

Psychology of Emotions, Motivations and Actions Series

Psychology of Risk Perception

Joana G. Lavino
Rasmus B. Neumann
Editors



NOVA

Chapter 6

THE SPIDER AND THE WEB: EMOTIONS, EVOLUTION AND THE ETHICS OF TECHNOLOGICAL RISK¹

Mark Coeckelbergh

University of Twente, Enschede, Netherlands

ABSTRACT

Evolutionary biology shows that organisms have many traits that developed by natural selection as adaptations to their environment. The so-called ‘mismatch theory’ holds that if the environment changes faster than the ability of the organism to adapt and evolve, it finds itself mismatched to its environment. Studies in evolutionary psychology suggest that this is the case with many human emotional responses. In this essay I explore the implications of these studies for ethics of technological risk, paying particular attention to risks related to the World Wide Web. Connecting insights from evolutionary psychology with (other) emotion theory and psychology of risk perception, I discuss the tension between the task of improving learning processes concerning present technological risks and the task of changing our social-technological environments guided by ethical considerations. I conclude that both tasks should be informed by the growing body of knowledge about the relation between our evolved emotional make-up and the way we live our lives. However, it is up to us to decide to what extent and how we take our evolutionary past into account in our attempts to reshape our environment and ourselves.

INTRODUCTION

Risk studies have moved away from simplistic understandings of the relation between risk experts and lay people such as ‘All we have to do is tell them the numbers’ (Fischhoff 1995, 138) and have come to recognize that in risk perception there is a complex interplay between

¹ An earlier version of this paper was presented at the *Philosopher's Rally* conference, University of Twente, May 2009.

emotions and rationality (Slovic et al 2004; Slovic and Peters 2006). However, the dominant view among scientists is still that experts have a correct, rational view of technological risks whereas lay people tend to respond emotionally to these risks and therefore often 'get it wrong'. On this view, ethics of technological risk should involve lay people but is mainly a matter of expert judgment and risk communication.

This view seems to be reinforced by evolutionary explanations of emotions. Evolutionary science suggests that many of our emotional responses to risk are ill adapted to contemporary socio-technological environments. Therefore, it seems, experts should communicate to lay people what the real risks are as opposed to the emotional perception of these risks. If their evolved emotional capacities do not allow them to adapt to contemporary environments, we should help lay people adapt by encouraging that they base their actions and decisions on (risk) science rather than feeling.

Is this the best way of conceiving of the expert's task with regard to emotional responses to risk? And does this line of argument correspond to the best current understanding we have of evolutionary psychology and risk psychology? In this paper, I will discuss the implications of evolutionary explanations of emotions for studies of risk perception and for ethics of technological risk. Connecting studies in evolutionary psychology with (other) emotion theory and with psychology of risk perception, I will argue that while we must support and promote learning processes concerning present technological risks using the knowledge gained in risk studies, we also face the task of changing our social-technological environments. This must be guided by ethical considerations and informed by risk studies that take on board insights from evolutionary science.

First I will summarize the framework developed by evolutionary psychology that offers evolutionary explanations of emotions. I give the example of fear. Then I will explore how this framework can help us to understand emotional responses to technological risk. This will lead me to discussions about emotions and rationality in emotion theory (philosophy) and risk perception research (psychology). Taking into account these insights, I then suggest ways in which risk ethics can engage with evolutionary psychology without waiving its normative task.

Whereas much work in risk ethics is directed towards 'off-line' technologies and environments, I will pay particular attention to risks related to the World Wide Web, an environment in which many of us spend a considerable amount of time.

EVOLUTIONARY PSYCHOLOGY OF EMOTIONS

Evolutionary biology shows that organisms have many traits that developed by natural selection as adaptations to their environment. Random variations occur and there is a natural selection of the variants best suited to the environment: in a given environment, some variants are more likely to survive and reproduce. However, environments change. The so-called 'mismatch theory' holds that if the environment changes faster than the ability of the organism to adapt and evolve, it finds itself mismatched to its environment.

Studies in evolutionary psychology suggest that this is the case with many human emotional responses. Evolutionary psychology defines itself as an interdisciplinary field that applies adaptationist thinking to psychology (Nesse 1990, 1998; Tooby and Cosmides 1990;

Haselton and Ketelaar 2006). It explains human emotions as adaptations: they are shaped by natural selection. They adjusted the organism in ways that increased fitness in specific situations (Nesse 1990) and maximized reproductive success (Nesse 1998, 413) in the evolutionary past. Since emotions evolved in response to repeating elements of past environments, there are causal links between past conditions and present biological 'design' (Tooby and Cosmides 1990) and we can understand them as 'condensed records of enduring conditions' (Tooby and Cosmides 1990, 390) and 'recurring situations' (407) in the past.

