

ARE EMOTIONS RELIABLE GUIDES FOR POLICY MAKING? AN EVOLUTIONARY APPROACH*

*¿Son las emociones una guía adecuada para actuar en la esfera pública?
Una perspectiva evolutiva*

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ABSTRACT

Technology has become all-important in modern society. For each application, it is crucial for society to have a good understanding of the risks and benefits involved. However, experts tend to assess the risks very differently than the public. One of the main reasons is that experts tend to rely on an objective analysis of the facts, whereas laypeople's judgment is also based on other factors, including emotional responses. The question remains however whether that is a good thing. Some argue that emotions lead to biases and should be treated with great suspicion; others claim that the laypeople's approach to risk is much richer and should also be taken into consideration. In this paper, I explore how we can answer that important question from an evolutionary perspective. First, I briefly outline the role of emotions in judgment and decision making. Next, I discuss two approaches that have defended the rationality of emotions: Roeser's concept of emotions as trustworthy indicators of moral risks and Kahneman's cultural evaluator theory. Subsequently, I briefly discuss the evolution of emotions and their impact on risk assessment. I conclude from that account that emotions are not trustworthy guide for policy making.

Key words: Emotions; Risk assessment; Evolution; Rationality; Disgust.

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RESUMEN

La tecnología ha sobrevenido como algo enormemente relevante en las sociedades modernas. En cada nueva aplicación, es crucial que la sociedad tenga una adecuada comprensión de los riesgos y de los beneficios de dicha tecnología. Sin embargo, los expertos evalúan los riesgos de un modo muy diferente a como lo hace la gente común. Una de las razones fundamentales es que los expertos se suelen apoyar en un análisis objetivo de los hechos, mientras que los juicios que hace la gente se basan también en otros factores, incluidas las respuestas emocionales. La cuestión pendiente es si es bueno que sea así. Algunos consideran que las emociones pueden generar sesgos y deberían ser tratadas con mucho cuidado; otros creen que la perspectiva de la gente común sobre el riesgo es mucho más rica de lo que se cree y debería también ser tenida en cuenta. En este ensayo exploro esta importante cuestión desde una posición evolutiva. Primero, describo brevemente el rol que tienen las emociones en nuestros juicios y toma de decisiones. Luego, debato dos aproximaciones distintas sobre la racionalidad de las emociones: el concepto de emociones de Roeser como indicadores valiosos de los riesgos morales y la teoría evolutiva del evaluador cultural de Kahan. Como resultado, trato brevemente la evolución de las emociones y su impacto en la valoración del riesgo. Concluyo desde ahí que las emociones no son guías fiables para la toma de decisiones públicas.

Palabras clave: Emociones; Evaluación de riesgos; Evolución; Racionalidad; Repugnancia.

I. EMOTIONS IN JUDGMENT AND DECISION MAKING

More than 30 years of research have shown that people generally do not make decisions and judgments on the basis of a careful evaluation of expected outcome of the available options, as classical models predicted, but rather spontaneously rely on mental rules of thumb, called heuristics (Kahneman 2011, Gilovich, Griffin & Kahneman 2002). These heuristics are in place because under ecologically relevant conditions they generate adequate responses. However, confronted with more complex and abstract situations, they tend to err, leading to persistent and systematic biases. For instance, when confronted with the Linda-problem¹, people tend to solve

1. The Linda-problem consists of a description of a bright, young, single woman called Linda who majored in philosophy, and was, as a student, very concerned about discrimination. Consequently, participants are asked which option is the

the puzzle by depending on how much Linda represents a particular social group, not by following basic logical rules, thus committing the conjunction fallacy (*representativeness heuristic*). When people are invited to gauge the probability of an event, they form their judgment not on the results of a statistical analysis, but rather they consult their memory for available and salient instances of that event (*availability heuristic*) (Kahneman 2011, Tversky & Kahneman 1974, Gilovich, Griffin & Kahneman 2002). The discovery of these and other heuristics have led to the development of a model of the human mind, dual mind or dual process theory, that holds that the mind comprises at least two different types of mind (Kahneman 2011, Evans 2010 b). *System 1*, also called the intuitive or reflexive mind, operates fast and automatically, functions without much effort and stays largely below the radar of consciousness. This is the realm of the heuristics. *System 2*, the reflective mind, is the mind that we are consciously aware of; it is deliberative and voluntary and gives us the feeling that we are in control of our thoughts. However, this feeling is often illusory and system 2 readily and uncritically accepts the input provided by System 1 leading to errors as described above.

