EMPOWERING CITIZENS AGAINST THE TYPICAL MISUSE OF DATA CONCERNING RISKS

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Risks have to be evaluated on the basis of information that media, advertisements and brochures provide. These are often incomplete, reporting, for instance, only relative risks instead of both relative and absolute risks. While it is important for the informed citizen to be trained in the evaluation of scales and diagrams on risk-related topics it is also relevant that she acquires basic competencies for the understanding of risk; this requires, as is the claim of this paper, minimal effort. Results will be presented that demonstrate current deficits in the understanding of risk which are the consequence of misinformation or of bad representation formats and can be eliminated by a good yet elementary training in the understanding of basic risk-related concepts.

INTRODUCTION

Facing emotion-laden, unfamiliar situations, we easily over-estimate risks based on data provided by the media. In such situations we tend to have exaggerated reactions and adopt costly attitudes. These can cause decisions which may lead us or our relatives astray. As is well known, the media often present data in ambiguous or incomplete formats which foster negative emotions. Remember, for instance, the widespread fears in the English speaking countries over the past 15 years concerning a connection between autism and the measles-mumps-rubella vaccine. In spite of lack of *any* convincing evidence for such a link an extraordinary number of parents chose not to have their children vaccinated, which caused a rise in cases of measles. As another famous instance of misleading information, consider the warning by the UK Committee on Safety of Medicines back in 1995 that the third-generation contraceptive pill would increase the risk of dangerous blood clots by 100%. This warning was followed by an extra 14,000 abortions during the next two years, mainly of very young women. The actual increase in risk amounted to only an additional case in 7,000 (Kurz-Milcke; Gigerenzer and Martignon, 2008). The "absolute risk increase" had not been grasped by women in general: they had simply panicked at the "relative risk increase" that had been communicated by the media.

Cases like this have abounded during the last decades. Medical brochures and medical advertisements have produced similar effects. Typically, the intake of specific medicines has been recommended in terms of "relative risk reduction", without further specifications (Martignon & Krauss, 2009). The question that arises here is whether the media or the pharmaceutical industry are to blame and whether citizens should be trained to go beyond *easy* news and search for more precise and transparent sources of information than newspapers and television. It is well known that sensationalism is a typical factor of those who produce news and ads. Risks tend to be vastly augmented. Pertaining data in percentages are sometimes communicated in ambiguous formats. The pharmaceutical industry also has specific interests, which have consequences on the presentation of medical products, although regulations concerning reliability of information are becoming ever stricter.

RISK ASSESSMENT FOR GOOD DECISION MAKING

Roughly speaking risks are *expected hazards* and assessing them requires an intuitive sense – if not a knowledge – of probabilities and expected values. Many cognitive scientists maintain, based on existing research, that humans will never be capable of interpreting the available information on risks without falling prey to biases and fallacies. "Risk decision-making should be concentrated to an even greater extent in politically insulated expert agencies" is the motto of these scientists (Bond, 2009). Decision makers, as these scientists explain, make risky choices in environments where many features influence their decisions. Risk assessment is achieved through the processing of several cues in the analyzed environments. Most of these environments and their features are far from natural: they are

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created by other people, so called *choice architects*. The goal of a ***new*** trend of applied cognitive science (Thaler & Sunstein, 2008) is to establish how choice architecture can be used to help stir people towards better choices. We list the most important tools used by choice architects (Bond, 2009):

- defaults,
- anticipating errors,
- understanding mappings,
- giving feedback,
- structuring complex choices, and creating incentives.

"Nudge" is the term adopted by policy makers to describe a program that has reached – both in the U.K. and in the U.S. – the status of a political instrument. As it has been presented by Thaler and Sunstein (2008), it is a consequence or reaction to the Heuristics and Biases (H&B) program, which began being developed in the late seventies and eighties (Kahneman, Slovic, & Tversky, 1982), or more specifically to aspects of this program, which describe the fallacies the mind is riddled with when dealing with choices based on probabilistic assessments. One important alternative to ***nudging*** citizens towards responsible and healthful decision making is ***boosting*** their competencies and empowering them so that they make their own cognitive illusions disappear.