Given this view of emotions that do things or get things done (or are instruments for these purposes), an analogy has been made between emotions and software: they have been compared with computer programs (Nesse 1990), information processing mechanisms (Tooby and Cosmides 1990, 417) and programs (Cosmides and Tooby 2000, 99), and algorithms (Nesse 1998, 413). They can also be seen as coordinators of other programs and cognitive components such as goals, memory, physiology, etc. (Cosmides and Tooby 2000).

To support their case, evolutionary psychologists study correspondences between specific emotions and specific situations. For instance, Nesse has studied various subtypes of fear and their corresponding situations (Nesse 1990). The pairs of emotions and situations they list can be interpreted as good matches: in a past environment and in specific situations, the emotion fitted the corresponding environment or risk. For instance, panic is adapted to situations of imminent attack by a predator or human, social anxiety fits a situation of threats to status or group membership, phobia of small animals suits situations when there are such animals around, and fear of blood is adapted to situations when one is wounded (Nesse 1990, 271). When such situation recurred, humans who – by chance – developed these emotions had more chance to survive and reproduce; hence, these genes were passed on to us, contemporary humans. Thus, emotions such as fear are useful in certain situations and entirely normal in certain environments. Of course pathological excesses may happen, but generally speaking emotions give advantages in certain situations: advantages to the individual organism (survival) and advantages to the genes, which get passed on to the next generations (reproduction). For instance, panic in response to a predator in a natural environment is very useful in that situation and in that environment.

However, at any given time² (this can happen now and it has happened in the past) there may occur a gap between a past situation in which the emotion was adaptive and a current situation in which the emotion is no longer adaptive. To the extent that we frame present situations in terms of the evolutionary past, there is a mismatch between the emotion and the situation. A typical example of such a mismatch is fear of spiders and fear of snakes. While these fear responses are fine adaptations to certain situations in an ancestral environment (or some contemporary environments) and are therefore easy to condition, they are useless in most contemporary urban environments. Fear of cars in city traffic, by contrast, is much harder to condition, since such situations and environments were not available to us in the past. Thus, evolutionary psychology does make sense of an 'otherwise puzzling array of fear responses'. It is worth further exploring its heuristic value in the field of technological risk.

² It is incorrect to say that the emotion was adaptive in a particular historical period. The so-called 'environment of evolutionary adaptedness' (EEA) is a statistical composite, not a specific time or place (Tooby and Cosmides 1990, 386; Cosmides and Tooby 2000, 97). In each period of time there will be situations in which a particular emotional response is adaptive and situations in which it is not.

EMOTIONS, EVOLUTION AND TECHNOLOGICAL RISK

The evolutionary view of risk suggests that some of our emotional responses are ill suited to risks in contemporary socio-technological environments. Technology and society as we know it is only a recent development. While of course humans have always used tools and lived together with other humans, human culture has never seen anything like the large-scale urban architectures, mobility infrastructures, technologies of mass production and information technologies of today. We created real and virtual environments and novel situations that are very different from those that were present 1000, 5000 or 10000 years ago – time spans which count as nearly nothing in the light of the time it takes organisms to evolve. This necessarily implies that many of our ‘pre-programmed’ emotional responses – or rather: our evolved capacities for easy conditioning of these responses – are obsolete. It also appears to imply that evolutionary psychology is not of much help as far as technological risk is concerned. What needs to be done, it seems, is to teach people how to adapt to the novel environments (communicate about technological risk), which is unfortunately a slow learning process compared to easy conditioning of spider fear type responses.

However, not all our emotional and cognitive capacities are spider fear type emotions or are all fully explicable in terms of evolution. If this were so, we would be completely lost in contemporary environments since we would have no capacity to learn about technological risk or to evaluate our emotional responses to risk. Luckily for us, we have developed emotional responses that go beyond spider fear type emotions. In order to fully understand these responses, we need to draw on other theories about emotions and on studies in psychology of risk perception. Let me discuss some results of these theories and studies in relation to emotions as adaptations.