Originally the research focus lays on heuristics of a more cognitive nature such as the representativeness or availability heuristic. Later, however, instigated by earlier works of Slovic (1987), Zajonc (1980) and Damasio (1994), researchers have come to pay much attention to the influence of affect. Slovic and colleagues (2002), for instance, refer to several experiments to demonstrate that people, when making decisions or judgments, follow an affect, a feeling, that something is good or bad heuristic:

Representations of objects and events in people's minds are tagged to varying degrees with affect. In the process of making a judgment or decision, people consult or refer to an "affect pool" containing all the positive and negative tags consciously or unconsciously associated with the representations. Just as imaginability, memorability, and similarity serve cues for probability judgments (e.g., the availability and representativeness heuristics), affect may serve as a cue for many important judgments (Slovic et al. 2002, 400).

According to Slovic and colleagues, the affect heuristic shows its face in many different situations, from the evaluation of gambles to the assessment of risk. With the latter, the affect heuristic touches upon the risks-as-feelings

most probable. 1) Linda is a bank teller, or 2) Linda is a bank teller and a feminist. Although the probability of a conjunction can never be higher than the probability of one of its components, the majority of people tends to choose the second option, thus committing the conjunction fallacy.

approach developed by Loewenstein and colleagues (2001). Loewenstein et al. argue convincingly that in order to assess risk, people often unconsciously rely on anticipatory emotions rather than upon cognitive evaluations. Not statistical data, but factors such as vividness of imagery and proximity in time determine how and to which extent feelings determine people's judgment and the subsequent behavioral response.

The fact that emotions exert considerable influence on judgment and decision making appears to be firmly established and is not under question in this chapter. Here we are more interested in the question whether the influence of emotions is a good or a bad thing. The answer of Slovic and his colleague to this question is ambivalent:

[The affect] heuristic appears at once both wondrous and frightening: wondrous in its speed, and subtlety, and sophistication, and its ability to "lubricate reason"; frightening in its dependency upon context and experience, allowing us to be led astray or manipulated –inadvertently or intentionally– silently and invisibly" (Slovic et al. 2002, 420)

However, Slovic and colleagues almost exclusively refer to studies in which affect can be easily manipulated and result in biases. As such, one might be tempted to conclude that they assume that the influence of emotions is not very reliable. Loewenstein et al. (2001) avoid making any explicit judgment about the desirability of the influence of feelings, but the way in which the authors juxtapose the impact of visceral emotions to the outcome of deliberate computations and the assessments of experts suggests that they too favor the latter. As such, one might feel tempted to conclude that the main thrust of studies on the impact of emotions within the dual process research tradition boils down to the idea that emotions are generally untrustworthy, lead to consistent biases and that their influence needs to be corrected by the reflective mind.

2. RATIONAL EMOTIONS?

2.1. *The moral rationality of emotions: Kass and Roeser*

Not everyone agrees, however, that emotions mainly distract us from making calculated and objective decisions and judgments. Notoriously, Kass (1997) has argued that feelings of disgust reliably tell us that an unsurpassable moral barrier has been breached, for instance in the case of human cloning.

This he calls the wisdom of repugnance. History clearly shows, however, that phenomena once deemed disgusting are today entirely acceptable and vice versa, which strongly undermines Kass's argument: how can we be sure that we can trust disgust in the case of human cloning? (Evans 2010 a, for a critique of Kass' position, see Kelly 2011).

Roeser (2010, 2011, 2006) defends a similar, but somewhat more nuanced position. She claims that dual process theorists sidestep emotions as subjective and irrational. In her view, emotions are more than mere gut feelings that can be contrasted with cognitive reflection. Emotions bear a cognitive, reflective component and thus hold "critical potential" (Roeser 2010, 239). Admittedly, Roeser argues, when emotions keep us from accurately assessing or even accepting scientific findings concerning the quantitative aspects of risk, then emotions lead to irrational conclusions and they need to be corrected in light of the available evidence (Roeser 2010). Roeser, however, thinks that there is more to risk than its quantitative dimensions. There is also the *moral* dimension of risk to which experts have no privileged access. When it comes to these moral risks, emotions can be "an invaluable source of wisdom" (Roeser 2011, 198), "ethical insight" (197) and "practical rationality" (197). For instance, feelings of sympathy and responsibility allow us to imagine the fate of fellow humans and thus make crucial contributions to our moral reflections. When lay people depend on emotions to assess the risk of a particular technology, they are not being irrational, but they use the only available means by which they can include their ethical considerations. Experts who disregard this multifaceted nature of risk are said to be suffering from "*complexity neglect*" (Roeser 2010, 242).

