Katedra: FMFIKAI - Katedra aplikovanej informatiky
Vedúci katedry: prof. Ing. Igor Farkaš, Dr.
Dátum zadania: 27.11.2013

Dátum schválenia: 18.05.2015

prof. Ing. Igor Farkaš, Dr.
garant študijného programu

študent

vedúci práce

ĎAKUJEM

Vám, drahí rodičia a Tebe, Miruško, za trpezlivosť, lásku a podporu.

Vám, milí priatelia, za to, že ste a akí ste.

Vám, dr. Svetlana Bednářová a Mgr. Jaroslav Ulický, za prebudenie vášne pre poznanie a vzdelávanie.

Vám, prof. Viera Bačová, doc. Alojz Ritomský, dr. Miroslav Sirota a dr. František Gyárfáš, za vzácne rady, inšpirácie, znalosti a skúsenosti, ktoré mi odovzdávate. Profesorke Bačovej špeciálne i za školenie tejto práce.

Skvelým pedagógom na Fakulte matematiky, fyziky a informatiky UK.

Janke Bašnákovej a všetkým, ktorí mi pomohli splniť si sen vyštudovať matfyz ☺.

ABSTRAKT

Už desaťročia sa výskumníci snažia odhaliť, ako sa u ľudí formujú postoje k rizikám, ktorým čelia. Podľa Teórie kultúrnych kognícií sa jednotlivci vysporiadajú s informáciami o rizikách spôsobom, reflektujúcim a posilňujúcim ich kultúrny svetonázor. V našej medzi-subjektivej štúdii ($N = 339$), sme skúmali kognitívne procesy, prostredníctvom ktorých by kultúrne hodnoty mohli ovplyvniť hodnotenie hrozieb a prínosov. Experimentálna manipulácia spočívala v poskytnutí protichodných argumentov – buď anonymných, alebo priradených špecifickým autorom. V našom výskumnom súbore zo Slovenska sme identifikovali všeobecnú predispozíciu mať či nemať strach, a podporili predpoklad "ľudia sa boja toho, s čím sú málo oboznámení". Navyše, zmeny v rizikových postojoch záviseli od blízkosti kultúrnych preferencií participantov a autorov argumentov. Venujeme sa diskusii našich zistení v interdisciplinárnom kontexte, a príslušným implikáciám – od debaty o ľudskej racionalite, cez umenie komunikácie vedeckých poznatkov, po intervencie verejnej politiky.

Kľúčové slová: kultúrne kognície, vnímanie rizika, predošlá znalosť, polarizácia, kredibilita

ABSTRACT

Decades of research sought to find out how people form positions on risks they encounter. According to the Cultural cognition theory, individuals deal with risk-related information in a manner that mirrors and reinforces their cultural worldview. In our between-subject study ($N = 339$) we examined cognitive processes through which cultural values might affect evaluation of threats and benefits. Experimental manipulation was based on providing opposing arguments, either anonymous or ascribed to specific authors. We identified a general predisposition to be or not to be afraid among our Slovak sample, and supported the assumption “people are afraid of thing they are unfamiliar with”. In addition, changes in risk attitudes have been subject to the proximity of cultural preferences of the participants and the authors. We discuss our findings within an interdisciplinary context, and specify corresponding implications – ranging from debate on human rationality, through “science of science communication”, to public policy interventions.

Keywords: cultural cognition, risk perception, prior knowledge, polarization, credibility

Content

Introduction	1
1 Review of the current state of knowledge	3
1.1 Perception of risk and probability	3
1.1.1 Heuristics and biases in risk perception	5
1.1.2 Neuroscientific evidence on risk perception	7
1.2 Cultural cognition theory of risk perception	10
1.2.1 Cultural cognition, confirmation bias and credibility heuristic	13
1.2.2 Socially relevant topics	14
1.3 Research aim and hypotheses	16
2 Methods	20
2.1 Participants	20
2.2 Design	20
2.3 Materials	21
2.4 Procedure	25
2.5 Implementation and statistics	27
3 Results	28
3.1 Hypothesis 1: Cultural values and risk perception	31
3.2 Hypothesis 2: Confirmation bias	33
3.3 Hypothesis 3: Credibility heuristic	36
3.4 Summary of main findings	40
4 Discussion	41
4.1 Findings and interpretations	41
4.2 Interdisciplinary perspectives	46
4.3 Implications and applications	48
4.4 Limitations and future directions	50
Conclusion	52
References	53

Introduction

“Risk assessment is inherently subjective and represents a blending of science and judgment with important psychological, social, cultural, and political factors” (Slovic, 1999, p. 689).

Terrorists strike twice. First, causing immediate consequences – casualties and property damage. However, the other source of harm is even more dangerous, because it receives less attention. So called “indirect damage” is mediated through the minds of people when they are seized with fear (Gigerenzer, 2008). U.S. traffic fatalities substantially increased after the 9/11 attacks, since a large part of the population chose driving instead of flying. Prevalence of this pattern of behavior was related to the proximity to New York (Gaissmaier & Gigerenzer, 2012).

In a similar manner, local herd immunity is at risk and epidemic is a real threat, due to growing negative attitude toward vaccination. In some Slovak regions, vaccination rate of children against measles, mumps and rubella fell below a critical threshold of 95% under which it ceases to fulfill its protective function (Tvardzík, 2015). And yet, secondary consequences of terrorism and irrational opposition to mandatory immunization are just two of the many examples of why studying risk perception is of a high importance.

Moreover, current empirical evidence suggests that understanding the reasons people are (or are not) afraid, is not enough. We need to analyze the complex model of environmental, individual and social factors which attenuate or facilitate manifestation of fear or tolerance in inadequate behavior. According to recent research, the basic and widespread assumption that “people are afraid of things they do not understand” applies only partially. Moreover, above all studied aspects, cultural values seem to represent the

most powerful predictor of risk assessment (Kahan, Braman, Cohen, Gastil, & Slovic, 2010; Kahan, Braman, Slovic, Gastil, & Cohen, 2009).

Do cultural worldviews really determine risk perception? And if so, what are the underlying psychological processes behind such findings? To address these primary questions, we will experimentally test specific mechanisms through which cultural orientation might influence assessment of dangers and benefits. Our research is set in the domain of two socially relevant topics, vaccination against HPV and nanoscience. The theoretical and empirical background of the thesis as well as the interpretation framework are interdisciplinary as they cover cognitive psychology, neuroscience, public policy and several other domains.

Before we proceed to description of the experiment itself, we take a closer look at the current state of knowledge on the research problem. First on risk perception in general, including the role of heuristics, cognitive biases and relevant neuroscientific evidence. Next, we introduce the cultural cognition theory and two main components of our model: confirmation bias and credibility heuristic. Finally, we briefly describe HPV vaccination and nanoscience, and we explain the rationale and hypotheses of the present research study.

1 Review of the current state of knowledge

1.1 Perception of risk and probability

“To think is to take a risk, a step into the unknown”
(Todd & Gigerenzer, 2000, p. 729).

Perception of risk and probability is an important line of research not only because of understanding cognitive functions and processes. It is also essential due to practical implications in communicating information on statistics, hazards and dangers to the public. Indeed, differences in risk perception – how worried or threatened people feel – predict real-life behavior (e.g., Brewer et al., 2007; Renner & Reuter, 2012; Weinstein et al., 2007).

So how do people evaluate risk-related information? According to modern theories in neuroscience and cognitive psychology, findings on how people react to hazards and dangers are in line with the conception of a “dual mind”. Dual-process theories (e.g., Epstein, 2003; Kahneman, 2011) assume that there are two distinct types of processes in human brain, belonging to System 1 or System 2. The first one is rather unconscious and automatic, holistic, associative, heuristic and emotional, and solves problems mainly by relying on prior knowledge and beliefs. Evolutionary more recent System 2 is analytic, controlled, based on rules, logic and elaboration, permits abstract and sequential thinking, and is rather rational, though very limited in capacity. The systems operate simultaneously and their work is effectively divided – minimizing effort and maximizing performance.

Thus, people process risk in two fundamental ways. First, through conscious, effortful and slow analytic (“risk as analysis”) system, using normative rules and algorithms. Then, by means of mostly automatic, fast and intuitive experiential system. The latter one is evolutionary older and, therefore, constitutes a most common and natural way of responding to risky situations and corresponding information. It relies on associations,

experience and affect – thus processes “risk as feelings”. Furthermore, it seems that risk-as-analysis reasoning is often effective only when it reflects information from the risk-as-feelings processes (Slovic, Finucane, Peters, & MacGregor, 2004).

And what about perception of risks versus benefits? Finucane, Alhakami, Slovic, and Johnson (2000) found that manipulating perception of one attribute (e.g., decreasing dangers) leads to change in the other attribute, in opposite direction (e.g., increasing profits). People tend to believe that beneficial activity contains only low risks, and vice versa (Sunstein, 2002). Even though benefits and risks are usually positively correlated in real-life environment, their relationship is likely to be inverse in human mind. For instance, food additives are often seen as high in risk and low in profit, and X-rays tend to be considered as high in benefit and low in hazard. As proposed by Finucane et al. (2000), this phenomenon occurs due to reliance on affect. Specifically, people use the affect heuristic which is based on the following principles. Our mental representations of events and objects are tagged to various degrees with affect. We consult this affective repertoire in the process of judgment and decision making and it serves as a cue for our responses. Affective heuristic works very well in situations when our experience facilitates adequate estimate of how we will appreciate the outcomes of our choices. However, it fails when the consequences are substantially different than we expected (Slovic et al., 2004).

Evaluation of risk is closely related to probability perception. Accurate processing and assessment of probabilities of potential outcomes is essential for informed decision making. However, people overweight low and underweight high probabilities (Tversky & Kahneman, 1992), react to mathematically equivalent information differently (Sirota, Juanchich, Kostopoulou, & Hanák, 2014), and attribute subjective values to verbal and numerical probabilities according to their interpretation of the speaker's intention (Sirota & Juanchich, 2012). And these are only few illustrations of the numerous phenomena that lead people astray in their probability judgments. As for the perception of risk, the situation is no different.

1.1.1 Heuristics and biases in risk perception

“Judgmental shortcuts that generally get us where we need to go – and quickly – but at the cost of occasionally sending us off course” (Gilovich & Savitsky, 1996, p. 48).

In plenty of situations people assess risk in complex domains, despite lacking necessary competence, experience, information and time. How do they handle that? Due to the limits of their cognition, they need to rely on approximate methods to deal with most tasks. Their rationality is inevitably bounded. And therefore, they engage in heuristic reasoning. Simon (1990), the author of bounded rationality perspective and the father of heuristic research, posits that heuristics are “methods for arriving at satisfactory solutions with modest amounts of computation” (p. 11). He also argues that heuristic search in stored knowledge represents a major strategy for intelligent adaptation to our constrained rationality.

Thus, heuristics – specific mental shortcuts – are fast and frugal (Gigerenzer, 2008). They reduce cognitive effort, lead to acceptable answers or even perform comparably to complex algorithms (Todd & Gigerenzer, 2000). And, they also work under difficult real-world conditions where optimal procedures are often unknown or computationally intractable (Gigerenzer, 2008). How is it possible? Heuristics exploit the ways how information is structured in particular environment. They are part of the “adaptive toolbox”: collection of specialized procedures that evolution has built into our minds for specific domains of reasoning and decision-making (Todd & Gigerenzer, 2000). Let’s look at some examples related to perception of risk and probability.

Three basic heuristics defined by Tversky and Kahneman (1974) are representativeness, availability and anchoring. People tend to evaluate the level of risk and probability based on similarity with the parent population (representativeness), ease of recall from memory (availability), and the first piece of information offered (anchoring).

Employing these principles, we are able to make accurate judgments and decisions, but only in appropriate environments. Otherwise, heuristic reasoning leads to illusions and errors, especially when it crowds out more systematic thinking. In laboratory conditions, these deviations occur very frequently. No wonder that the first decades of research in this domain are characterized by a pessimistic picture of heuristics and their functionality.

Indeed, numerous cognitive biases due to applied heuristic principles have been reported in human reasoning about risk and uncertainty. Examples include over- and underestimating risks of different causes of death according to extent of media coverage (e.g., homicides versus diabetes) or tendency to be over-optimistic in self-related predictions. And also biased assimilation of new information according to prior beliefs and subjective evaluation of the source of arguments, as described further in more details.

Confirmation bias

Confirmation bias, also known as myside bias, is a tendency to favor, seek, interpret and recall information in a way that corresponds to prior expectations, beliefs, or hypotheses of a person (Nickerson, 1998). This is a substantial cognitive difficulty, since open-minded critical thinkers should be capable of decoupling their existing views and attitudes from evaluation of arguments and evidence (Stanovich, West, & Toplak, 2013). Distorted search, interpretation and memory – due to myside bias – have been suggested to explain several robust phenomena of human cognition. For example, illusory correlation – false perception of association between events, primacy effect – attributing more weight to information acquired early than to that coming later, or belief persistence in the face of compelling evidence that it is wrong, and also attitude polarization. Significant consequences of this cognitive deviation range from biased evidence-evaluation of jurors to conservatism among scientists (Nickerson, 1998). Resistance to myside bias seems to represent a rational thinking skill which is unrelated to intelligence (Stanovich et al., 2013).

Credibility heuristic

“Ethos” or source credibility is associated with situations where information believability depends on “the credibility status of the sender in the minds and eyes of the receivers” (Umeogu, 2012, p. 112). The concept of credibility has been defined in numerous ways: expertness and trustworthiness, attractiveness of a source of influence, source's prestige, or the history of previous accuracy of the source (Nesler, Aguinis, Quigley, & Tedeschi, 1993). An important factor closely related to perceptions of trustworthiness, accuracy and validity, and judgments on credibility, is expertise (Hilligoss, & Rieh, 2008). People rely on credibility of the source, especially when they lack prior attitudes toward the issues and knowledge about the phenomena, and when the message content is presented only once (Kumkale, Albarracín, & Seignourel, 2010). Thus, a rule of thumb suggests that the more credible the source of an argument, the stronger the argument.

Most of the evidence on risk perception comes from research in psychology and behavioral economy. Especially cognitive illusions and fallacies related to evaluation of probability, danger and uncertainty, are well documented. But what about studies using neuroscientific methods? How do they contribute to the picture of a person, standing face to face with risky choices, with all their cognitive limitations?