EMOTIONS AND RISK PERCEPTION

There is little doubt that emotions play a role in risk perception (Slovic et al 2004). But what is the nature of these emotions? When I say that some emotional responses go ‘beyond’ spider fear type emotions, what do I mean? A term we can use to describe this ‘beyond’ is cognition: emotions about technological risk are often cognitive or involve a certain type of cognitive processing that goes beyond, or is opposed to, the emotional process involved in fear of spiders. But this formulation leaves still too much open. How different in kind are these two emotions or emotional processes, if they are different at all? And how are the two related (if at all)? An answer to these questions depends on your view of emotions.

In philosophical theory of emotions there is a tension between, on the one hand, the view that emotions are bodily feelings (James 1884, 1890) or gut reactions (Prinz 2004) and on the other hand, the view that emotions are themselves cognitions (de Sousa 1987; Solomon 2003) – a view which been applied to risk emotions (Roeser 2006). This divide appears to roughly correspond to the opposition between the view that emotions are irrational and the view that emotions are (or can be) rational – an issue which I already mentioned in my introduction. But do we have to choose between these opposite poles?

In psychology of risk perception there is a theory which might be interpreted as an elegant solution to these problems (the problems regarding the nature of emotions and the

rationality of emotions) and which at the same time allows for development towards a theory that fully takes into account evolutionary psychology. Paul Slovic and others have argued that there are two ways in which people comprehend risk: the experiential system (risk as feelings) and the analytic system (risk as analysis). The experiential system depends on images and emotions; it is fast, automatic, intuitive and largely unconscious. The analytic system, by contrast, is slow and conscious and uses algorithms and rules, e.g. formal logic and risk assessment. The authors argue that both systems have advantages and disadvantages, that there is an interplay between the two, between emotions and rationality, and even that both systems depend on one another (Slovic et al 2004). On this view, emotions are not cognitive (as cognitivists argue), they are on the side of (bodily) experience, but they are still understood as necessary for us to comprehend risk and therefore they are not irrational. Moreover, this view has the advantage of being able to accommodate evolutionary science. The experiential system is seen by Slovic and others in evolutionary terms. This is their argument for saying that there is also rationality in the experiential system:

It was the experiential system, after all, that enabled human beings to survive during their long period of evolution. Long before there was probability theory, risk assessment, and decision analysis, there were intuition, instinct, and gut feeling to tell us whether an animal was safe to approach or the water was safe to drink. As life became more complex and humans gained more control over their environment, analytic tools were invented to “boost” the rationality of our experiential thinking. Subsequently, analytic thinking was placed on a pedestal and portrayed as the epitome of rationality. Affect and emotions were seen as interfering with reason. (Slovic et al 2004, 313)

However, this argument is rather speculative compared to what evolutionary psychology has to offer. Slovic’s story is based on neo-Freudian psychology which presupposes the existence of something called ‘the cognitive unconscious’ (Epstein 1994). And for his claim that emotion and reason work together, Slovic refers to neurology (Damasio 1994). But this work would benefit from engagement with adaptationist evolutionary psychology, which explains why emotions appear irrational (perhaps *are* irrational) in a contemporary context: we call them ‘irrational’ if there is a mismatch between emotion and situation (Haselton and Ketelaar 2006). And since there often are mismatches in the case of technological risk, this can explain why the experiential system often gets it wrong. Slovic’s explanation suggests that it must be a lack of reason which does not ‘temper’ the emotions. From an adaptationist evolutionary perspective, we may add that sometimes it is not so much a lack of reason but rather a mismatch between the emotion as adaptation and the specific situation. It is not the strength of the emotion that is problematic but the kind of emotion, the type of emotional response.

This also shows another weakness in Slovic’s account: while being much more appreciative of emotion than the ‘tell them the numbers’ view, it remains dualist as far as the relation between reason and emotion is concerned. There are still two systems, albeit related. The advantage of a straightforward evolutionary view of emotions is that it overcomes dualism without becoming (a strong version of) cognitivism, according to which emotions are beliefs or actions. It gives emotions a cognitive role, but it does not neglect the bodily feelings that go with it. For instance, the emotion is seen as steering physiology. Thus, emotion is not seen as belonging to a different system, but as being part of the same cognitive-emotional

system that has an evolutionary origin. Even Slovic's analytic system has such an origin: the rationality 'boost' he talks about has come about by way of natural selection.