However, according to Roeser, even if emotions can offer important insights into the moral dimensions of risk, they are by no means infallible. As Roeser (2010, 239) notes: "Emotions are necessary for moral knowledge, but they are no guarantee for success. We need to critically examine our emotions, by exploiting the reflective and critical potential of emotions, which is given through their possibility of shifting points of view and caring for the wellbeing of others". Indeed, in light of the evidence of emotions unjustifiably biasing people's moral judgment, it would be difficult to maintain otherwise. This single sentence, however, beautifully captures two insurmountable weaknesses in Roeser's position. First, granting that emotions are not infallible and need to be assessed critically implies that the evaluation of the normative weight of the emotion depends not upon the activation of the emotion itself, but upon criteria independent of the emotion. The fact that the emotion is activated does not in itself justify the moral judgment based on that emotion.

Seemingly, Roeser acknowledges this when she writes that “emotions such as sympathy, empathy, and compassion *can* point out unfair distributions of risks and benefits. Indignation and resentment *can* point to moral digressions such as involuntary risk impositions. Experts *might* feel responsible and worried about the technologies they develop. Fear *might* point to concern about unforeseen negative consequences of a technology. Disgust *might* point to the ambiguous moral status of, for example, clones and human-animal hybrids”. (Roeser 2011, 198, *my italics*) Feelings *might* and *can*, but whether they do appears to lie outside their normative reach. Roeser might object to the first point that the deliberation is not based on independent criteria, but upon feelings of empathy and sympathy (“shifting points of view” and “caring for the wellbeing of others”) (Roeser 2010, 239). Emotions have the potential to critically assess the effect of other emotions.

This argument of critical potential constitutes the second weakness in Roeser’s argument, which is similar to the first: as sympathy and empathy are emotions themselves, the evaluative power of sympathy and the like does not depend on the nature of these emotions, but, again, on other criteria. Indeed, feelings of empathy are not trustworthy in and because of themselves. As Bloom has noted in his notorious piece called “Against empathy” (Bloom 2014), the emotion itself can be biased (e.g., we feel more sympathy towards beautiful people) and narrow (e.g., we can empathize with the suffering of one single individual but disregard the torments of anonymous thousands). In other words, the evaluators need to be evaluated (and we have no recourse to emotions, otherwise we end up with a vicious circle). In sum, either as indicators of moral risk, or as evaluative faculties with critical potential, emotions can hardly be regarded as reliable tools. This conclusion does not deny that we need emotions to be moral. However, as Evans (2010 a) notices in his *critique of safeguards views on moral risks*, this is entirely a matter of empirical psychology. Even if emotions play an unavoidable role in our moral judgment and decision making, this does not entail that we should not treat their influence without suspicion (cf. De Sousa 2010).

2.2. *The cultural rationality of emotions: Kahan*

Another approach that questions the alleged irrationality of emotions is Kahan’s cultural evaluator theory (Kahan 2008). According to Kahan, the influence of emotions might appear to result in irrational conclusions or behavior from an objective, scientific point of view, a position he labels as the irrational weighter theory. However, for the individual, following their

emotions is a rational course of action, because emotions play an important role in aligning the individual's judgment with their cultural values. Kahan explains:

The cultural evaluator theory views emotions as enabling individuals to perceive what stance toward risks coheres with their values. Cultural norms obviously play a role in shaping the emotional reactions people form toward activities such as nuclear power, handgun possession, homosexuality, and the like. When people draw on their emotions to judge the risk that such an activity poses, they form an *expressively rational attitude* about what it would mean for their cultural worldviews for society to credit the claim that that activity is dangerous and worthy of regulation (Kahan 2008, 750, *my italics*).