1.1.2 Neuroscientific evidence on risk perception

“To date, little is known about how the brain processes risk” (Mohr, Biele, & Heekeren, 2010, p. 6613).

Behavioral research on evaluation of risk and uncertainty, and corresponding cognitive failures and illusions, often leads to inconsistent findings. Therefore, neuroscience can be helpful for the purpose of informing and refining psychological models of risk processing. Supporting risk-taking evidence for validity of neuroscientific research shows that neural responses to tailored persuasive messages predicted quitting smoking in a 4-month follow-

up (Chua et al., 2011) and using sunscreen in the subsequent week after the data collection (Falk, Berkman, Mann, Harrison, & Lieberman, 2010). Neural responses of a small focus group to television campaigns even predict large-scale population effects in behavior (Falk, Berkman, & Lieberman, 2012). We further discuss selected neuroscientific studies on processing risk-related and threatening information.

Westen, Blagov, Harenski, Kilts, and Hamann (2006) conducted an fMRI study of biased interpretation in the context of the U.S. presidential election. They recruited people with strong feelings about one of the candidates. Experimental material was based on contradictions between the person's words and actions. Participants were asked to decide whether each candidate's statements are inconsistent. They were much more likely to consider message from the candidate they opposed as contradictory comparing with other candidates (some of them were only control ones). More importantly, so called "motivated reasoning" while evaluating the statements of their favorite candidate, was qualitatively different from the other situations. Regions linked to "cold" reasoning and conscious emotion regulation (e.g., dorsolateral prefrontal cortex) were not involved in the motivated reasoning. It was associated with activations of the anterior cingulate cortex, ventromedial prefrontal cortex, insular cortex, posterior cingulate cortex and lateral orbital cortex. These areas are responsible for implicit affect regulation, processing distress related to error detection, implicit appraisal of frightening information, and cognitive suppression of emotionally charged stimuli. The findings indicate that the different responses to threatening information about the preferred candidates were not based on passive reasoning biases. Instead, the participants were actively reducing cognitive dissonance induced by reading about their favorite candidate's irrational or hypocritical behavior.

By means of meta-analyses, Mohr et al. (2010) investigated how brains process risk. They chose 30 fMRI experiments which met required criteria and used the activation likelihood estimation method. Their results showed that both anticipation risk and decision risk are represented in the anterior insula (aINS), a region responsible for processing

aversive emotions, such as regret, fear, sadness or disappointment. Activation of aINS was strong predominantly when participants were confronted with potential losses. Most studies found risk representation in the thalamus. It is known to be related to handling emotions and reflecting information on outcome magnitude. The network involved in risk processing also consisted of the dorsomedial prefrontal cortex (DMPFC) and the dorsolateral prefrontal cortex (DLPFC) but only in choice situations. DMPFC is associated with cognitive processing of stimuli and DLPFC is related to evaluating choice alternatives. The authors deduced that neural processing of risk is context-dependent and proposed the following mechanism. When facing risky stimulus, two parallel processes – emotional and cognitive – are induced. The aINS provides a quick approximation for the capacity of the stimuli to result in an undesirable outcome. Thus, thalamus might reflect anticipated level of regret in reaction to potential outcomes of the stimuli. Subsequently, the DMPC evaluates the risk of the stimulus on a cognitive level, e.g. computing probability of loss. Finally, the DLPFC integrates the information and forms the decision.

In their fMRI study, Schmälzle, Häcker, Renner, Honey, and Schupp (2013) measured neural data during realistic TV report on H1N1 pandemic. Brain regions of the posterior cortex, engaged when people paid attention to, and extracted information from the H1N1 video, were similarly activated among viewers. However, the authors found group differences in postperceptual regions associated with responses to emotional significance. Participants with intensive H1N1-risk perceptions exhibited intersubject correlations in the anterior cingulate related to evaluation of threatening information. Thus, neural processes during real-life health messages seem to be influenced by preexisting risk perceptions.

Whether economic, psychological or neuroscientific evidence, there exist various individual differences on how people evaluate and respond to risk. Some of them seem to be quite robust. According to recent research findings, people identify themselves with specific cultural values, which are reflected in their risk perceptions. In addition, cultural worldview predicts assessment of threats and benefits better than any other characteristics.

1.2 Cultural cognition theory of risk perception

“Risk is a collective construct” (Douglas & Wildavsky, 1983, p. 186).

Disagreement on societal and personal hazards is not randomly distributed. It also does not simply correlate with personal characteristics related to specific types of heuristics (Kahan et al., 2010). In fact, assessment of hazards and dangers is linked to membership in social categories and groups important for social and personal identity: gender, race, political and religious affiliation (Kahan & Braman, 2006). However, Kahan, Braman, Gastil, Slovic, and Mertz (2007) found that cultural worldview – preference for egalitarianism versus hierarchism, and communitarianism versus individualism – predicts risk attitudes strongly more than these characteristics, most of which explain variance in risk perception only because they interact with or are related to cultural values. Numerous widely discussed socially relevant topics, such as tuition payment, migrants or progressive taxes, contain a cultural element underlying arguments on societal benefits and dangers.

How culture affects risk perception? According to the Cultural theory of risk (Douglas & Wildavsky, 1983), individuals form beliefs about threats and hazards in a way that reflects and reinforces their commitments to an idealized form of social order. According to their “group” and “grid” typology, people can be placed on a two-dimensional scale of individualism/communitarianism and hierarchism/egalitarianism, as depicted in Figure 1. A “high group” worldview favors a solidaristic, communitarian society, where the needs of the collective are superior to those of the individual and in which society is responsible for securing the conditions of individual growth and prospering. Conversely, a “low group” way of life is characterized by a low level of collective control or interference, and a society in which individuals are expected to take care of the conditions of their own well-being. A “high grid” worldview prefers hierarchical social order, with a stratified way of assigning resources, privileges, rights and obligations on the basis of stable personal

characteristics, such as gender, class, ethnicity, and lineage. A “low grid” way of life is typical for an egalitarian society, in which such individual attributes are irrelevant to the distribution of opportunities, prerogatives, wealth and status (Kahan & Braman, 2006).

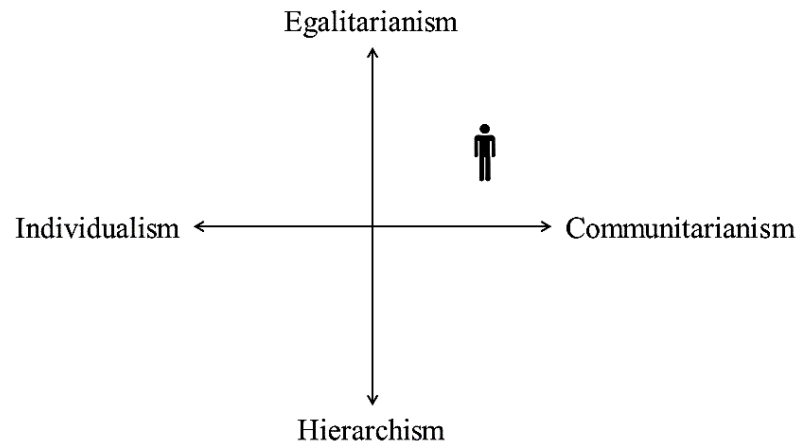


Fig. 1 Dimensions of cultural values (adapted from Kahan, 2012)

Since people are expected to conform their risk perception to own cultural evaluations of dangerous activities and policies for their regulation, the following assumptions can be derived. Individualists are against any action which might intrude on individual choices (e.g., regulations based on mandatory behavior). They tend to react disapprovingly to claims of technological and environmental risks, recognition of which threatens markets and private ordering as such. Hierarchists also dismiss statements on these categories of potential threats. Thus, claims about negative aspects of such activities question the authority and credibility of social elites. They are also in opposition to anything that could jeopardize the traditional norms – regarding gender roles or any other. Egalitarians and communitarians, in contrast, believe that industry and commerce – both associated with selfishness and inequity – represent danger for society and nature, and accept claims of corresponding risks. In addition, people preferring egalitarianism encourage behavior that breaks conventions and traditional, patriarchal standards. Finally, people of communitarian worldview support collective commitments and restricting promotion of individual interests (Kahan et al., 2009, 2010).

There is a considerable amount of empirical evidence for these patterns. Peters and Slovic (1996) showed that cultural values are highly predictive of risk perceptions associated with nuclear power. The authors conclude that our worldviews act as an orienting mechanism, navigating us in an uncertain, complex world. In the study by Jenkins-Smith (2001), stigma associated with nuclear waste repositories was less prevalent among hierarchists and individualists, and the most negative attitude was found in the group preferring egalitarian values. According to research by Kahan et al. (2007) members of majority, especially men, are more individualistic and hierarchical than women and minorities, and consequently less fearful of various risks. Moreover, their findings indicate that cultural values explain variance in risk perception better than myriad other variables, including political and religious affiliation.

The risk-containing information could even be associated with topics on which experts largely agree. Kahan, Jenkins-Smith and Braman (2011) provided evidence that cultural worldview affects individual beliefs regarding existence of scientific consensus. Hence, people systematically over- or underestimated the amount of scientific support, consistently with the positions they are culturally predisposed to reject or accept. Moreover, public's incomprehension of science is not a crucial problem. When people disagree with experts, it is not necessarily due to less knowledge but because of their values (Sunstein, 2002). Indeed, cultural polarization in the domain of climate-change risk was greatest among people with the highest degree of technical reasoning and science literacy (Kahan et al., 2012). Therefore, cultural cognition is more than a simple heuristic compensation for inability to evaluate scientific information in an analytical manner. It involves and is manifested by a variety of processes.

Which psychological concepts could shed light on why are people likely to conform their opinion on risk and its sources to their cultural worldview? First, they probably avoid cognitive dissonance. It is a natural tendency to seek consistency in beliefs and perceptions. The next candidate is affect. Cultural orientations may determine whether our reactions to

particular activities or objects are negative or positive, and to what extent. Finally, impact of cultural values can work through the in-group / out-group dynamics. When we are confronted with conflicting views and we possess neither sufficient knowledge nor experience, we often rely on the ones who share our worldviews (Kahan & Braman, 2006).

Thus, the question is not only whether the cultural cognition theory partially explains risk perception. It is important to search for the mechanisms clarifying the effect of cultural worldview on evaluation of dangers and benefits. Kahan et al. (2010) found empirical evidence for two of them: confirmation bias and credibility heuristic. Both are closely related to the aforementioned psychological concepts.

1.2.1 Cultural cognition, confirmation bias and credibility heuristic

“Hierarchy and egalitarianism, individualism and communitarianism underwrite the social affinities that make others credible and trustworthy sources of risk information, and create identity-protective motivations to conform one’s beliefs to those of like-minded others”
(Kahan et al., 2011, p. 148–149).

According to the cultural cognition thesis, the tendency of people to dismiss and acknowledge information consistently with their initial beliefs, interacts with cultural values. Hence, people selectively seek, integrate, interpret and remember information on risks and benefits in a way that corresponds with their cultural worldview (Kahan et al., 2009). As a consequence, individuals of opposing predispositions will become more divided when faced with balanced arguments. The gap between hierarchists and egalitarians, and between individualists and communitarians, is expected to grow after being exposed to information about profits and dangers of phenomena they disagree upon (Kahan et al., 2010).

Cultural cognition proponents claim that shared values are crucial in credibility judgments (Kahan et al., 2011). Thus, use of the credibility heuristic is highly sensitive to the target's and source's cultural orientations. Accordingly, people tend to trust advocates who share their worldview and who take position which fits their beliefs. From the in-group / out-group perspective, differences and similarities in cultural values supply relevant references that govern whom a person considers as sincere, knowledgeable, unbiased, and worthy of being credited when discussing particular risks and benefits (Kahan et al., 2010). It is likely that the factors of confirmation bias and credibility heuristic interact in the process of risk perception.

It is quite legitimate to believe that – at least a little bit of – risk and uncertainty is contained in every human decision. But, in order to examine the factors underlying evaluation of potential dangers and profits, we need to specify the domains we are going to focus on. The most relevant ones are those with possible severe consequences (Bačová, 2013), for both individuals and society.

1.2.2 Socially relevant topics

“People do not think and act in a social vacuum”
(Lerner & Tetlock, 1999, p. 270).

Our judgments and decisions may affect not only ourselves but also a much wider range of people. Several domains receive special attention, because their consequences concern the entire society. Examples include tuition payments, gender equality, freedom of speech, public safety versus personal privacy, capital punishment, possession of handguns, marijuana legalization and regulation, euthanasia, interruptions, animal testing, stem cells research, GMO, use of pesticides and herbicides, climate change, LGBT rights, multiculturalism, helping refugees and the developing world. We decided for two topics that have not been extensively discussed among Slovak media and public yet:

nanotechnology and vaccination against human papillomavirus. They provide us with a unique opportunity to test the cultural cognition thesis of risk attitudes toward novel domains. We introduce them briefly.

Vaccination against HPV

Human papillomavirus (HPV) is the leading cause of cervical cancer. At the same time, it is one of the most common infections transmitted by sexual contact. However, prevalence of HPV vaccine is low (Dunne et al., 2007). There is a lot of misunderstanding about cervical cancer screening, HPV vaccination and consequences of the infection (Zimet, 2005). The controversy associated with the proposal for mandatory vaccination of young girls stems from its limited effectiveness, adverse side effects, and a false sense of security, potentially leading to unprotected and promiscuous sexual behavior (Kahan et al., 2010). But is it all about health of young women and efficacy of the vaccine? Or are the positive and negative attitudes toward immunization (as such) closely related to the worldview of the proponents? In fact, a review made by Brewer and Fazekas (2007) indicates that most of the parents do not possess enough knowledge on HPV and the vaccine, to make informed decisions.

Nanotechnology

Nanoscience, a rapidly progressing field, is focused on materials at atomic and molecular scale, their aspects and manipulation. Nanotechnologies represent specification, design, production and application of systems and devices by controlling size and shape at nanometer level (Whatmore, 2006). Products containing nanomaterials (e.g., cosmetics, computers and clothing) are lighter, stronger and more effective (Kahan et al., 2009). However, potential drawbacks have been pointed out regarding the very properties of nanomaterials that make them unique and attractive. These concerns relate to possible harm to the environment and people. Fear of the dangers of nanotechnologies is

exaggerated, but it is not unfounded (Maynard et al., 2006). Overall, the main relevant argument claims that as the nanoscience “leaps ahead, the ethics lags behind”, i.e. serious research into social, legal and ethical implications of nanotechnologies is missing (Mnyusiwalla, Daar, & Singer, 2003). Yet, the question again arises, which factors play a role in the perception of benefits and threats of nanotechnology, and whether cultural worldview is one of them.