Nudge versus Boost is becoming an ever more present dichotomy in the civic scenario (Grüne-Yanoff & Hertwig, 2016) tightly connected with the search of sustainable statistical citizens' empowerment in democracies. Nudge is a top-down way of inducing people to make the "right" choices and the "right" decisions in cases in which, as the nudge philosophy claims, the right decisions are those which will satisfy them in the long run. Boost, as described by Grüne-Yanoff and Hertwig (2016), is the solution to (some of the) human biases and fallacies. To help citizens in civic decision-making means to make them aware of ways for making cognitive biases disappear and also of possible imprecisions on the side of the media and the practitioners' communication. Boost is advertised (by Grüne-Yanoff & Hertwig, 2016) in a special disguise which is perhaps most adequately rendered by the German term "Bildung."

Bildung is "guided human development", actually a "process of formation of a citizen"; it is a bottom-up process which empowers people to think for themselves in a Kantian sense, to estimate risks and make choices in the environments they encounter. Bildung may equip them, for instance, with strategies for translating information about risks provided by (possibly) any environment into formats they can *naturally* understand and deal with. Once they are confronted with adequate information formats, they can make choices and decisions, often by means of very simple heuristics (Gigerenzer, Hertwig, & Pachur, 2011). To cite an example, people making decisions under risk need to make use of information often presented in percentages or even in probabilities, formats which can be misinterpreted by the punter (Kahneman, Slovic, & Tversky, 1982). Nevertheless those who have been empowered by simple rules for dealing with information can translate these formats into so called natural frequencies, which are akin to the mind and foster understanding (Wassner, Martignon, & Biehler, 2004). Once they grasp the validity or "diagnosticity" of the features in their decision environment in terms of natural frequencies they tend to make use of simple heuristics for making comparisons, for estimation and for categorization (Martignon & Hoffrage, 2002; Martignon, Katsikopoulos, & Woike, 2008; Hertwig, Hoffrage, & Martignon, 1999). This process is ecologically rational, i.e., it profits from the adaptation of the mind to the environments it has to interact with.

Those who defend *nudge* are reluctant to believe that cognitive fallacies can disappear. In particular, Daniel Kahneman, one of the two main protagonists of the H&B program, has expressed only a very moderate optimism towards the possibility of "educating" human intuitions for solving probabilistic tasks. In his recent book "Thinking fast and slow" (Kahneman, 2011), which is a wonderful, well written recount of the discoveries of H&B, Kahneman devotes one short chapter to Nudge and tends to see it as a necessity. Education is not mentioned as a means to foster the "right" choices of humans. In fact education is hardly mentioned in his book at all. While the H&B program and its followers – Cass Sunstein and Richard Thaler among them – have been seen as pessimistic as far as the

chances of empowering the human mind are concerned, Gigerenzer, Hertwig and the Center for Adaptive behavior and Cognition, ABC, can been seen as *panglossian* thinkers, for whom the human mind is, if not *the best of all possible minds*, definitely one that can be empowered to succeed by means of its own choices and heuristics. Gigerenzer and his collaborators report, for instance, that doctors, medical journalists or financial speculators, often fall prey of probabilistic traps (Gigerenzer, Gaissmaier, Kurz-Milcke, Schwartz and Woloshin, 2007). In one experiment, 160 gynecologists were asked to interpret some basic probabilities about a woman's chances of having breast cancer, given that her mammography screening had come back positive: only 21% gave the right answer. This kind of findings has influenced the attitudes of modern educators in the UK and in the German speaking countries with respect to the fostering of probabilistic and statistical competencies at an early age.

"Exaggerated risk judgements can lead to anxiety that degrades quality of life and causes excessive vigilance and self-protective behaviors"(Bond, 2009, pp. 1189-1192). Exaggerated risk judgements are common and frequent in our information laden society on all sorts of issues. Typical examples include, for instance, persistent fears over the dangers of genetically modified crops. These fears are exaggerated despite studies showing that the risks are considerably lower than the scare news report. The hysteric reactions reported in the United States during the late 1980s, were overblown and still considered controversial. The news communicated by the media were that the plant growth regulator Daminozide[1] (Alar), used on apples and other fruit, was a potent human carcinogen, raising the risk of such cancer form of at least 200% in those with a weak immune system. This datum was utterly unprecise and, again, it only communicated a relative risk increase (for a detailed discussion on relative/absolute risks, see below).