Thus, here we have a plausible view of the origin of our emotional capacities which, combined with insights from emotion theory and psychology of risk perception, enhances our understanding of emotions – including emotional responses to technological risk. The latter are not always of the spider fear type; they might involve 'higher' cognitive processing – without necessarily being 'analytic' in Slovic sense. We can expect a whole spectrum of emotional responses to lie between spider fear and risk assessment. All of them rely on 'sub-programs' that have evolved. But which emotional response one is right for whom in which situation and environment?

ETHICS OF TECHNOLOGICAL RISK

Many responses to technological risk do not only involve cognitive processing, they involve cognitive processing of a certain type: arguments that involve normative considerations and that aim at evaluating technological risks and our emotional responses to them.

Certainly, evolutionary psychology (among other sciences: neurology, cognitive science, etc.) is helpful to understand the mind-body architectures that are involved when we engage in ethical reasoning and I have shown that they aid our understanding of some emotional responses to technological risk. Such understanding is badly needed when we try to educate both experts and lay people about how to cope with technological risk. On the one hand, experts may become more patient when confronted with 'irrational' emotions if they can track down these emotions to aspects of our evolved emotional make-up. Moreover, they might come to view their *own* over-reliance on 'facts and figures' as at least as one-sided and as having as much its origins in evolution as the emotional responses they question. On the other hand, both lay people and experts may gain more control over their emotions if they rationally accept that some emotional responses are not adapted to the situation and the environment they are concerned with. However, with regard to the task of ethics, these explanations offered by evolutionary psychology are not enough. Let me explain.

First, it is thanks to cognitive processes that go beyond the programs that evolution and natural selection have provided us with that we are able to adapt to contemporary environments and situations. Thus, in order to understand how we adapt or could adapt to given environments and situations, we also need knowledge of learning processes such as nurturing and education. These are slow processes, require hard work, and depend on social and cultural context. Of course in such processes we use our evolved brain and our evolved basic emotional and other capacities, but these are our tools, our instruments. Compare it with using computer software: what matters to us most of the time, as a user, is what we do with the software, not the software itself. I need not care much about the *origin* of the software in order to work with it. What really matters to us is the aim we use it for: our intentions, plans, hopes, and dreams. When we write we use a word processor, but we understand ourselves as doing writing, not just as software that is processing words. The relation between the sciences and human cultural self-understanding has a similar structure. The sciences can help us to understand our emotional capacities. But when we fear a particular technology, for instance, what matters to us is what we think about the technology, what we feel about it, and so on –

regardless of the origin of our capacity to feel something particular when faced with a certain situation. What matters to our self-understanding are the stories we tell about ourselves. The origin of something (for instance, the evolutionary origin of emotions) is only one of the stories we can tell. Understanding experience of risk (including technological risk) can never be reached by running a story about origins alone. Again, our narrative capacities may be themselves adaptations (perhaps adaptations to more complex social environments where group identity became more prominent), but this is not the only and not the most prominent question with regard to human self-understanding.

Second, understanding (of risk and self-understanding) is not enough. In the first place, it is not enough if understanding is understood as a descriptive task alone, since description has always a normative dimension. When we are concerned with risk perception, we (experts, lay people, philosophers) are not entirely disengaged scientists who look upon the world from a 'point of nowhere', as gods or aliens who take an interest in the human species and wish to understand it from an external point of view. Technological risk is of concern to all of us as we are engaged in practices that involve risk. We are always stakeholders. This influences the way we describe risk. Second, one of the things we do is *evaluating* risk, not just describing it or trying to understand it. We evaluate technologies and what they do with our lives. Academic risk studies and academic ethics of technology do this in a systematic way, but these activities are part of how we exist as humans: although we cannot judge from a point of nowhere, we are able to take distance from what we do, from how we live together and from how we shape our environment. In other words, whatever we were before (whatever our origin), we humans are engaged in ethics by nature: we are evaluators and re-designers by nature. (Sometimes we try to do this in a disengaged way and sometimes we try to design the world as if we were gods, but we're not very good in either.) Technology is partly driven by such ethical concerns: they are solutions to situations that we evaluate as deficient and in the course of trying to solve the problem we re-shape the world.