Taken together, recent empirical evidence implies that people recognize and assess the pros and cons of socially relevant – usually controversial – domains according to their cultural orientation and preferred image of society. To verify this hypothesis, we decided to partially replicate the research by Kahan et al. (2009, 2010) on a sample from a culturally different region, with modified methodology, testing the model as described in the following chapter.

1.3 Research aim and hypotheses

“Who fears HPV vaccination [and nanotechnology],
who doesn’t and why?” (Kahan et al., 2010, p. 501).

Our hypotheses, as well as the complete model, are based on the studies by Dan Kahan and his colleagues, who are part of the “Cultural cognition project” at Yale Law School. In 2009, they conducted an experimental investigation aimed at determining how people react to information about pros and cons of nanotechnology. In control condition, participants received no information except that nanotechnology is based on production and manipulation of small particles. In experimental condition, people were exposed to balanced information – two paragraphs on either risks or benefits of nanoscience, of comparable content and equal length. The familiarity hypothesis was not supported: holding cultural values constant, information exposure (i.e. whether participants read arguments or not) did not have an effect on perception of nanotechnology. However, the

results were consistent with the assumption of cultural cognition theory: after reading the paragraphs, attitudes toward nanoscience became more radical – in line with cultural preferences. Those of egalitarian and communitarian values polarized towards “risks > benefits” attitude, and hierarchists and individualists moved in the opposite direction, closer to “benefits > risks” position. Thus, the study of Kahan et al. (2009) yielded substantial proof that public opinion is shaped by psychological dynamics related to cultural cognition.

In a subsequent research on HPV vaccination, Kahan et al. (2010) enriched the design by additional condition. Two experimental groups received the same pro- and con-arguments. However, paragraphs of the latter one were referenced to one of four possible authors. These “culturally identifiable” advocates represented prototypes of the four extreme cultural positions, as depicted in Figure 2. Affiliation to the corresponding cultural values has been induced by the photographs of the authors and the titles of their publications. Both manipulations were pretested. The biased assimilation hypotheses has been once again confirmed. After reading anonymous arguments, attitudes of people became polarized in accordance with the initially preferred cultural worldviews. Moreover, extent of the information exposure effect varied depending on the affinity with the cultural values of the two advocates (proponents of the opposing pro- and con- arguments).

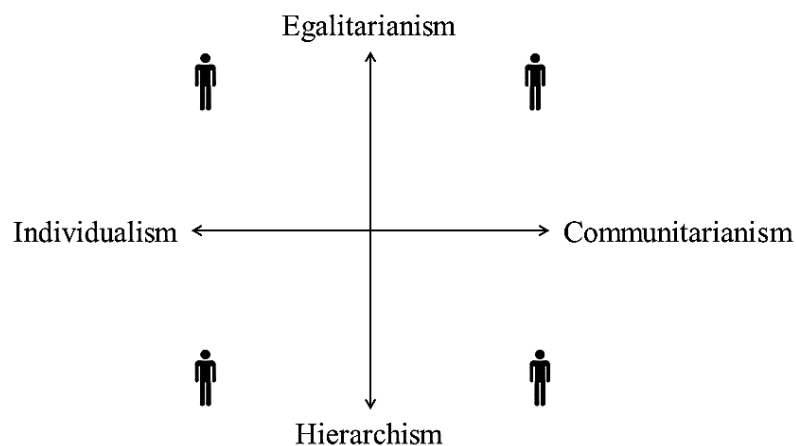


Fig. 2 The four culturally identifiable advocates

In our research, we aim to test the cultural cognition hypotheses of risk perception on a sample from Slovakia. Given the historical, social, political and economic differences, we believe that there are also distinctions between US and Slovak population in cultural values. Another important feature of the present research is that *no intensive discussions*, neither public nor scientific, on the two topics – nanotechnology and HPV vaccination – have taken place in Slovakia yet. Nevertheless, both of them are of a high social importance and they allow us to study the domain specificity of risk attitude. Based on the current empirical evidence, our objective is to examine *two mechanisms through which culture could influence risk perception: credibility heuristic and confirmation bias*. Further we formulate our main assumptions.

According to our first hypothesis, *perception of risks and benefits will be associated with cultural affiliation*. Hence, individualists and hierarchists will recognize fewer advantages and greater dangers of vaccination, and they will consider the benefits of nanotechnology to outweigh potential harm it might cause. The opposite trends are expected among egalitarian and communitarian people: greater fear of nanoscience and rather positive attitude to vaccination against HPV.

In accordance with the confirmation bias, we further assume that *exposure to arguments will lead to polarization of opinion in line with the cultural affiliation*. People of particular cultural values will become even more or less frightened compared with the control condition. Thus, the contrast between egalitarians and hierarchists, and between communitarians and individualists, will become more pronounced after they read balanced pro- and con- arguments.

As implied by the credibility heuristic, we expect the *polarization effect to be dependent on the relative distance between the cultural values of the participant and those of the two authors of the arguments*. For instance, the more is cultural orientation of the initially “benefits-inclined” respondent similar to that of the pro-advocate and different from that of the con-advocate, the stronger the confirmation bias, etc. For this indicator of

relative distance from the authors, we adopted the term “cultural affinity” as used in Kahan et al. (2010).

Finally, we designed the entire model – Figure 3 – which postulates: *relation between cultural worldview and risk perception will be affected by exposure to arguments, and this effect will be moderated by cultural affinity*. Actually, we need to divide the model into smaller parts and test them separately for HPV vaccination and nanotechnology, and for various operationalization of cultural values and their combination.

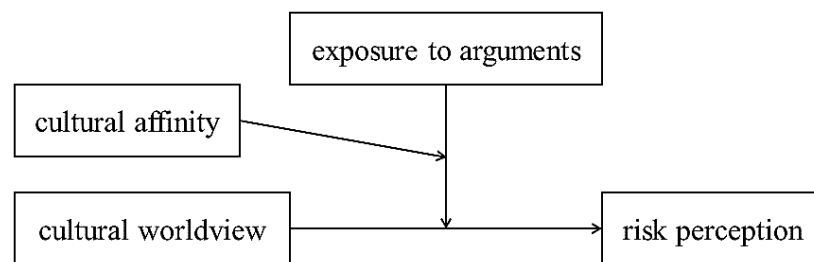


Fig. 3 Cultural cognition theory model of risk perception

2 Methods

2.1 Participants

Using personal and collective invitations via emails, electronic and printed calls, we recruited people of various age and occupation to obtain a diversified sample. For this purpose, the calls for participation were also published on the forums and social network websites that are visited by individuals of specific “non-mainstream” views and values. Based on the pretest ($n = 30$) results, we set the threshold for reading the screens with arguments to be at least 30 seconds. Therefore, we excluded those ($n = 142$) who failed to reach the limit. We further report results based on analyses of responses from remaining 339 participants (234 females and 105 males, $M = 30.6$ years, $SD = 10.2$). Regarding main daily activities, 42.5% ($n = 144$) of them study or work in social sciences sector, 25.4% ($n = 86$) in natural / technical sciences, and 32.2% ($n = 109$) in other domains (e.g., art, sport).

2.2 Design

In a between-subject experimental design, the respondents were randomly allocated to one of the three conditions. The control group ($n = 60$) evaluated statements on risks and benefits of HPV vaccination and nanotechnology without reading any arguments. Members of the first experimental group ($n = 46$) were exposed to anonymous pro- and con- arguments prior to the assessment. In the second experimental group ($n = 233$), the same paragraphs with arguments were assigned to two of the four possible advocates. Two thirds of the sample were redirected to this condition, since there were 12 subgroups, as explained later. Before the main tasks, people provided some socio-demographic information (age, gender, status, and study/occupation) and filled out the Cultural cognition worldview scales (Kahan, 2012). Items of the two scales, paragraphs with arguments, and order of the two domains were randomized.

Main anticipated predictors of risk perception are cultural values – hierarchism-egalitarianism and individualism-communitarianism. The true independent variables are exposure to arguments and combination of authors of the arguments. Our dependent variables are participants’ evaluations of risks versus benefits of nanotechnology and HPV vaccination. Thus, operationalization of our model looks as follows (Figure 4).

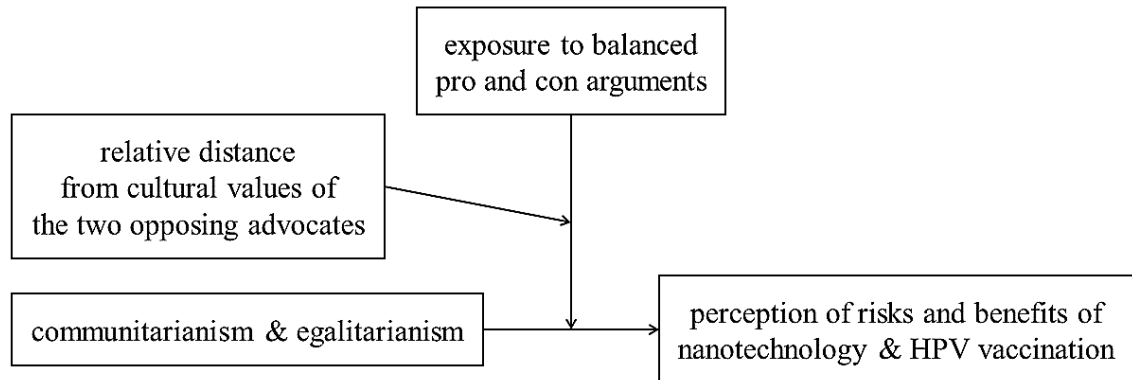


Fig. 4 Operationalized model of the Cultural cognition theory of risk perception

Balanced pro- and con- arguments are expected to cause polarization of attitudes in line with the participants’ cultural worldviews. Furthermore, this effect of argument exposure should, as hypothesized, be conditioned by the difference in the proximity of cultural values between the respondent and the advocates (i.e., cultural affinity).

2.3 Materials

We translated and modified a part of the materials used in the two studies by Kahan et al. (2009, 2010). Translation adjustments were carried out on the basis of consultation with experts from different disciplines (psychology, linguistics, anthropology, political science) and by incorporating suggestions and insights from the pretest. We experienced difficulties with the items of cultural values, since the original wording is partially tied to American society. For instance, some of the items are about “blacks” – the African-American U.S. minority. We used a phrase “people of other color” instead. After completion of the

translation process, we concluded that remaining complications and discrepancies regarding comprehension of the items stem from the original wording of the scales.

Cultural cognition worldview scales (CCWS)

Cultural orientation was measured with Cultural cognition worldview questionnaire: 13-item Hierarchy-Egalitarianism and 17-item Individualism-Communitarianism scale (Kahan, 2012). Participants indicated their attitude on 6-point Likert scales [strongly disagree, moderately disagree, slightly disagree, slightly agree, moderately agree, strongly agree]. After reversing part of the responses, two scores were calculated for each respondent – the degrees of egalitarianism and communitarianism. Both scales were reliable, $\alpha_{\text{egalitarianism}} = .74$, $\alpha_{\text{communitarianism}} = .79$. Further we list four examples of the CCWS statements (Kahan, 2012; available at <http://www.sjdm.org/dmidi/>; “R” for reversed).

Hierarchy-Egalitarianism:

“We have gone too far in pushing equal rights in this country (R).”

“Our society would be better off if the distribution of wealth was more equal.”

Individualism-Communitarianism:

“Private profit is the main motive for hard work (R).”

“It is society’s responsibility to make sure everyone’s basic needs are met.”

Arguments

The pro- and con- information consisted of two paragraphs. Their quantitative and qualitative aspects were balanced, including the length of the text, number of arguments mentioned, frequency and format of numerical data, presence of expressive words or level of emotional charge. Below we present short passages from the pro- and con- arguments on vaccination (adapted from Kahan et al., 2010) and nanoscience (adapted from Kahan et al., 2009).

Vaccination against HPV:

[Pro-argument] “... The vaccine against HPV has been approved by the European Medicines Evaluation Agency (EMA) ...”

[Con-argument] “... However, vaccinated girls may assume that the vaccine provides them with complete protection ...”

Nanotechnology:

[Pro-argument] “... Nanotechnologies also have a potential to provide new and better treatments for diseases ...”

[Con-argument] “... There are justified concerns that certain useful properties of nanomaterials may also be dangerous ...”

Advocates

Manipulation of cultural orientation of authors of the arguments was twofold in the study by Kahan et al. (2010). First, they used pretested photographs of four white males – public policy experts – which should have evoked the four combinations of egalitarianism x communitarianism. Moreover, the pictures were accompanied by a set of titles of fictional books written by the four advocates. Since we believe that operationalization via photographs may induce effects we are not able to control, and for the purpose of overall methodological rigor, we decided to use only the titles of the publications. Given the within-subject factor of two different domains (HPV vaccination and nanotechnology), we needed 2x3 titles for each of the four advocates. Here are some examples:

Egalitarian & Communitarian:

“How to raise children: struggling with stereotypes about men and women”

“Selfishness of individualism: divided we fall”

Egalitarian & Individualist:

“For equal rights and responsibilities, regardless of gender, age or origin”

“We are not small kids: the government cannot make decisions for us”

Hierarchist & Individualist:

“Where feminists are wrong: society needs strong men”

“Strong government: a threat to our personal freedom”

Hierarchist & Communitarian:

“Not discrimination against minorities, but against majority, is the problem”

“Towards progressive taxation: the richer pay more”

The arguments were randomly matched with the authors. Every advocate [A, B, C, D] could be allocated to each paragraph and, at the same time, be opposed to any one of the other advocates. Hence, there were 12 possible pairings in total [AB, AC ..., DC]. Members of the 2nd experimental condition were randomly assigned to one of these culturally identifiable advocate pairs. Cultural affinity, relative distance from the two advocates, was calculated as the difference in Euclidean distances between points. An example is depicted in Figure 5.