The irrationality of emotions is only apparent, but in fact, as they serve the purpose of calibrating an individual's response to their cultural background, we might conclude that emotions are culturally rational. However, the question is whether this approach successfully safeguard emotions from the irrationality claim. I am afraid not. In fact, Kahan's theory suffers the same weakness as Roeser's approach. Kahan too acknowledges that even when one bears in mind the cultural rationality of emotions, their influence is not entirely foolproof:

Recognizing that emotions enable persons to perceive expressive value doesn't imply that the insight it imparts can never be challenged. Indeed, the idea that emotions express cognitive evaluations is historically conjoined to the position that emotions can and should be evaluated as true or false, right or wrong, reasonable or unreasonable, in light of the moral correctness of the values those emotions express (Kahan 2008, 762).

Again, emotions in themselves are insufficient to warrant the claim that they are rational; they can only deserve that label by a critical reflection on the impact of the emotion in each and every case. Anger might be an appropriate and reasonable response in some circumstances (e.g., when someone harms your children), but not in others (e.g., towards a person with a different skin color). The strategy of using cultural values as standards to measure the appropriateness of emotions runs aground on the fact that moral values themselves are not just for the take. Values too need to be and are continuously evaluated in terms of the harm and benefits they cause, of whether or not they hinge on accurate views concerning a particular phenomenon, and of their relation to other values. Values in themselves do not and cannot make emotions rational. What makes them rational is

whether they stand up against a critical and balanced evaluation of their effects. Moreover, even if emotions were truly culturally rational, this would not make them rational in the context of assessing risks.

2.3. *Implications for policy, communication and education*

Both Roeser and Kahan draw implications of their respective theory for the role of emotions in policy making and science education and communication. Unsurprisingly, both think it necessary to credit emotions with a more positive role. Roeser claims “policy making about risky technologies should do justice to emotions as an invaluable source of ethical insight” (Roeser 2010, 241) and proposes “the arguments, reasons and considerations that are revealed by or lie behind emotional responses to technological risks and benefits have to be taken seriously” (Roeser 2010, 241). She concludes: “Emotions and scientific methods should be in a good balance when thinking about risks: where science can inform us about magnitudes, emotions inform us about moral saliences. Both kinds of information are inevitable if we want to make well-grounded judgments about acceptable risks” (Roeser 2010, 242). Kahan focuses more on the implications for education and communication: “The prospects for making members of the public receptive to sound empirical information, then, doesn’t depend on whether they can be trained not to apprehend risk through their emotions; it depends on whether scientifically sound information can be made to bear a social meaning that fits citizens’ cultural values” (Kahan 2008, 764) As such, “information about risks must be framed in a way that affirms rather than denigrates recipients’ cultural identities; to make it possible for persons of diverse cultural persuasions to experience that affirmation simultaneously –and thus reach consensus on a contested risk issue– the information must be framed in a way that expresses a plurality of social meanings” (Kahan 2008, 765).

Interestingly, both Roeser’s and Kahan’s recommendations on how to deal with emotions stand even if one does not accept their claims about the rationality of emotions. For policy, education and communication purposes, and even for democratic reasons, it can be simply sound practice to take emotional responses into account. People get the feeling that decisions are not being forced upon them and that they are being taken seriously, and they are; developing and following strategies that explicitly address concerns driven by emotions can facilitate considerably the public acceptance of a particular technology or policy; and the literature in conceptual change (Vosniadou 2008) suggests that educational approaches that deal with conceptions inspired and

strengthened by emotional appraisals will have more success to improve the understanding of (the nature, the applications and implications of) a particular technology. In sum, emotions can be taken seriously at many different levels and many different ways. However, given the fact that emotions can misguide us, it is questionable whether emotions should play an important role in policy making.

A serious hiatus in both Roeser's and Kahan's theory, is that they fail to account for how emotions came to perform their purported function, respectively as an ethical guide or as an expression of one's cultural values. Where, how and why did emotions acquire the capacity to point to genuine moral concerns? What process drove emotions into the role of cultural evaluation? Does that process generate reliable results? Was that their original function or have they been co-opted? Both Roeser and Kahan remain silent on these questions. However, by answering them, we could go a long way determining whether we can trust emotions as guides for assessing the risks of modern technologies. What we need is an evolutionary approach to emotions.