THE RARE EVENT PANIC EFFECT AND MAGNIFIED RISK PERCEPTION

Fukushima is, no doubt, one of the most dramatic accidents happened during our millennium. It is not necessary to retell the story of this catastrophe here. Let us simply recall that it was an energy accident at the Fukushima I, Nuclear Power Plant, initiated by a tsunami which was triggered by an earthquake on 11 March 2011. The real catastrophe was the sequence of consequences of the tsunami. It was actually caused by equipment failures, which, in a chain of reactions, produced the loss-of-coolant accident, resulting in a series of three nuclear meltdowns[2] and the immediate uncontrolled release of radioactive material. It was the largest nuclear disaster since Chernobyl in 1986. Just like Chernobyl it was given the Level 7 event classification of the International Nuclear Event Scale. This scale has been established for classifying nuclear accidents[3]. The aim here is to briefly analyze how panic about catastrophic ***rare*** events can cause an explosion of new casualties and deaths far beyond the effects caused by the original catastrophe. A word has to be said, in the case of Fukushima, on the lies communicated by the Tokyo Electric Power Company (TEPCO), the company that had constructed the Fukushima reactor. TEPCO was reluctant to declare the technical problems that had, if not caused, failed to hinder the original catastrophe.

Five years after the catastrophe epidemiologists declare that there has been an increase of thyroid cancer in children after the catastrophe. One question that arises here is whether these thyroid cancer cases are really connected with the catastrophe or are caused by screening. Another question is "Were the massive evacuations really justified?" Last spring, four years after the nuclear accident, a group of world famous scientists met in Tokyo to evaluate the deadly aftermath. It makes sense to present a synthesis of the report releases of the International Atomic Energy Agency (IAEA)[4] because the results are relevant: No one has apparently been killed or sickened by the radiation — a point confirmed last January by the Agency. Even among Fukushima workers, the number of additional cancer cases of adults has been low. It is pertinent to note that "the number of reported cases of cancer caused by the aftermath of Fukushima had been apparently magnified during the first two years after the catastrophe in the media." The number of adult cancer patients in the aftermath of Fukushima is, accord-

[1] Daminozide is a plant growth regulator, a chemical sprayed on fruit to regulate their growth, make their harvest easier, and keep apples from falling off the trees before they are ripe.
[2] https://en.wikipedia.org/wiki/Nuclear_meltdown
[3] https://en.wikipedia.org/wiki/International_Nuclear_Event_Scale
[4] https://www.iaea.org/newscenter/focus/fukushima

ing to the studies of the epidemiological experts, low to the point of being classified as negligible. To be precise, the number of cancer cases caused by radiation after the accident is impossible to discern against the statistical background noise (https:// www.iaea.org/newscenter/news/iaea-releases-director-generals-report-on-fukushima-daiichi-accident). But about 1,600 people died from the stress of the evacuation — one that some scientists believe was not justified by the relatively moderate radiation levels at the Japanese nuclear plant. Epidemiologists speak of "stochastic deaths," those they predict will happen in the future because of radiation or *some other risk*. With no names attached to the numbers, they remain an abstraction.

The political consequences of Fukushima were immense. We, as critical citizens, necessarily have to ask: Were they *all* really justified? Which are, if any, the possible "pros" that can still be invoked today in order to justify all the still existing nuclear plants? Considering TEPCO's statements at the time which covered the errors and omissions in the construction of the nuclear plant it is plausible to compare the Fukushima catastrophe to an air crash due to a natural accident and the human failure to control it. In European Nuclear plants, as reported by the IAEA, all devices to curtail and reduce effects of possible earthquakes or tornadoes are continually controlled and, if necessary, upgraded. The (non-transparent and incomplete) news about Fukushima had huge, unexpected consequences for the Nuclear Policy in several European countries, especially in Germany. The German Chancellor, a physicist by training and a former environment minister, reacted with the same radicalism we observe today in her policy concerning refugees. In record time the once most pro-nuclear German government modified legislation in order to phase out all reactors by 2022 at the latest (of the seventeen reactors only nine are still functioning at present).