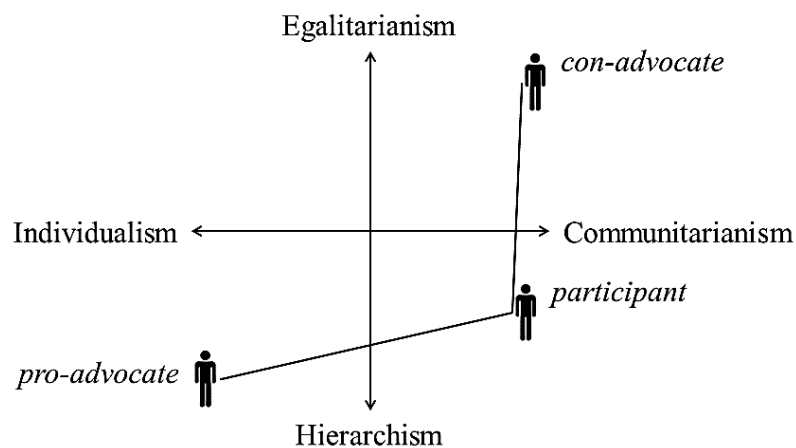


Fig. 5 One possible combination of advocates and their distances from the participant

Risk/benefit scales

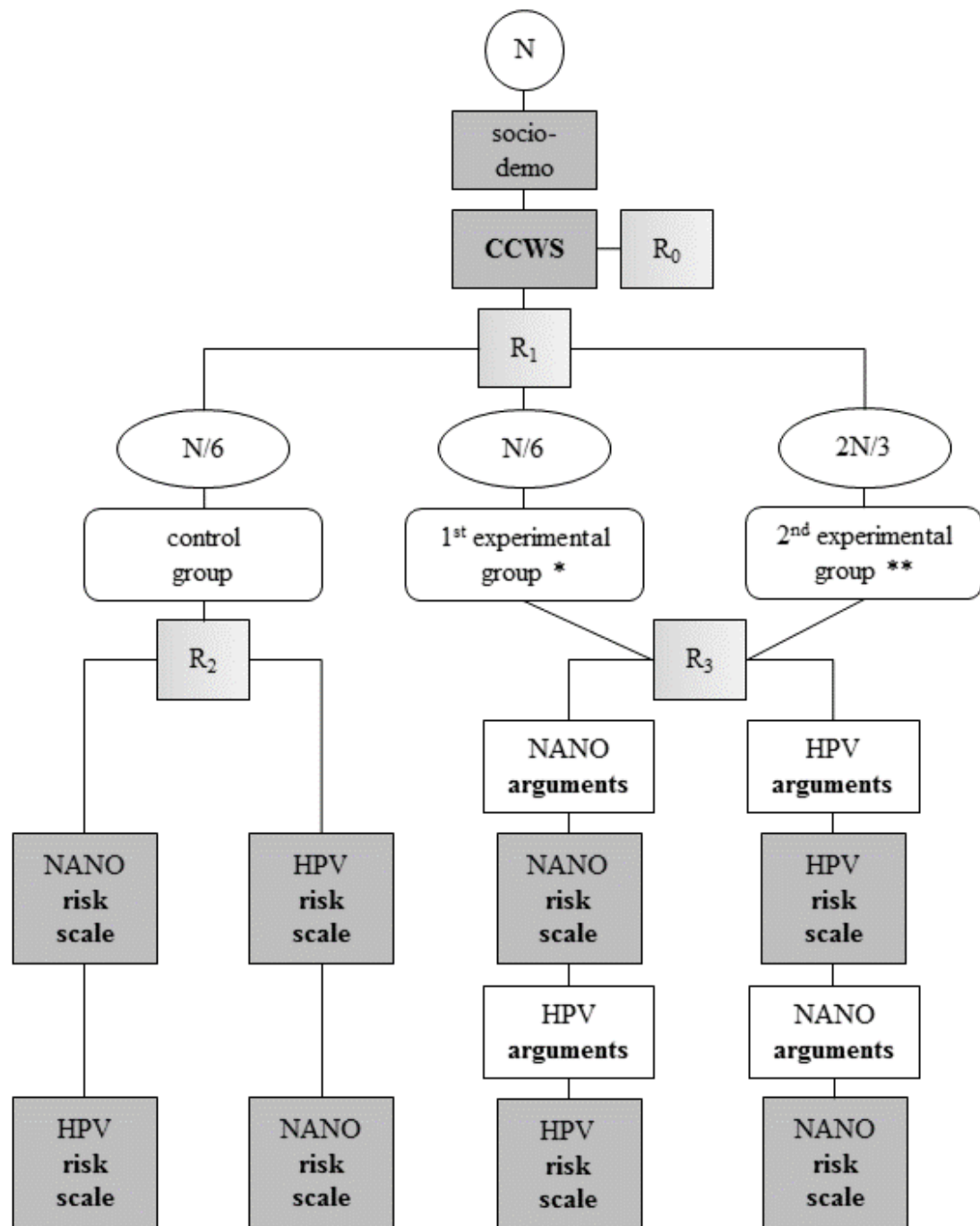
In this part of the experiment, all groups first answered “familiarity” questions: “How much have you known about nanotechnology / HPV vaccination before today?” [1 nothing at all – a lot 6]. Subsequently, participants responded on 6-point Likert scales [strongly disagree – strongly agree or not at all beneficial – absolutely beneficial] to set of items associated with dangers and profits of nanotechnology and HPV vaccination. Both scales showed sufficient internal consistency, $\alpha_{\text{risk_hpv}} = .70$, $\alpha_{\text{risk_nano}} = .75$. Further we include two of the twelve items for illustration.

“Girls vaccinated against HPV may have a tendency to practice unprotected sex.”

“Nanotechnology products are generally safe for use.”

2.4 Procedure

Design and procedure of the experiment are depicted in Figure 6 (“R” for randomization). First, participants read an informed consent and basic introduction about principles of the study. Next, they were asked to follow the instructions, answer the socio-demographic questions, express their opinion on statements in the CCWS, and respond to risk/benefit and familiarity items. Half of the sample first reported their risk/benefit attitude toward nanotechnology and then toward vaccination, the other half proceeded in reverse. In the experimental conditions, risk assessment was preceded by balanced pro- and con-information. These arguments were either anonymous (1st experimental group) or were assigned to two randomly chosen culturally identifiable authors (2nd experimental group). Due to the order of the two domains and the twelve different combinations of advocates, we ended up with 28 distinct research groups. Upon completion of the experiment, people were debriefed and instructed for the case of further questions and concerns about the study, or interest in its final results.



* anonymous arguments

** culturally identifiable advocates

pro-advocate:

A, B, C or D

con-advocate:

A, B, C or D

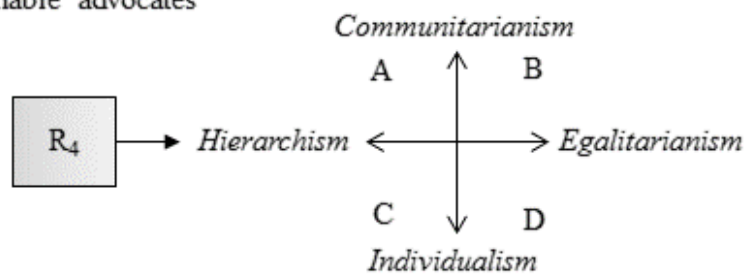


Fig. 6 Design and procedure of the experiment

2.5 Implementation and statistics

Taking into account the complexity of the design, including several randomizations, we decided for an online procedure. Thus, the experiment environment was represented by a standard web application used for automatic data collection and preprocessing. Design and implementation was created by cooperation with a more proficient programmer. It was developed on the Java platform with the help of Spring MVC framework. Frontend, the part visible to the user, was generated with Thymeleaf template engine. Sites were responsive, i.e. they were also applicable to mobile devices, thanks to the Bootstrap library. In the backend side, we have used object-relational mapping technique with use of JPA and Hibernate as its provider. Data was persisted in the PostgreSQL database. The application supported export of processed results in form of an Excel file. From the infrastructure point of view, application was deployed on a virtual instance of CentOS operating system within Google Compute Engine platform, which has enabled us to use their services for free within the trial period. All the technologies we used during development are open-source. We recorded responses and time people spent reading the two series of arguments.

In addition to standard descriptive and inferential statistical procedures, we also used the SPSS macro PROCESS – a computational tool for moderation and mediation analysis and complex conditional process models (Hayes, 2013). It is based on path-analyses, bootstrapping, ordinary least squares regression, estimation of direct, indirect and conditional indirect effects, and two- and three-way interactions. Since our design does not allow us to test the model in Figure 4 with all main variables directly, we divided it into several partial models, as described in the next chapter.

3 Results

Our 339 participants scored within the dimensions of cultural values as is shown in Figure 7. Allocation into four groups of egalitarianism x communitarianism was highly non-uniform. More than two thirds of the sample (67.3%) expressed individualistic worldview and almost half of the respondents were egalitarian individualists. Groups based on cultural dimensions or their combinations did not differ according to gender, age and study/occupation. Overall ($n = 339$) relations among the main variables are shown in Table 1. All values represent Spearman's correlation coefficients.

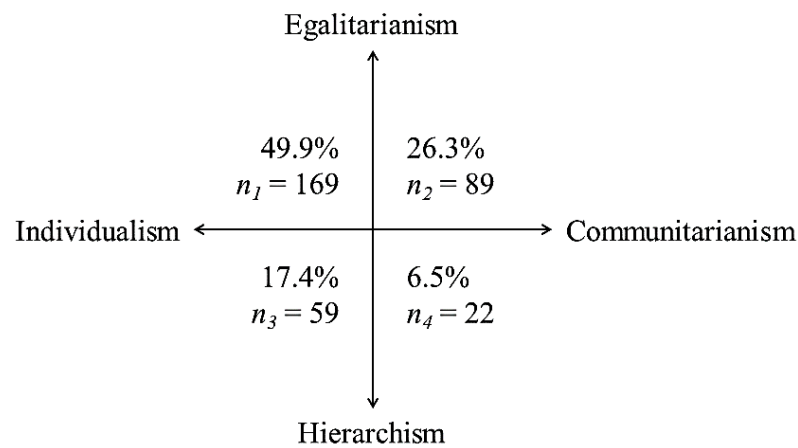


Fig. 7 Classification of overall responses in the CCWS

Tab. 1 Results of the correlation analyses across whole sample

		2	3	4	5	6
1	Egalitarianism	.21**	-.11*	-.06	-.22**	.14**
2	Communitarianism		.08	-.02	.05	.05
3	Risk_nano			-.18**	.32**	.02
4	Knowledge_nano				-.18**	.14*
5	Risk_hpv					-.12*
6	Knowledge_hpv					

Note. * $p < .05$, ** $p < .01$

In partial contradiction with our hypotheses, hierarchism and risk perception were negatively associated in both domains. Evaluation of benefits relatively to hazards was positively linked to prior familiarity with vaccination and nanoscience. At the same time, initial knowledge of HPV vaccination increased with egalitarianism. Interestingly, both knowledge and risk indicators as well as communitarianism and egalitarianism were positively correlated. None of the two variables except for hierarchism fulfilled the criteria for a normal distribution. Therefore, we mostly report medians and interquartile ranges, and results of non-parametric tests in this section. Risk/benefit values ranged from 0 (absolute predominance of benefits) to 30 (absolute predominance of risks); initial knowledge indicators from 1 (lowest prior familiarity) to 6 (highest prior familiarity); egalitarianism from 13 (full preference for hierarchism) to 78 (full preference for egalitarianism); and communitarianism from 17 (full preference for individualism) to 102 (full preference for communitarianism).

Regarding control variables, younger participants (age < 28; $M = 50.5$, $SD = 8.6$) showed a lower preference for egalitarian values than the older ones (age 28+; $M = 53.2$, $SD = 9.9$), $t(337) = -2.60$, $p = .010$, $d = 0.28$. Next, people who study or work in natural/technical sciences sector ($Mdn = 4.0$, $IQR = 3.0$) expressed a higher knowledge of nanoscience than those in social sciences ($Mdn = 2.0$, $IQR = 1.0$) as well as participants in other fields ($Mdn = 2.0$, $IQR = 2.0$), $H(2) = 36.86$, $p < .001$, $r_m = .33$. Moreover, we found several gender differences. Women were more egalitarian, better informed about HPV vaccination, less familiar with nanotechnologies and more afraid of them than men (egalitarianism: $M = 52.9$, $SD = 9.0$ vs. $M = 49.6$, $SD = 9.7$; HPV knowledge: $Mdn = 4.0$, $IQR = 2.0$ vs. $Mdn = 2.0$, $IQR = 2.0$; nanoscience knowledge: $Mdn = 2.0$, $IQR = 2.0$ vs. $Mdn = 3.0$, $IQR = 2.0$; risk perception of nanoscience: $Mdn = 17.0$, $IQR = 6.0$ vs. $Mdn = 15.0$, $IQR = 5.0$); egalitarianism: $t(337) = -3.06$, $p = .002$, $d = 0.36$; HPV knowledge: $M - W U = 5577.5$, $p < .001$, $r_m = .45$; nanoscience knowledge: $M - W U = 8460.5$, $p < .001$, $r_m = .26$; risk perception of nanoscience: $M - W U = 8963.5$, $p < .001$, $r_m = .22$.

Evaluation of dangers and profits in the four cultural worldview groups (Figure 8) significantly differed, nanotechnology: $H(3) = 8.44$, $p = .038$, $r_m = .16$; vaccination: $H(3) = 12.44$, $p = .006$, $r_m = .19$. According to pairwise comparisons applying a Bonferroni correction, communitarian hierarchists feared nanotechnology more than both the egalitarian groups, $M - W U = 1251.0$, $p = .012$, $r_m = .18$; $M - W U = 676.0$, $p = .024$, $r_m = .21$, and the same applies for vaccination against HPV, $M - W U = 1142.5$, $p = .013$, $r_m = .21$; $M - W U = 572.0$, $p = .003$, $r_m = .29$. There was no substantial difference between individualists and communitarians in risk perception, but egalitarians were afraid significantly less ($Mdn_{nano} = 16.0$, $IQR = 5.0$; $Mdn_{hpv} = 12.0$, $IQR = 7.0$) than hierarchists ($Mdn_{nano} = 17.0$, $IQR = 5.5$; $Mdn_{hpv} = 14.0$, $IQR = 7.0$), nanotechnology: $M - W U = 8513.5$, $p = .012$, $r_m = .14$; vaccination: $M - W U = 8120.5$, $p = .002$, $r_m = .16$.