3. EVOLUTION OF EMOTIONS

3.1. *Why are emotions?*

Bringing an evolutionary perspective to the study of judgment and decision making and to the assessment of risk in particular is not new. In fact, it lies implicit in the heuristics and biases approach (Gilovich, Griffin, and Kahneman 2002, Kahneman 2011). The heuristics that make up System 1 are generally described as adaptive, meaning that they are in place because on average they automatically and spontaneously generated adequate solutions to problems faced by our ancestors such as finding a mate, collecting food, navigating social contacts, etc. In the struggle for survival, only organisms that responded quickly and aptly in response to threats and opportunities survived. In most cases, there was simply no time and energy to calculate and compare the outcomes of the different options available. Moreover, taking into account too much information leads to perplexity and indecisiveness, which in evolutionary terms means almost certain death. The same reasoning applies to the affect heuristic (Slovic *et al.*, 2002). By allowing people to respond to particular events and situations by tagging them with a positive or negative feeling, the heuristic is believed to offer a quick and dirty, but adequate solution to problems that would take too long to calculate carefully. Because they function automatically and without much reflective interference, it is no surprise that they sometimes go awry. In

their risks as feelings approach, Loewenstein and colleagues (2001) identify evolutionary preparedness as one of the determinants of the influence of feelings. For instance, people have no problem facing lethal traffic day in day out, while they might be terrified by a small, innocent spider. The reason is that spiders constituted a real threat in our ancestral environment; hence our brain evolved a predisposition to develop a fear of spiders. Automobiles however were completely absent in the world of our ancestors and 150 years is simply too short a period for natural selection to adapt the brain to this modern hazard.

Despite the fact that the heuristics and biases approach builds on an evolutionary perspective, it has, unfortunately, not developed that perspective to its fullest potential (Fessler, Pillsworth, and Flamson 2004). Here, however, I will not expand on the evolution of emotions to explain how such an account may shed new light on risk assessment. Instead, I will focus on how an evolutionary account may help us settle the question whether emotions are trustworthy indicators of risk and whether they can be used as guides for policy making. Taking an evolutionary perspective to emotions implies that one looks for the function of emotions, as Roeser and Kahan did. However, instead of looking for functions that emotions might perform nowadays, an evolutionary approach searches for functions at the ultimate level, that is the functions emotions evolved to perform in our ancestral environment. In other words, an evolutionary approach is concerned with emotions' adaptive function. This adaptive function not only explains why emotions are in place, but also accounts for their properties: Why do emotions take on the form that they do? Why do they respond to certain cues and not to others? As such, these evolved properties explain both the reach and constraints of emotions (Tooby & Cosmides 2008, Haselton & Ketelaar 2006).

Evolutionary psychologists have developed several scenarios to account for the existence of emotions (Haselton, Nettle, & Andrews 2005). Frank (1988) has argued that emotions can be viewed as commitment devices that enabled our human ancestors to pursue long-term strategies while forfeiting short-term temptations. Love, for instance, binds people into long-lasting relationships, forgoing mating opportunities that might bring immediate benefits but that deter us from reaping the benefits in the long run. Frank's theory has some experimental backup but it fails to account for emotions such as fear and disgust, which do not seem to display or maintain any commitment (Kelly 2011). Tooby and Cosmides (2008) have suggested a more inclusive theory that views emotions as superordinate cognitive programs. They argue that the human mind consists of multiple domain-specific mechanisms

dealing with perception, memory, attention, etc., the output of which needs to be coordinated into a coherent behavioral pattern in response to particular adaptive problems. Emotions perform that coordinating function. As such, they form complexes of mental and behavioral programs that include much more than the subjective experience we commonly associate with emotions².

3.2. *Are our evolved emotions trustworthy?*

The fact that different emotions evolved in response to different adaptive challenges must caution us about drawing conclusions about the trustworthiness of emotions in general. Each emotion becomes triggered by specific conditions, comes with a typical set of behavioral responses and might be more or less error prone. In addition, we might even have to revise our folk categories such as disgust, fear, etc. to make room for more fine-grained divisions that cut the emotions at their joints (see Tybur et al. 2013 for an evolutionary analysis of disgust), which makes the situation even more complex. Nevertheless, despite the diversity, based on emotions' evolutionary origins, we can at least make a number of general remarks about their reliability. First, emotions evolved to generate adequate behavior in response to particular adaptive problems; they are not concerned with producing scientifically accurate assessments of risk. They become triggered when they are confronted with cues that sufficiently resemble ecological relevant conditions in the ancestral environment. Tooby and Cosmides aptly describe emotions as bets:

[An emotion] is the evolved mind's bet about what internal deployment is likely to lead to the best average long-term set of payoffs, given the structure and statistical contingencies present in the ancestral world when a particular situation was encountered. Running away in terror, vomiting in disgust, or attacking in rage are bets that are placed because these responses had the highest average payoffs for our ancestors, given the eliciting conditions (Tooby & Cosmides 2008, 117).