The question that arises again and again in this context is whether the "impact of rare catastrophes" and the public's lack of understanding of rare risks and of residual risks has had more negative, unexpected consequences than the catastrophe itself (e.g., lethal consequences of evacuation). It was, as it seems, the fear of radiation that ended up killing people, more than radiation itself. Had the evacuees stayed home, their cumulative exposure over four years, in the most intensely radioactive locations, would have been about 70 millisieverts[5] — roughly comparable to receiving a high-resolution whole-body diagnostic scan each year.

What can a "citizen of the world" learn from the Fukushima catastrophe and its treatment by TEPCO and by the media? The data about the actual radioactive emissions have been controlled by TEPCO and state authorities that have been tightly connected to TEPCO. This has to be grasped by anybody who strives for an informed opinion on nuclear energy supplies. The decision is not between adopting nuclear energy supply and adopting alternative energy supplies. It is about how to organize and control nuclear energy supply whenever that way of energy supply is adopted and to be aware of the possible risks involved with it. At the same time a citizen should be able to understand a transparent discussion of the ruling organizations on the prices a society has to pay for different sources of energy. Citizens need representations of pros and cons. To present many alternatives would be ideal. Ordinary people have seen experts following their own interests presenting just one strategy and defending it as the correct one many times. Thus statistics teaching should empower citizens to ask for open, multiple discussions on relevant topics.

The conclusion from this section motivated by the Fukushima catastrophe is perhaps that citizens should become aware of the impact of rare events. Rare events are either horribly magnified or utterly neglected, wrote Kahneman and Tversky back in 1979. This is, of course, not a falsifiable statement and it is easy to accept. In questioning the consequences of Fukushima it would be dangerous to end up trivializing that catastrophe. What nevertheless seems relevant is that the analysis of the catastrophe in the media and the consequences of this analysis were, in some aspects, biased and even misleading. The critical citizen has to be aware of (at least some of) the interests involved to cover up the human failures by a company like TEPCO and by the Japanese authorities. As mentioned above it was the phenomenon of hurried evacuation which caused large number of deaths.

[5] The millisievert (mSv) is a measure of the absorption of radiation by the human body.

ABSOLUTE AND RELATIVE RISKS: REPRESENTATIONS THAT FOSER THEIR UNDERSTANDING

Should we wear helmets when riding a bicycle and thereby reduce the risk of severe injury when having an accident? What is the risk reduction? Should we take Lipitor[6] to reduce infarction risk by 33 %? Again, what is here the risk reduction? How should risk reduction and risk increase be communicated by the media and the pharmaceutical industry?

It is often said and written that wearing a helmet reduces severe head injuries by fifty per cent in case of an accident. Here, as in several examples mentioned above, a *relative* risk is communicated rather than an *absolute* risk. In order to empower youngsters to understand relative and absolute risks a dynamic webpage has been produced that can be successfully used by teenagers and adults: www.eeps.com/riskicon. This page has been created by Tim Erickson for instruction on both conditional probabilities and risk assessment. It consists of iconic representations that can be varied by means of sliders. Figure 1 illustrates the tool for representing absolute risk.