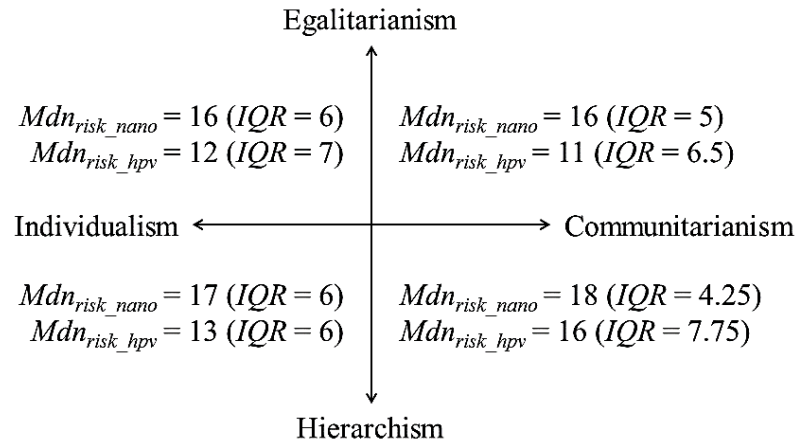


Fig. 8 Overall risk/benefit perception according to the cultural dimensions

The four groups representing combinations of cultural values, did not differ in self-reported prior knowledge of the two domains. However, we found a marginally significant result regarding HPV vaccination, $M - W U = 9036.5$, $p = .061$, $r_m = .10$, since egalitarians ($Mdn = 4.0$, $IQR = 3.0$) were slightly more familiar with the domain than hierarchists ($Mdn = 3.0$, $IQR = 2.0$). Further we report results of testing the three main hypotheses, as postulated in chapter 1.3.

3.1 Hypothesis 1: Cultural values and risk perception

We expected risk perception to be associated with cultural affiliation. Namely, communitarians and egalitarians would see more benefits and fewer dangers of HPV vaccination, and they would consider the risks of nanotechnologies to outweigh potential advantages. The opposite trends were hypothesized to be found among hierarchical and individualistic people: tendency toward fear of vaccination and tolerance toward nanoscience-related hazards.

Relations among variables in the control group ($n = 60$), which was not exposed to arguments before its members expressed their views, are shown in Table 2. All numbers, except for the first one (.23) represent Spearman's correlation coefficients. Contrary to our assumption, we discovered negative association between egalitarianism and risk perception of nanotechnologies. Prevalence of benefits over dangerous aspects was positively related to prior knowledge of the domains. Interestingly, the more people perceived risk in the context of vaccination, the more they recognized dangers associated with nanoscience.

Tab. 2 Results of the correlation analyses within control group

		2	3	4	5	6
1	Egalitarianism	.23	-.27*	.13	-.14	.02
2	Communitarianism		-.09	-.05	.16	< .01
3	Risk_nano			-.26*	.30*	-.08
4	Knowledge_nano				-.36**	.13
5	Risk_hpv					-.28*
6	Knowledge_hpv					

Note. * $p < .05$, ** $p < .01$

Figure 9 presents the comparison of risk/benefit perception among the four cultural worldview groups. The ratios of recognized dangers to perceived profits were similar, and overall attitudes in both the domains were rather neutral (close to 16). In the control group, we were not able to reject the null hypotheses concerning risk perception and cultural worldview, nanoscience: $H(3) = 3.84, p = .280, r_m = .25$; vaccination against HPV: $H(3) = 1.67, p = .645, r_m = .17$. Thus, people preferring individualism did not differ from communitarians in evaluation of threats and benefits, and similar results were found analyzing responses of the groups based on combinations of values. The only marginally significant finding was a less intense risk perception of nanotechnology among egalitarians ($Mdn = 14.0, IQR = 4.0$) compared with hierarchists ($Mdn = 16.5, IQR = 4.75$), $M - W U = 288.0, p = .076, r_m = .23$, but it contradicts our hypothesis, since the latter were afraid more. Indeed, none of the variables predicted risk perception of nanoscience, and the only powerful predictor of hazard/benefit evaluation of HPV vaccination, was prior knowledge, $\beta = -.33, t(53) = -2.22, p = .031$.

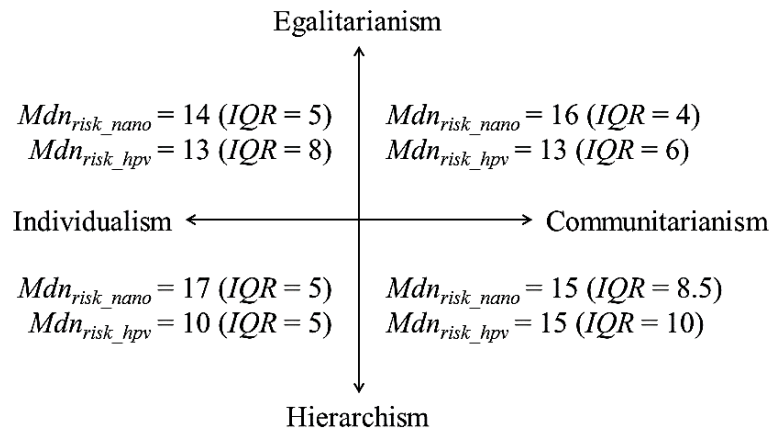


Fig. 9 Risk/benefit perception according to the cultural dimensions in the control group

3.2 Hypothesis 2: Confirmation bias

In line with the biased assimilation and polarization effect, we assumed that argument exposure would lead to more radical risk/benefit attitude consistently with the cultural orientation. Hence, the gap between communitarians and individualists, and between egalitarians and hierarchists, would increase after people read the pro- and con- arguments. To test this hypothesis we analyzed responses of the control and the 1st experimental group.

Relations among variables in the experimental group with balanced anonymous arguments ($n = 46$) are presented in Table 3. All numbers, except for the three (-.06, -.06, .43) stand for Spearman's correlation coefficients. Again, risk indicators were positively correlated, and perception of nanotechnologies was negatively associated with egalitarianism. Both connections were stronger after argument exposure in comparison with the "no-argument" condition.

Tab. 3 Results of the correlation analyses within the 1st experimental group

		2	3	4	5	6
1	Egalitarianism	.23	-.45**	-.11	-.15	.02
2	Communitarianism		-.06	-.03	-.06	.26
3	Risk_nano			-.21	.43**	-.27
4	Knowledge_nano				-.20	.09
5	Risk_hpv					-.09
6	Knowledge_hpv					

Note. ** $p < .01$

In contrast with the control group, we found differences in risk perception according to cultural worldview after argument exposure (Figure 10). We use median values in the figure for an easier comparison with the other groups, although both the risk indicators

were normally distributed, therefore we further report results of parametric tests. Hierarchists ($M = 20.8$, $SD = 3.0$) feared nanoscience substantially more than egalitarians ($M = 15.4$, $SD = 4.1$), $t(44) = 3.66$, $p = .001$, $d = 1.36$. This finding was confirmed by means of analyses of the four groups of cultural value combinations, $F(3, 42) = 4.70$, $p = .006$, $\eta^2_p = .06$, comparisons between egalitarian and hierarchical groups were significant ($p < .013$) after a Bonferroni adjustment. Furthermore, communitarian hierarchists ($M = 19.0$, $SD = 4.2$) were afraid of HPV vaccination more than the three other groups ($M_{DIFF} = 7.3$, $M_{DIFF} = 7.8$, $M_{DIFF} = 6.7$), but the comparisons are slightly above the level of statistical significance ($p > .017$) applying a Bonferroni adjustment.

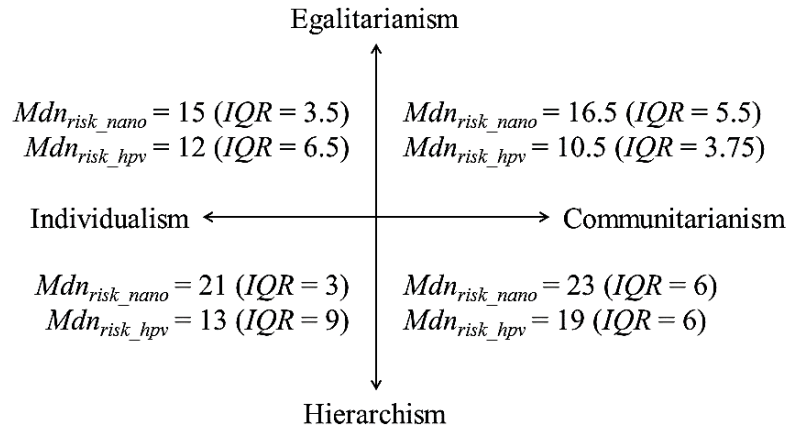


Fig. 10 Risk/benefit perception according to the cultural dimensions in the 1st experimental group

Analyzing the effect of exposure to balanced pro- and con- information we found the following. Risk evaluation of vaccination did not substantially change after reading the arguments, $M - W U = 1299.5$, $p = .607$, $r_m = .05$. However, in case of nanoscience we identified a marginally significant increase of risk perception ($Mdn_1 = 15.0$, $IQR = 4.0$; $Mdn_2 = 16.0$, $IQR = 6.0$), $M - W U = 1100.5$, $p = .074$, $r_m = .17$. Out of all groups, only individualistic hierarchists became significantly more fearful due to argument exposure, in the domain of nanotechnology ($Mdn_1 = 17.0$, $IQR = 5.0$; $Mdn_2 = 21.0$, $IQR = 3.0$), $M - W U = 21.0$, $p = .026$, $r_m = .49$.

Out of the all tested models regarding nanotechnology, taking into account possible covariates and moderators, the one depicted in Figure 11 was the most appropriate: $R^2 = .22, p < .001$, increase due to interactions R^2 change = .05, $p = .046$. Conditional effects of egalitarianism on risk perception of nanotechnology were substantially negative among all participants who read the arguments, regardless prior knowledge (95% CIs [-.31, -.04], [-.40, -.13], [-.53, -.17]). Although, in the control group without information exposure, the effect increased with familiarity and was significantly negative only among those with high initial knowledge of nanotechnology (95% CI [-.28, -.04]). We fail to find any model of risk perception regarding HPV vaccination and its association neither with cultural worldview and argument exposure nor with the other relevant measures. Indeed, the only significant predictor of risk/benefit evaluation within the vaccination context, was prior knowledge, $\beta = -.29, t(98) = -2.54, p = .013$.

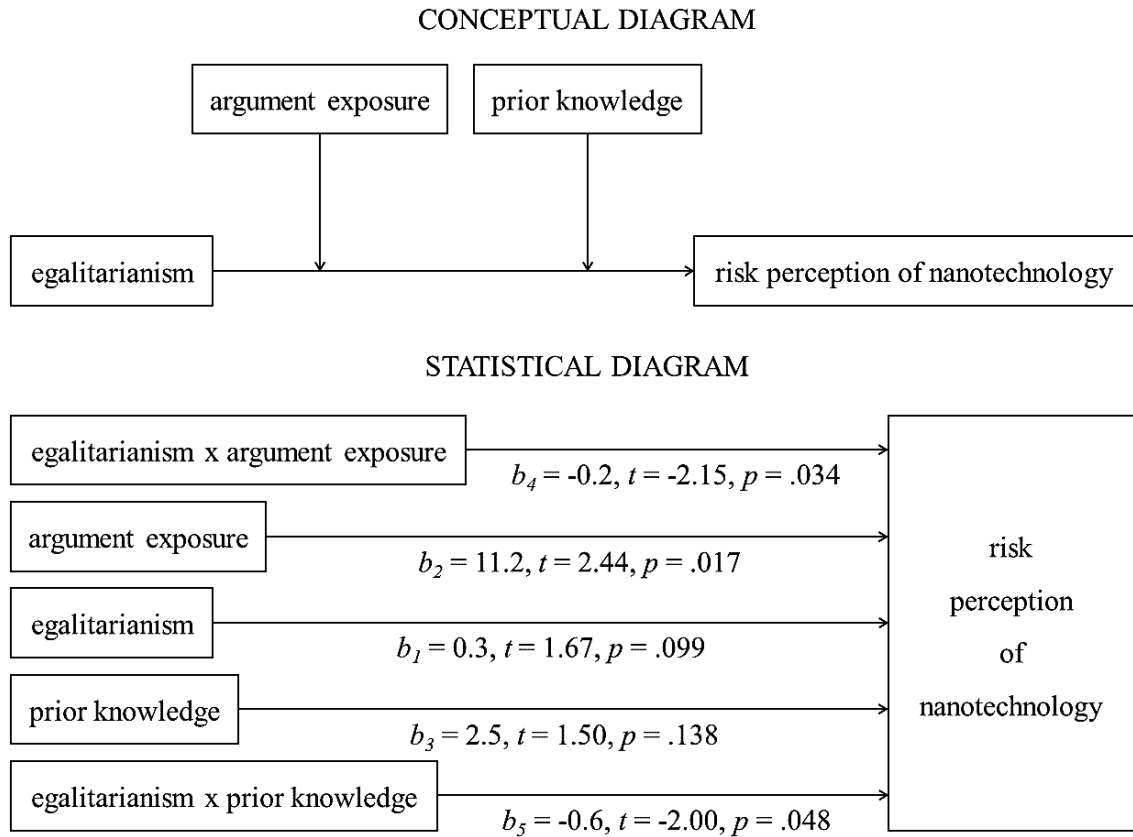


Fig. 11 Model I. of risk perception of nanotechnology

3.3 Hypothesis 3: Credibility heuristic

In line with the credibility heuristic, we hypothesized that the impact of argument exposure would depend on the distance between cultural values of the respondent and of the two opposing authors. For instance, the more is cultural orientation of the initially “risks-inclined” respondent similar to that of the con-advocate and different from that of the pro-advocate, the stronger the confirmation bias. To evaluate this hypothesis, we conducted analyses of responses within the 2nd experimental condition. In testing the credibility heuristic mechanism, the cultural affinity indicator is important. It was derived by subtracting similarity of respondent’s and con-advocate’s worldview from proximity of respondent’s and pro-advocate’s values. Thus, it reflects how much closer the participant’s cultural orientation is to that of the con-advocate relatively to that of the pro-advocate (Kahan et al., 2010). According to the cultural-credibility hypothesis, the level of cultural affinity should be positively associated with risk perception. Relations among variables in the experimental group with arguments by culturally identifiable advocates ($n = 233$) are displayed in Table 4. Each value, except for the first one (.26) represents Spearman’s correlation coefficients.