But just as every other bet, emotions can be mistaken. Moreover, the tendency to err is actually built into the detection system of emotions that are involved with the gauging of risk such as fear and disgust. Because of the unequal distribution of potential costs, these emotions do not tend to

2. Limitations of space prevent me from discussing the notion of ecological rationality. However, it is unlikely that this approach makes emotions more reliable. For a general discussion, see BOUDRY, VLERICK & MCKAY 2014, in press.

err in any old way, but on the side of caution (cf. Haselton & Buss 2000). False positives will be far more common than false negatives. To infer that the wind rustling in the leaves indicates the presence of a predator is far less costly than to take a predator for the wind. To forfeit a nutritious meal under the suspicion that it carries pathogens is a less dramatic mistake than to consume a possibly sickening meal. As a result, emotions will be activated much more often than the circumstances require.

In modern times, the emotions' vulnerability becomes even more pronounced. To understand why, it might be helpful to introduce the distinction between a mental mechanism's proper and actual domain, a distinction first proposed by the French anthropologist and philosopher Dan Sperber (1996, 134-138). The proper domain of a mental mechanism is the collection of adaptive problems the mechanism evolved to neutralize. The actual domain is the collection of environmental cues that are able to trigger the mechanism into action. The proper domain of disgust, for instance, is possible contaminating sources and poisons, whereas the actual domain comprises everything that elicits disgust. Situations do not have to pose a real threat or adaptive challenge to elicit a response from our evolved mechanisms, including emotions; they only need to mimic the conditions that the mechanism has evolved to respond to. Our modern cultural environment largely consists of such situations and conditions. We have moved far away from the ancestral environment that shaped our mind. However, this means that emotions will often respond to situations for which they are not well equipped to deal with. Add this to the hypersensitivity of emotions, and we can conclude that, in modern society, emotions are very likely to react for no good reason. As such, we should not trust our emotions at face value, especially when they respond to complex issue such as modern technologies.

3.3. *Emotions and technologies: the case of GMOs*

Indeed, modern technologies form a prime example of situations that did not exist in the ancestral environment. Hence, we can expect that when people respond to them emotionally, that their response will not be necessarily attenuated to the actual risks these technologies pose. For instance, since genetically modified organisms (GMOs) have been commercialized since the 1990s, public opinion has turned against the technology, particularly in Europe. Under the influence of campaigns orchestrated by environmental groups such as Greenpeace and Friends of the Earth, people became increasingly worried about the risks this

technology would pose for their health and the environment. They also became suspicious that the technology only served the best interest of industry and the big farmers at the expense of the small farmers, particularly in the developing countries. From 1999 to 2004, in the European Union, a de facto moratorium put the commercialization of GMOs effectively on hold and, today, before any application can be released onto the European market it has to abide by very strict and expensive regulations. However, the evidence has abundantly shown that the concerns about health and environmental are entirely unsubstantiated and that local farmers too (and their families and communities) have benefited considerably from using the technology (e.g., Qaim 2010, Brookes & Barfoot 2011, D'Agnolo 2005). Moreover, applications such as golden rice may actually improve health conditions of people living in developing countries and thus help to save thousands of lives. Other applications make considerable contributions to the development of a sustainable form of agriculture and some argue that the technology can even be integrated into organic farming (e.g., Ammann 2008). Yet, the public opposition to the technology remains formidable and sometimes even becomes quite aggressive when field trials are charged and destroyed. How can we explain this paradox?