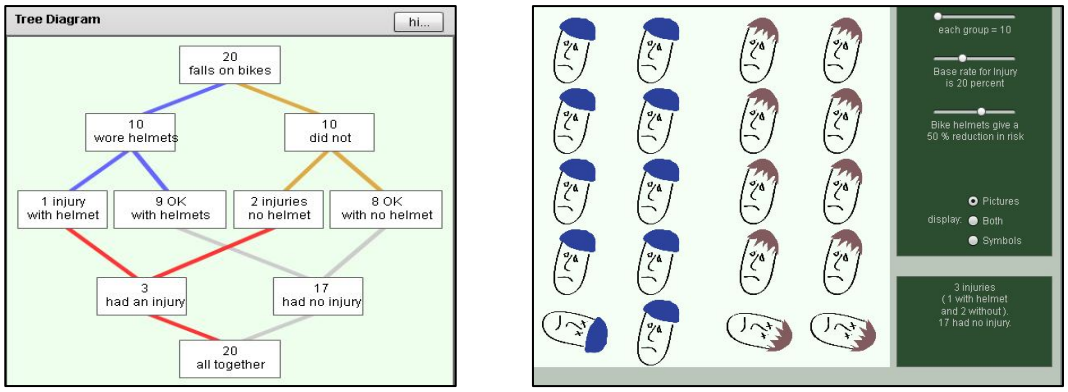

Figure 1: The left hand side tool allows exploring risk reduction: A number of people have had bike accidents. Half of them were wearing helmets. While two out of ten of those without helmet had a severe injuries only one of ten had such an injury among those wearing a helmet. The left hand side double tree is obtained by clicking a button in the menu at the bottom of the tool at the left hand side. The double tree represents the data on bike accidents and severe injuries. The top-down direction is causal: Wearing helmets – or not wearing helmets – has a causal influence on the rate of severe injuries. The bottom-up direction is diagnostic, because the presence – or absence – of a helmet can be diagnosed by the proportions of people with or without injuries.

The sliders on the right hand side can be used to adjust the probabilities. The base rate of bike accidents is fundamental and is ignored when only the relative risk reduction of 50% is reported. It has been shown empirically that children in fourth class can acquire elementary competencies for understanding relative and absolute risks by means of both haptic and iconic representations (Martignon, 2014: Till, 2014).

[6] Lipitor is used to treat high cholesterol, and to lower the risk of stroke, heart attack, or other heart complications in people with type 2 diabetes, coronary heart disease, or other risk factors (http://www.drugs.com/lipitor.html).

Similar displays were created by Erickson as visual aids for explaining the predictive value of a test. Figure 2 illustrates a tool for representing the validity computation of an HIV-test by means of a display based on natural frequencies and iconic grids.

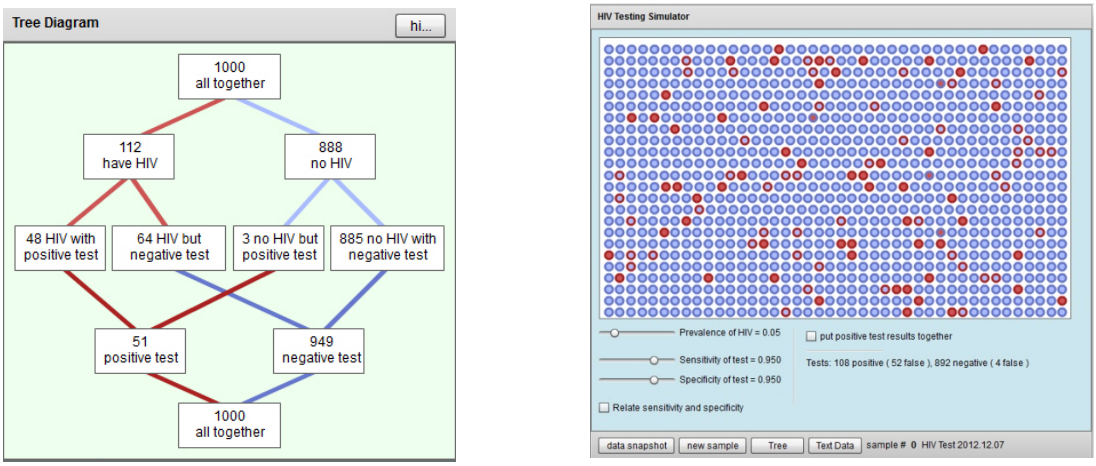

Figure 2: The left hand side tool allows exploring natural frequencies: A population of 1000 people is represented. The base rate of the disease corresponds to the 112 people with HIV, while the nodes below carry information on those who have the disease and test positive and those who have the disease and test negative. The top-down direction is causal: Having or not having the disease has a causal influence on the test's results. The bottom-up direction is diagnostic, because the presence – or absence – of the disease can be diagnosed by the proportions of people with positive or negative tests. The left hand side double tree is obtained by clicking a button in the menu at the bottom of the tool at the left hand side. The sliders are used to modify the prevalence of the disease, the sensitivity and specificity of the test.

CONCLUSION

Understanding risks and estimating the involved probabilities becomes an ever more necessary competency for good decision making in a modern society. Typical biases and fallacies in risk assessments are sometimes due to the exaggerated perception of rare events or their utter neglect (Kahneman & Tversky, 1979). A healthy skepticism and the very basic elements required for understanding risks can be conveyed to youngsters/children by means of simple, transparent representation formats.

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