Tab. 4 Results of the correlations analyses within 2nd experimental group

		2	3	4	5	6	7
1	Egalitarianism	.26**	-.06	-.08	-.23**	.18**	-.09
2	Communitarianism		.15*	-.01	.05	.02	-.02
3	Risk_nano			-.15*	.33**	.09	.14*
4	Knowledge_nano				-.13*	.15*	.02
5	Risk_hpv					-.08	.11
6	Knowledge_hpv						.02
7	Cultural affinity						

Note. * $p < .05$, ** $p < .01$

Risk perception of nanoscience was negatively associated with corresponding prior knowledge and individualism. Negatives of vaccination outweighed positives the more people preferred hierarchism. Again, we identified positive connection between the two risk indicators. Interestingly, also communitarianism/individualism and egalitarianism/hierarchism were positively correlated and knowledge of HPV vaccination increased with the level of egalitarian orientation. Furthermore, fear of nanotechnology correlated positively with the level of cultural affinity.

There were differences in risk perception (only) of HPV vaccination according to cultural worldview after exposure to arguments of culturally identifiable advocates (Figure 12). Hierarchists ($Mdn = 14.0$, $IQR = 6.75$) feared vaccination more than egalitarians ($Mdn = 11.0$, $IQR = 7.0$), $M - W U = 3386.0$, $p = .002$, $r_m = .20$. In addition, the two hierarchical groups were substantially more afraid than communitarian egalitarians $M - W U = 805.5$, $p = .013$, $r_m = .25$; $M - W U = 273.0$, $p = .013$, $r_m = .28$, after applying a Bonferroni adjustment.

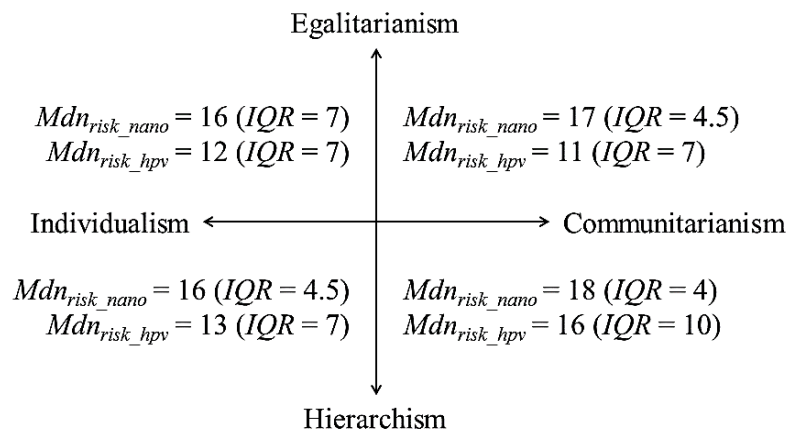


Fig. 12 Risk/benefit perception according to the cultural dimensions in the 2nd experimental group

Examining the impact of exposure to pro- and con- arguments of culturally identifiable advocates, we found the following. Risk assessment of vaccination against HPV was not substantially different after reading the information, $M - W U = 6631.5$, $p = .539$, $r_m = .04$.

Although, in the domain of nanotechnology we identified a significant increase of risk perception ($Mdn_1 = 15.0$, $IQR = 4.0$; $Mdn_2 = 16.0$, $IQR = 5.0$), $M - W U = 5666.0$, $p = .023$, $r_m = .13$. Across all groups, only individualistic egalitarians became substantially more fearful of nanoscience due to arguments of the culturally identifiable advocates ($Mdn_1 = 14.0$, $IQR = 5.0$; $Mdn_2 = 16.0$, $IQR = 7.0$), $M - W U = 1081.0$, $p = .031$, $r_m = .18$.

Testing various models of nanotechnology risk/benefit perception, the one depicted in Figure 13 seemed to be the most adequate: $R^2 = .08$, $p < .001$, increase due to interaction R^2 change = .02, $p = .020$. Conditional effect of cultural affinity on risk perception of nanoscience decreased with prior knowledge and it was substantially positive only among participants with a low (95% CI [.03, .12]) and a medium (95% CI [.01, .06]) initial familiarity with the domain. The model took into account communitarianism as a covariate, significantly predicting prevalence of perceived dangers of nanotechnologies over potential profits.

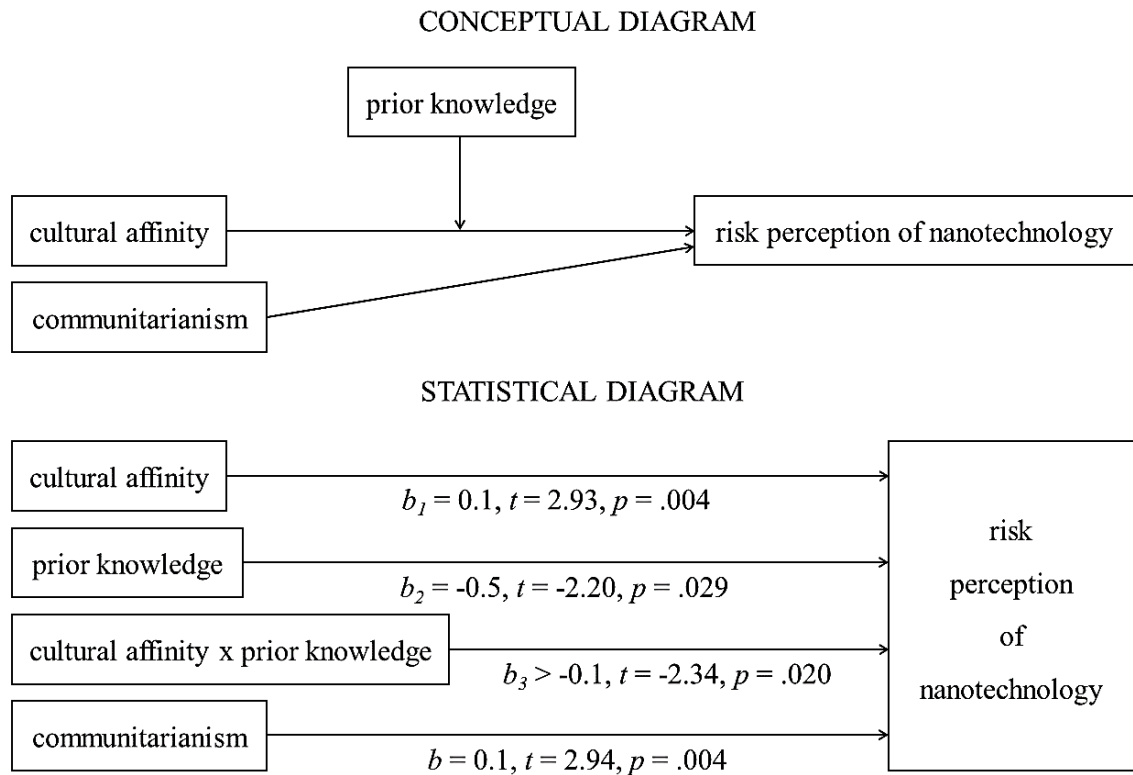


Fig. 13 Model II of risk perception of nanotechnology

Regarding HPV vaccination, model depicted in Figure 14 was the most appropriate: $R^2 = .10$, $p < .001$, increase due to interactions R^2 change = .02, $p = .055$. People with a low prior knowledge and / or egalitarian worldview were not affected by relative distance from the advocates. Conditional influence of the cultural affinity on risk perception increased with hierarchism and initial familiarity. Thus, it was substantially positive among participants with a medium and a high level of prior knowledge in combination with a strong (95% CI [.02, .12]; 95% CI [.03, .16]) or a moderate (95% CI [.01, .08]; 95% CI [.02, .12]) preference for hierarchism. As in the previous case, this model took into account communitarianism as a covariate, significantly predicting prevalence of perceived dangers of HPV vaccination over positive aspects.

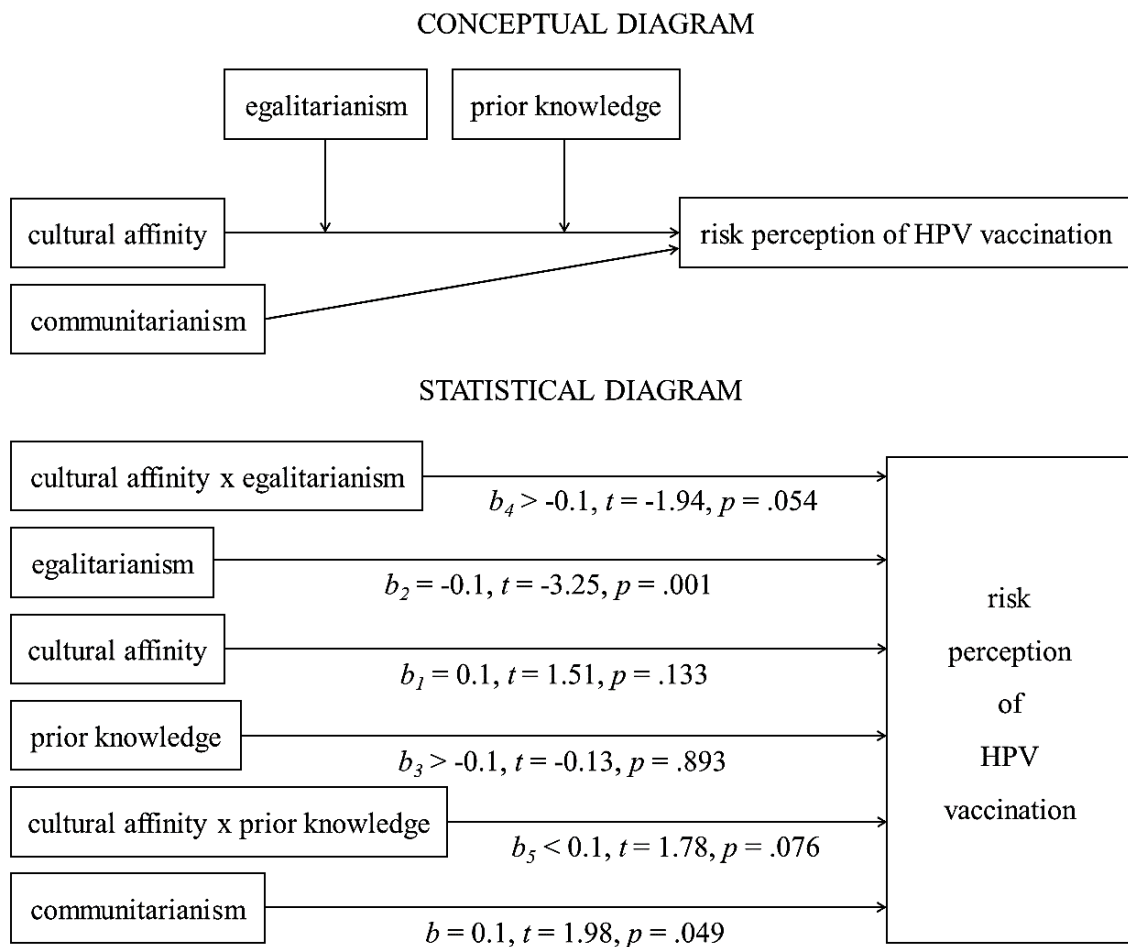


Fig. 14 Model of risk perception of HPV vaccination

3.4 Summary of main findings

Taken together, the results given our three main hypotheses are as follows. Hierarchists were more afraid than egalitarians – regardless of the domain – especially when they preferred communitarian society. In the domain of HPV vaccination, the only factor predictable of risk perception among people who read no or anonymous arguments was prior knowledge.

Next, people feared nanotechnologies more after information exposure. The gap in risk assessment between participants with hierarchical and egalitarian worldview grew after reading anonymous arguments. Conversely, the impact of initial familiarity was less strong after this intervention. Overall, egalitarianism reduced perception of dangers associated with nanoscience among people with sufficient knowledge – either thanks to initial familiarity or information gained through provided arguments.

We also found evidence supporting the credibility heuristic principles. Hence, cultural affinity interacted with prior knowledge in both the domains. The relative closeness to the con-advocate led to predominance of risks over benefits among those who did not know much about nanotechnology before. Similarly, participants were afraid of HPV vaccination more if their cultural values resembled the con-advocate's and differed from the pro-advocate's. But only if respondents were familiar enough with the domain and (or) when they did not strongly prefer egalitarianism. In both cases, communitarianism was in a role of a covariate, significantly predicting more intensive perception of risks. Interestingly, we identified a pattern of a general predisposition to be or not to be afraid, since the two risk perception indicators correlated irrespective of the manipulations. Finally, the more people preferred egalitarian values, the more they were inclined to support the communitarian worldview.

4 Discussion

“Establishing association does not translate into deep understanding even when a causal association can be established” (Hayes, 2013, p. 6).

Recent research has focused on experimental testing of the Cultural cognition thesis of risk perception (Kahan et al., 2009, 2010, 2011). It is based on an assumption that people selectively dismiss and credit asserted profits and dangers in a manner consistent with their preferred cultural worldview and desired form of social organization (Douglas & Wildavsky, 1983). Whereas all the studies we built our research upon have been conducted in the U.S., we decided to find out whether the theory explains risk evaluation of people from a culturally different region, Slovakia. Moreover, using two distinct socially relevant domains – nanotechnology and vaccination against HPV – we also examined domain specificity of risk attitudes. And since it is crucial to search for the mechanisms clarifying association between cultural worldviews and perception of threats and benefits, we tested two of them: credibility heuristic and confirmation bias. Further we summarize our assumptions and conclusions.

4.1 Findings and interpretations

In line with the previous research, we expected that individualists and hierarchists will fear HPV vaccination, and communitarians and egalitarians will be afraid of nanotechnology [Hypothesis 1]. Why? First, because people who prefer a low level of collective control and a society where citizens take care for their well-being on their own, are likely to believe that mandatory vaccination restricts individual decision making. On the other hand, those who favor a stratified societal order of assigning rights and duties according to stable characteristics, tend to think that HPV vaccination leads to sexual behavior which

contradicts traditional gender norms (Kahan et al., 2010). Then, people preferring solidaristic society and a frequent interference from the government, and also those who consider individual characteristics to be irrelevant to distribution of status, wealth and opportunities, are prone to perceive environmental risks. It is natural for them to believe that industry and commerce are selfish and produce inequity and harm to society and environment (Kahan et al., 2009). These patterns have been confirmed in numerous studies (e.g., Jenkins-Smith, 2001; Peters & Slovic, 1996).