Patterns in surveys inquiring about people's opinion about GMOs and in the representations of GMOs by anti-GMO activists strongly suggest that the resistance is largely driven by emotions, particularly by disgust. Disgust is an emotion that Steven Pinker (1997) describes as our intuitive microbiology. Before we became aware of the existence of microbes, disgust alerted us of their presence. The emotion steers us away from possibly contaminating sources and poison, thus preventing us to take in or get into contact with sickening and even lethal substances. As such, objects that trigger the emotion are either pathogenic or indicative of the presence of pathogens. These triggers include feces, corpses, blood, ulcers and maggots, for example. The mouth is an important way by which pathogens can enter the body, so food is another important category that disgust is concerned with (Kelly 2011). Surveys disclose that people tend to be more averse of GM applications that are grown for food than for something else, such as clothes or biofuels (Gaskell et al. 2010). They tend to be scared that GM food is poisonous, that it will cause sterility and diseases such as cancer and they worry that GM crops will *contaminate* the environment. The very nature of these concerns (illness, poison, contamination) indicates the involvement of disgust. Anti-GMO groups have successfully tapped into feelings of disgust. They distributed edited images of children with clear signs of disease consuming GM food; a dead mouse lies dead next to a corn it has just nibbled on, and so on. A recent,

fraudulent paper that allegedly demonstrated that GMOs cause cancer in rats contained images of rats with enormous ulcers that were subsequently widely dispersed via the media (Séralini et al. 2012, see also European Food Safety Authority 2012). The influence of disgust would also explain why not only the scientists who developed the technology, but also the environmentalist groups themselves were taken by surprise by the success of the campaign. When ideas are able to hitchhike on feelings of disgust, they stand a far greater chance of spreading through a culture than non-disgusting ideas (Heath, Bell, & Sternberg 2001, Nichols 2002). More importantly, the influence of disgust could also explain why people continue to oppose the technology. They assess the risks involved not by relying on a balanced analysis of the costs and benefits, but on rather viscerally responses to the technology. Disgust emerges because agricultural applications for agriculture, especially when grown for food, display sufficient signals that alert the disgust system. The reason might be that people consider an organism's DNA to constitute its essence (on essentialism, see Gelman 2004) and that the essence becomes "contaminated" with alien DNA, in particular when the DNA is derived from organisms that are commonly deemed disgusting, such as rats. The resulting effect is that people come to oppose a technology that actually has enormous potential of realizing the very goals that people find important (Blancke, Van Breusegem, De Jaeger, Braeckman, Van Montagu, 2015, in press)³.

Moreover, in modern society, emotions do not only detect and respond to illusory risks. Some technologies bear so few resemblances to threats common in the ancestral environment that emotions completely fail to notice the risks involved (Loewenstein et al. 2001). Many people are deeply concerned about nuclear energy, which is relatively safe, but are not the least worried about the impact of charcoal plants, which in fact costs thousands of lives annually (Brand 2009, 81). Hence, the complexity of modern times appears to confuse our evolved emotions, leading them to churn both false positives *and* false negatives. As such, it becomes clear that emotions do not constitute a very trustworthy basis on which one can develop a policy that adequately meets the environmental and social challenges that humanity has to deal with.

3. This does not entail that any concern about GMOs is necessarily emotionally driven and/or unsubstantiated. Some applications might have some disadvantages (as do products of conventional breeding), but that needs to be assessed on a case-to-case basis. However, emotions appear to blind people for these important distinctions, leading them to reject GMOs as a whole on the basis of unfounded arguments.

4. CONCLUSIONS

Emotions undeniably affect people's risk assessment, but the question is whether that is a good thing or not. Scientists working in the field of heuristics and biases seem to be quite skeptical about the impact of emotions, because emotions tend to lead people to prefer irrational outcomes. Some philosophers such as Roeser and Kahan however think that emotions are rational, at least to a certain extent, and should be taken into consideration when building policy and in science education and communication. Based on the evolutionary analysis above, and for reasons explained earlier, one can perfectly agree with the latter conclusion, but not with the former. Because of their evolutionary history, emotions are simply not well equipped to deal with complex and difficult tasks such as assessing the risks of modern technologies. Hence, it is better not to trust them as guides to develop policy. We might end up taking decisions that have the opposite effect of what we are trying to achieve.

Besides communication and education, there is at least one more way in which we can take emotions seriously. If emotions have such a great effect on the way people respond to technologies, we can appeal to those emotions to make technologies more attractive (Evans 2010 a). Studies suggest, for instance, that emphasizing the benefits helps people to accept technologies that otherwise would induce public opposition. This might sound as cold manipulation of the masses, but in the light of the goods that technologies deliver and given sufficient transparency, such paternalism might be called for to balance the inescapable impact of emotions.

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