However, our findings are slightly different: hierarchists were generally more afraid than egalitarians, especially in the domain of nanoscience. The explanation could lie in their generally conservative worldview, which may be the reason for distrust or skepticism toward modern technologies. Perhaps they are likely to avoid any substantial changes that could impair the way of life they are used to, committing the status-quo bias. Conversely, among more liberal people of egalitarian worldview, the overall benefits of nanotechnologies for society and its progress substantially outweighed potential threats which are not yet scientifically proven. Maybe they are also less sensitive to wealth inequality (due to technological and industrial progress) compared with egalitarians in the U.S., given Slovak legacy of communism.

Further, we repeatedly found evidence for the familiarity hypothesis, especially among people who did not read any arguments, but also overall. The assumption posits that support for nanoscience and HPV vaccination will grow as knowledge of them increases (Kahan et al., 2009). Indeed, in both the conditions without advocates, only prior knowledge was predictive of a lower perceived risk of vaccination, irrespective of cultural worldview. While domain of nanotechnology is rather a matter of future, more abstract and more difficult to imagine, it is not the case of vaccine against HPV. And since vaccination is generally a topic controversial enough to raise doubts among people of all cultural values, it is possible that only higher awareness and more knowledge can suppress them.

According to the first proposed mechanism [Hypothesis 2], confirmation bias, individuals of opposing cultural orientation become more divided when faced with balanced pro- and con- views. In other words, the gap between hierarchists and egalitarians, and between communitarians and individualists, is expected to grow after being exposed to information about benefits and dangers of a topic they disagree upon (Kahan et al., 2010). People tend to suppress and avoid cognitive dissonance and, therefore, sympathize with, look for, understand and remember evidence in a manner consistent with their expectation and prior opinion (Nickerson, 1998). Has it happened in our experiment?

Partially. Amplification of risk attitude towards HPV vaccination among communitarian hierarchists caused a substantial difference between them and the rest of the sample. It is possible that individualists are more likely to believe in free will of girls and independence of their thoughts and actions from this form of prevention against cervical cancer. At the same time, promiscuous and unprotected sexual behavior is too threatening for the ideal image of society among people preferring social hierarchy. In addition, egalitarians became even less afraid of nanotechnologies than hierarchists after being exposed to pro- and con- arguments. Overall, preference for general equality among humans led to a balance between perceived dangers and benefits among people who knew a lot about nanotechnology before or read the provided information during the experiment. Thus, familiarity and argument exposure moderated the association between hierarchism/egalitarianism and risk perception of nanoscience. Among those for which nanoscience was an unknown mysterious area and who did not become aware of its principles even during the experiment, cultural values did not play a role in the risk assessment, as they probably did not know how nanotechnology fits into their preferences.

In line with the other, complementary, mechanism [Hypothesis 3] – credibility heuristic – extent of the polarization effect depends on relative proximity of respondents' cultural values to those of the advocates (Kahan et al., 2010). Faced with contradicting arguments, people rely on the ones who share their opinion and attitude, especially when

they lack sufficient knowledge and experience (Kahan & Braman, 2006; Kumkale et al., 2010). This perspective fits the in-group / out-group dynamic principles and results in a simple rule: the similar cultural values, the credible (sincere, knowledgeable, and unbiased) the source, the stronger the argument. Did we find support for these assumptions?

Indeed, the closer the cultural values of the opponent of nanoscience and vaccination from the respondent's worldview and the distant the values of the proponent, the more risks outweighed benefits. Although not entirely straightforward, but with certain boundary conditions. First, the relative distance in favor of the con-advocate – cultural affinity – interacted with prior knowledge. Cultural affinity facilitated negative attitude toward nanotechnologies among those non-familiar with nanoscience before participating in the study. On the contrary, in the other domain this effect was present only among people who were familiar enough with HPV vaccination and (or) did not strongly prefer egalitarian worldview. Furthermore, in both the domains communitarianism acted as a separate factor inducing prevalence of perceived hazards over profits.

Greater fear of HPV vaccine in association with higher level of pro-collective orientation is a surprising finding. Hence, herd immunity is one of the cornerstones of support for vaccination as such. Although this is a specific category of vaccination. Dangers pointed out by its opponents, e.g. irresponsible behavior of young girls, may be in contrast with the image of ideal communitarian society. Thus, it can lead to general threat by spreading HIV or other sexually transmitted diseases. The next discovery about HPV vaccination was more predictable: those who had almost no knowledge of the domain were afraid the most and convinced egalitarians were afraid the least, irrespective of the affinity manipulation. The rest of the sample was influenced by the proximity to culturally identifiable advocates in their risk evaluation. Conversely, the impact of cultural orientation of the authors has been substantial in the domain of nanoscience only among people who did not know much about nanotechnologies prior to the study. Whereas the

information about nanoscience was not rigorous, and substantially less supported by numerical data and scientific evidence compared with vaccination, the key factor for a priori less knowledgeable people was credibility of the advocates. People who were sufficiently familiar with nanoscience expressed the lowest level of worries, regardless of the cultural affinity – they were “immune” to cultural similarity with the advocates.

Analyzing domain specificity versus generality, we identified a tendency for being afraid or tolerant to risks across all groups. Those who recognized more dangers than advantages of vaccination were likely to consider “dark side” of nanoscience to be dominant in comparison with its “bright side”. The reason for this pattern among our results may lie in the choice of domains for our research. They are quite novel for Slovak population as evidenced also by self-reported levels of prior familiarity. Unlike the U.S., the media coverage and the state of public discourse on them are rather in an initial period. Accordingly, just as risk perception indicators were linked, so was the initial knowledge of nanotechnology related to prior familiarity with vaccination against HPV. In case we had used domains that are more known within Slovak public, the results regarding domain specificity of risk perception could have been different.

In sum, we partially supported the hypotheses regarding confirmation bias and credibility heuristic within cultural cognition of risk perception. First, it seems that intuitive assumption of rational information processing of balanced pro- and con- information does not apply. Risk attitude of people becomes rather radical than neutral, in line with the previous position. Moreover, when the arguments come from advocates of culturally or otherwise distinctive values, a person can identify with or be opposed to, relevant characteristics of the speaker can play a greater role than the message content. However relationship between cultural worldview and risk perception seems to be more complicated than we expected based on the previous research findings. It is linked to previous knowledge of people and to their overall tendency to worry or tolerate risk. Further we discuss the findings through the lens of different disciplines.

4.2 Interdisciplinary perspectives

Current theories in cognitive psychology and neuroscience explain risk processing through the dual-process mechanisms. The slow elaborative rule-based system works simultaneously with the fast intuitive experiential system, and they produce the “risk as feelings” and “risk as analyses” processes. The evidence indicates that adequate reasoning stems from optimal interaction of the two systems (Slovic et al., 2004). Thus, relying on affect does not automatically lead to poorer judgments. It constitutes a valuable source of information based on previous experience. However, emotional reactions might sometimes crowd out more systematic processing of information in situations where it is appropriate to treat the problem more analytically. It is the case of socially relevant topics which are usually controversial and evoke very intense affective responses. To deal with them appropriately, one probably needs to have at least basic knowledge of the domain and some specific cognitive abilities important for critical thinking, such as cognitive reflection or open-mindedness. Namely, the actively open-minded thinking as a disposition toward flexibility of thought, avoiding absolutism and weighing new evidence against prior belief (Haran, Ritov, & Mellers, 2013; Stanovich & West, 1997) and the cognitive reflection as an ability to produce cognitive effort, engage in analytical thinking and suppress intuitive answers (Frederick, 2005).

Regarding education and subsequent knowledge of the relevant domains, it is not that straightforward as posited by the familiarity hypothesis. First, relevance of the sources is important and the ability to assess it, too. Furthermore, it is possible that cognitive heuristics and biases might endorse anxiety as people learn more about the novel science (Kahan et al., 2009). Although this did not happen in our study, the trend may vary depending on the domain. Besides, people systematically under- and overestimate the extent and strength of scientific information according to their previous positions (Kahan et al., 2011). In our experiment, this ostensibly happened among people of a hierarchical

worldview. Anyway, current and previous findings suggest that cultural cognition is not a simple compensation for incapability to appraise and understand scientific evidence. It is based on numerous mechanisms of various complexity, and their interactions. Therefore cultural cognition requires an interdisciplinary approach.

A promising line of research are neuroscientific studies. Indeed, neural responses to risk-containing messages are predictive of a real-world behavior (Chua et al., 2011; Falk et al., 2010, 2012). By means of a meta-analytic approach, Mohr et al. (2010) localized brain centers where anticipation and decision risks are represented. Their results are consistent with the dual-process theories. Activation of areas responsible for handling aversive affect – disappointment, sadness, fear, regret – is strong especially when potential losses are in play. This applies to all socially important topics. Moreover, the cultural worldview interferes here, since it determines what we consider as danger profit, and loss. Thus, when we process risk-related information, we might engage in motivated reasoning – especially when we consider the domain personally relevant and when the credibility of the people we prefer is in danger. This cognitive mode is associated with activations in the brain regions corresponding to appraising and suppressing emotionally charged and threatening stimuli, and processing distress as a result of error detection (Westen et al., 2006). These findings support the assumption of active coping with the cognitive dissonance rather than a passive reasoning bias. In addition, the fMRI study of Schmalze et al. (2013) reached a conclusion that neural processing of risk-related messages is influenced by preexisting perceptions of risk, congruently with the confirmation bias.

Research on risk perception of nanoscience and vaccination against HPV concerns also other fields, including science literacy, media communication, artificial intelligence, law, public policy or medicine. Furthermore, the cultural cognition theory is closely linked to the philosophical and multidisciplinary debate on human rationality. These topics as well as subsequent implications are discussed in the following chapters.

4.3 Implications and applications

Research on perception of risk and probability is crucial not only for the purpose of understanding cognitive processes. It is of a high importance also because of the practical implications within communicating information about dangers and benefits to the public. Indeed, differences in how threatened and worried people feel, successfully predict real-life behavior (e.g., Brewer et al., 2007; Renner & Reuter, 2012; Weinstein et al., 2007).

As we have ensured over the last half century, man is not a “homo economicus” – a rational weigher of information according to the expected utility. Therefore, it is no surprise that due to our cognitive limitations, we do not perceive risk normatively rationally. Although, experimental evidence is growing that people use simple cognitive shortcuts to make choices in an ecologically rational way. They use the fewest possible information and tailor their search to the available environmental structure (Todd & Gigerenzer, 2003). Hence, what if following rational rules is not the key to being accurate in real world conditions? McKenzie (2003) argues that rational models should be treated as theories, not standards, of behavior. He illustrates his position on the failure of artificial intelligence attempts to perform real-world tasks by implementation of rules and logic. Researchers should test multiple models and, eventually, modify the existing ones – such as the Cultural cognition theory – to be able to explain and understand human behavior.

Thus, applying context-blind norms is inappropriate in analyzing and predicting risk perception, as it is in general. Dissatisfaction with risk management can be credited to a failure to appreciate socially determined nature of risk (Slovic, 1999). Despite misunderstandings, controversies and conflicts, changes in public consciousness and education in the domain of risk and its sources are possible. Science community, policy-makers and all the people interested in promoting enlightened evaluation of risk-related information should seek to establish a deliberative atmosphere, neutralizing polarization and other undesirable tendencies.

Conveying scientifically sound objective information is not enough. People recognize it as sound only when it corresponds to their cultural orientation. The statement must bear a tolerable social meaning, and needs to be communicated in a manner that makes cultural worldview and acceptance of the content compatible (Kahan et al., 2007). Communicators and their strategies should be tailored to preferences of the listeners, taking into account cultural meaning of the messages. Hence, the central and at the same time the most difficult task for those who understand the principles of cultural cognition is to devise procedures thanks to which risk regulation will be rational but also respectful of diverse cultural values (Kahan, Slovic, Braman, & Gastil, 2006). A likely effective strategy for counteracting the impact of cultural cognition is to promote a pluralistic-argument environment during the debates (Kahan et al., 2010).

Messages addressed to the public should be balanced in all aspects. Statements with a focus on only selected point of view, biased toward one position (e.g., pros) and disregarding the other (e.g., cons), are suspicious and give rise to mistrust. Further, the content should not cover just general profits and dangers. Attributes of the discussed topic must be linked to priorities of the specific groups of people whose attitudes require intervention. For example, if individualistic hierarchists are those who express an inadequate level of fear and opposition to the mandatory vaccination of children, it is appropriate to highlight advantages it can bring to people of their worldview. However, not neglecting respective hazards. Thanks to this, consequently, explanation of why widespread rumors about the specific risks are not justified, might also work.

It would be beneficial, for example, in the “autism as a result of MMR (measles, mumps & rubella) vaccination” affair. It is still a frequently used and resistant assertion, even though the article which started the frenzy was later retracted, and subsequent papers refused its claims. However, people are prone to believe it, especially when facing an opponent who prefers particularly different image of society. As stated by Kahan (2013) conflict over vaccination stems from a failure to reflect social factors important in public

understanding of science. Thus, counterproductive risk communication is an inevitable consequence when systematic, evidence-based alternative is missing. Such was the case of proposal for universal immunization of girls against HPV in 2006 in the U.S., which was mired in an intense controversy.

As a result, excessive or insufficient risk concerns may lead to demands for regulations that are not sufficiently based on facts. Moreover, interest groups might exploit cognitive processes to diminish worries of serious problems or create an atmosphere of exaggerated fear (Sunstein, 2002). Regardless of the campaign messages, tailored to people of different cultural preferences, government regulations should be principally based on thorough cost-benefit analyses. Subsequently, research evidence on risk perception and corresponding factors might be used for choice architecture design or enhancement of public support for the interventions. In this context, one of the cornerstones is building trust – whether in state institutions and their representatives, scientific community or industry. In a climate of distrust, risk communication and management have very limited chance of success. Follow-up research on cultural cognition could shed more light on how people perceive risk. We introduce some suggestions in the next chapter.

4.4 Limitations and future directions

The current study could be improved in several ways. First, our sample was neither large enough nor representative. And, despite our effort to recruit people of diverse worldviews, it was not balanced in this respect. The question is, to what extent such distribution resembles real preferences of Slovak citizens. Nevertheless, greater variability in age, education and prior knowledge as well as a higher proportion of men should be ensured. For the purpose of a more comprehensive analysis, it would be beneficial to collect additional data – e.g. category of residence (urban, rural, capital city), religiosity (active participation rather than passive belief), political preferences and civic engagement,

involvement in volunteering and charity, time spent abroad (experience with other cultures). Regarding the cultural cognition worldview questionnaire, appropriateness of its use in the context of Central European post-communist society needs to be assessed. The content and meaning of the concepts within the scales may vary due to different history and current conditions in the countries. It would be appropriate to evaluate reliability and validity of the scales, and compare the results with those in other measures of cultural values. Incorporating items specific for local conditions is also worth considering.

In contrast to socio-demographic variables and other relatively stable characteristics, individual differences in cognitive abilities and competencies are more worthy of our attention and efforts. Those which might play a role in perception of risk and probability, are critical thinking and its components, numeracy, and graph, methodological and overall science literacy. Especially cognitive reflection, actively open-minded thinking or intellectual autonomy (as opposed to conformity) could attenuate undesirable attitude polarization or undue reliance on culturally conditioned credibility of a speaker.

Our findings may not be generalized to other topics. Further research is required to verify the identified patterns, using different socially relevant domains. Suitable candidates are those that are publicized and, therefore, induce intense emotions – such as invasion of refugees, referendum for the protection of family or existence of a single state health insurance company. How people perceive respective dangers and their counterparts might be manifested in their actions – engagement in political activities or humanitarian aid.

Hence, follow-up applied research might compare self-reported attitudes, beliefs and fears, with real-life behaviors. Another practically-oriented studies might test effectivity of interventions aimed at neutralizing insufficient or exaggerated risk concerns and impact of cultural cognition mechanisms. Last but not least, it is necessary to examine verbal, numerical and graphical representations of risk and uncertainty in order to improve understanding of laymen and professionals, and help them make optimal decisions.

Conclusion

“Understanding and preventing risk often has a low priority in the competitive worlds of intellectual property, research funding and technology development”” (Maynard et al., 2006, p. 267).

Day by day we encounter more information than we are able to process and use. Media, internet, books, relatives, friends and other resources provide us with fresh news, ideas, knowledge. We inevitably need to filter them not to become overwhelmed. Moreover, human reasoning is full of risk estimates, often within domains complex enough to elicit disagreement even among experts. And here the cultural cognition comes on the scene.

Thus, we see the world through the lens of our values, ideologies and worldviews. And these very attributes underlie our judgments on how serious are certain benefits and threats, how convincing is the evidence and the arguments, and how credible and relevant is a particular source. Whether cultural cognition is a product of bounded rationality or not, it may reinforce specific heuristic mechanisms to an undesirable extent and, thus, lead us astray even in situations with high stakes – for us and for others.

For this reason, two lines of efforts are crucial. First, looking beyond the traditional “one-discipline” approach to find what drives risk perception and decision making. Only dynamic collaborative research network can reach in-depth understanding of the complex model of cognitive processes, and facilitate evidence-based policies. And, at the same time, searching for and applying methods of reinforcing the ability of people – particularly students – to reflect critically on knowledge and its creation. Only then they could be able to suppress inadequate effects and distinguish reliable resources, especially in the era of information overload. Of course, it is difficult to resist skeptical consideration on whose interests are these endeavors compatible with.

References

- Báčová V. (2013). Rozhodnutia so závažnými dôsledkami [High-consequence decisions]. In I. Sarmány-Schuller (Ed.), *Otázniky rozhodovania: teória, empiria, život. 31. Psychologické dni: Zborník príspevkov* (pp. 14-18). Bratislava: STIMUL.
- Brewer, N. T., Chapman, G. B., Gibbons, F. X., Gerrard, M., McCaul, K. D., & Weinstein, N. D. (2007). Meta-analysis of the relationship between risk perception and health behavior: The example of vaccination. *Health Psychology, 26*, 136–145.
- Brewer, N. T., & Fazekas, K. I. (2007). Predictors of HPC vaccine acceptability: A theory-informed, systematic review. *Preventive Medicine, 45*, 107–114.
- Chua, H. F., Ho, S. S., Jasinska, A. J., Polk, T. A., Welsh, R. C., Liberzon, I., & Strecher, V. J. (2011). Self-related neural response to tailored smoking-cessation messages predicts quitting. *Nature Neuroscience, 14*, 426–427.
- Douglas, M., & Wildavsky, A. B. (1983). *Risk and culture: An essay on the selection of technical and environmental dangers*. Berkeley: University of California Press.
- Dunne, E. F., Unger, E. R., Sternberg, M., McQuillan, G., Swan, D. C., Patel, S. S., & Markowitz, L. E. (2007). Prevalence of HPV infection among females in the United States. *Journal of American Medical Association, 297*, 813–819.
- Epstein, S. (2003). Cognitive-experiential self-theory of personality. In T. Millon & M. J. Lerner (Eds), *Comprehensive Handbook of Psychology, Volume 5: Personality and Social Psychology* (pp. 159-184). Hoboken, NJ: Wiley & Sons.
- Falk, E. B., Berkman, E. T., & Lieberman, M. D. (2012). From neural responses to population behavior: Neural focus group predicts population-level media effects. *Psychological Science, 23*, 439–445.
- Falk, E. B., Berkman, E. T., Mann, T., Harrison, B., & Lieberman, M. D. (2010). Predicting persuasion-induced behavior change from the brain. *The Journal of Neuroscience, 30*, 8421–8424.

- Finucane, M. L., Alhakami, A., Slovic, P., & Johnson, S. M. (2000). The affect heuristic in judgments of risks and benefits. *Journal of Behavioral Decision Making*, 13, 1–17.
- Frederick, S. (2005). Cognitive reflection and decision making. *Journal of Economic Perspectives*, 19, 25–42.
- Gaissmaier, W., & Gigerenzer, G. (2012). 9/11, act II: A fine-grained analysis of regional variations in traffic fatalities in the aftermath of the terrorist attacks. *Psychological Science*, 23, 1449–1454.
- Gigerenzer, G. (2008). *Rationality for mortals. How people cope with uncertainty*. New York: Oxford University Press.
- Gilovich, T., & Savitsky, K. (1996). Like goes with like: The role of representativeness in erroneous and pseudo-scientific beliefs. *Skeptical Inquirer*, 20, 34–40.
- Haran, U., Ritov, I., & Mellers, B. A. (2013). The role of actively open-minded thinking in information acquisition, accuracy, and calibration. *Judgment and Decision Making*, 8, 188–201.
- Hayes, A. F. (2013). *An introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York: Guilford Press.
- Hilligoss, B., & Rieh, S. Y. (2008). Developing a unifying framework of credibility assessment: Concept, heuristics, and interaction in context. *Information Processing and Management*, 44, 1467–1484.
- Jenkins-Smith, H. (2001). Modeling stigma: An empirical analysis of nuclear waste images of Nevada. In J. Flynn, P. Slovic & H. Kunreuther (Eds.), *Risk, media, and stigma: Understanding public challenges to modern science and technology* (pp. 107–132). London, Sterling, VA: Earthscan.
- Kahan, D. M. (2012). Cultural cognition as a conception of the cultural theory of risk. In S. Roeser, R. Hillerbrand, P. Sandin & M. Peterson (Eds.), *Handbook of risk theory: Epistemology, decision theory, ethics, and social implications of risk* (pp. 725–759). New York: Springer.

- Kahan, D. M. (2013). A risky science communication environment for vaccines. *Science*, 342, 53–54.
- Kahan, D. M., & Braman, D. (2006). Cultural cognition and public policy. *Yale Law & Policy Review*, 24, 147–170.
- Kahan, D. M., Braman, D., Cohen, G. L., Gastil, J., & Slovic, P. (2010). Who fears the HPV vaccine, who doesn't, and why? An experimental study of the mechanisms of cultural cognition. *Law and Human Behavior*, 34, 501–516.
- Kahan, D. M., Braman, D., Gastil, J., Slovic, P., & Mertz, C. K. (2007). Culture and identity-protective cognition: Explaining the white male effect in risk perception. *Journal of Empirical Legal Studies*, 4, 465–505.
- Kahan, D. M., Braman, D., Slovic, P., Gastil, J., & Cohen, G. (2009). Cultural cognition of the risks and benefits of nanotechnology. *Nature Nanotechnology*, 4, 87–90.
- Kahan, D. M., Jenkins-Smith, H., & Braman, D. (2011). Cultural cognition of scientific consensus. *Journal of Risk Research*, 14, 147–174.
- Kahan, D. M., Peters, E., Wittlin, M., Slovic, P., Ouellette, L. L., Braman, D., & Mandel, G. (2012). The polarizing impact of science literacy and numeracy on perceived climate change risks. *Nature Climate Change*, 2, 732–735.
- Kahan, D. M., Slovic, P., Braman, D., & Gastil, J. (2006). Fear of democracy: A cultural evaluation of Sunstein on risk. *Harvard Law Review*, 119 (Yale Law & Economics Research Paper No. 31).
- Kahneman, D. (2011). *Thinking, fast and slow*. New York: Farrar, Straus and Giroux.
- Kumkale, G. T., Albarracín, D., & Seignourel, P. J. (2010). The effects of source credibility in the presence or absence of prior attitudes: Implications for the design of persuasive communication campaigns. *Journal of Applied Social Psychology*, 40, 1325–1356.
- Lerner, J. S., & Tetlock, P. E. (1999). Accounting for the effects of accountability. *Psychological Bulletin*, 125, 255–275.

- Maynard, A. D., Aitken, R. J., Butz, T., Colvin, V., Donaldson, K., Oberdörster, G. ... Warheit, D. B. (2006). Safe handling of nanotechnology. *Nature*, *444*, 267–269.
- McKenzie, C. R. M. (2003). Rational models as theories – not standards – of behavior. *Trends in Cognitive Sciences*, *7*, 403–406.
- Mohr, P. N. C., Biele, G., & Heekeren, H. R. (2010). Neural processing of risk. *The Journal of Neuroscience*, *30*, 6613–6619.
- Mnyusiwalla, A., Daar, A. S., & Singer, P. A. (2003). ‘Mind the gap’: science and ethics in nanotechnology. *Nanotechnology*, *14*, 9–13.
- Nesler, M. S., Aguinis, H., Quigley, B. M., & Tedeschi, J. T. (1993). The effect of credibility on perceived power. *Journal of Applied Social Psychology*, *23*, 1407–1425.
- Nickerson, R. S. (1998). Confirmation bias: A ubiquitous phenomenon in many guises. *Review of General Psychology*, *2*, 175–220.
- Peters, E., & Slovic, P. (1996). The role of affect and worldviews as orienting dispositions in the perception and acceptance of nuclear power. *Journal of Applied Social Psychology*, *26*, 1427–1453.
- Renner, B., & Reuter, T. (2012). Predicting vaccination using numerical and affective risk perceptions: the case of A/H1N1 influenza. *Vaccine*, *30*, 7019–7026.
- Schmälze, R., Häcker, F., Renner, B., Honey, C. J., & Schupp, H. T. (2013). Neural correlates of risk perception during real-life risk communication. *The Journal of Neuroscience*, *33*, 10340–10347.
- Simon, H. A. (1990). Invariants of human behavior. *Annual Review of Psychology*, *41*, 1–19.
- Sirota, M., & Juanchich, M. (2012). To what extent do politeness expectations shape risk perception? Even numerical probabilities are under their spell! *Acta Psychologica*, *141*, 391–399.

- Sirota, M., Juanchich, M., Kostopoulou, O., & Hanák, R. (2014). Decisive evidence on a smaller-than-you-think phenomenon: Revisiting the “1-in-X” effect on subjective medical probabilities. *Medical Decision Making*, 34, 419–429.
- Slovic, P. (1999). Trust, emotion, sex, politics, and science: Surveying the risk-assessment battlefield. *Risk Analysis*, 19, 689–701.
- Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2004). Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. *Risk Analysis*, 24, 311–322.
- Stanovich, K. E., & West, R. F. (1997). Reasoning independently of prior belief and individual differences in actively open-minded thinking. *Journal of Educational Psychology*, 89, 342–357.
- Stanovich, K. E., West, R. F., & Toplak, M. E. (2013). Myside bias, rational thinking, and intelligence. *Psychological Science*, 22, 259–264.
- Sunstein, C. R. (2002). *Risk and reason. Safety, law, and the environment*. Cambridge University Press.
- Todd, P., & Gigerenzer, G. (2000). Precis of simple heuristics that make us smart. *Behavioral and Brain Sciences*, 23, 727–780.
- Todd, P., & Gigerenzer, G. (2003). Bounding rationality to the world. *Journal of Economic Psychology*, 24, 143–165.
- Tvardzík, J. (2015, May). Očkovanie: Kolektívna imunita je v ohrození. Epidémia je reálna [Vaccination: Herd immunity is in danger. Epidemic is real]. *Trend*. Retrieved from <http://www.etrend.sk/ekonomika/ockovanie-kolektivna-imunita-je-v-ohrozeni-epidemia-je-realna-varuje-expertka.html?split=1>
- Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty – heuristics and biases. *Science*, 185, 1124–1131.
- Tversky, A., & Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty*, 5, 297–323.

- Umeogu, B. (2012). Source credibility: A philosophical analysis. *Open Journal of Philosophy*, 2, 112–115.
- Weinstein, N. D., Kwitel, A., McCaul, K. D., Magnan, R. E., Gerrard, M., & Gibbons, F. X. (2007). Risk perceptions: assessment and relationship to influenza vaccination. *Health Psychology*, 26, 146–151.
- Westen, D., Blagov, P. S., Harenski, K., Kilts, C., & Hamann, S. (2006). Neural bases of motivated reasoning: An fMRI study of emotional constraints on partisan political judgment in the 2004 U.S. presidential election. *Journal of Cognitive Neuroscience*, 18, 1947–1958.
- Whatmore, R. W. (2006). Nanotechnology—what is it? Should we be worried? *Occupational Medicine*, 56, 295–299.
- Zimet, G. D. (2005). Improving adolescent health: Focus on HPV vaccine acceptance. *Journal of Adolescent Health*, 73, 17–23.