Viewed in this way, our task is not only to better understand technological risk and our emotional responses to risk *in order to become better adapted* to socio-technological environments (this is not an imperative dictated by evolutionary science and is not directly related to slow adaptation during million years of evolution; it is a bare necessity if we are concerned with our immediate survival and well-being). We also face the task to adapt the *environment* and shape *situations*. Technological development, society and ethics are paired here: we try to find out how we best build and change our socio-technological environments. While we cannot and should not design such environments from scratch (this is impossible and trying to do so is very risky and has caused many deaths), we have some freedom to do so. It is up to us to what extent we want to take into account the evolutionary origin of our emotions when taking on both tasks. But it must be given a place in our efforts to understand and evaluate technological risk, our response to technological risk, and ourselves.

AN EXAMPLE: RISK AND THE WORLD WIDE WEB

To end, let me discuss an example in order to explore how we might understand and evaluate technological risk in a way that is informed by evolutionary psychology but goes beyond science into the ethical-technological domain.

Most of us spend a lot of time on the World Wide Web (WWW), a socio-technological environment built on the Internet which has had an enormous influence on how we work, live, and think. As any such environment, it is a risky environment. Dangers include abuse of bank accounts and credit card numbers, violation of privacy, and attacks by a computer virus that can distort, disable or take over our information and communication systems. Of course we try to protect ourselves against these hazards but as in the offline world security measures never wipe out the risk entirely. As a result, some of us may fear this environment and/or certain situations (e.g. paying with a credit card or using a social networking site).

One way to respond to this emotion is to rely on statistics and argue that there is no need for anxiety since with virus scan and fire wall software the chance that something bad happens is relatively low. Another response is to take the emotion seriously and inquire into its origin. Let me first explore an evolutionary-psychological perspective. At first sight, from an evolutionary perspective alone it seems incomprehensible that we are able to 'live' in WWW environment at all: we only know it for 15 to 20 years and most of us have less than 15 years experience with it. There is no way we could ever have developed *any* traits as adaptations to this environment. Thus, we do not have an emotion-as-adaptation available to cope with WWW risks. In order to explain why we are nevertheless able to cope and in order to understand the emotion involved here, we need a two-fold analysis. First, staying within the adaptationist framework we can suggest that although the emotion as a whole is not directly and not fully explicable in evolutionary terms, it draws on (perhaps coordinates) emotional sub-programs that *are* adaptations to particular situations in EEAs (which might happen in ancestral or contemporary environments). For instance, we might want to relate fear of a computer virus to the very functional fear of disease. And surely fear of hacking and privacy violation could be related to fear of other humans; it can be seen as a case of social anxiety. However, we also need another level of analysis. These explanations tell us something about the origin of our emotional apparatus, but they fail to explain the particular emotion.

First, in order to have the specific fear mentioned, we need *knowledge* that can only be attained by nurturing and education. For instance, the first virus was only discovered at the end of the 19th century (after bacteria were discovered), hence fear of viruses has been only around for probably less than a century. Before, people would not recognize the situation as a risk situation and if they did, then they would not recognize it as having to do with a virus. Second, in order to fully understand the fear, we need reference to various (other) beliefs, concerns, commitments, narratives, values, and principles – all elements that depend on personal and cultural context. For example, in order to frame a particular situation as constituting a risk of privacy violation, one needs to live in a culture in which privacy is much valued and the individual needs to endorse this value. Whatever the perspective we use, it will not be enough to refer to evolutionary origins. The architecture of the mind-body may consist of adaptations as building blocks, but to understand what goes on in the architectural space created by these adaptations one needs to tell other stories as well. Moreover, sometimes we disagree about values. Here ethics comes in. Many think privacy is very important, but should it be that important? And suppose that young people value privacy less than older people (suppose that we observe that they are willing to share more personal information), are they right to do so? Of course an argument in this discussion could refer to evolution: it is plausible that some degree of desire for privacy or some degree of desire for social interaction can be explained by means of evolutionary psychology. But this can never *determine* the normative conclusion or the outcome of the normative discussion: it is up to us how much

weight we give to knowledge about the evolutionary past of our traits. For instance, if it turned out that our love of social interaction is an adaptation to a specific situation and environment, this does not tell us if we should encourage the specific kind of (intense) social interaction going on at social network sites in the WWW environment.

This does not render evolutionary psychology irrelevant to ethics. We can use that body of knowledge to better understand existing technological practices and their ethical problems. Moreover, we can also take into account studies in evolutionary psychology when we try to re-shape socio-technological environments such as the WWW. For example, if we found out that the WWW environment promotes forms of interaction that tend to create many situations where there is a mismatch between our (evolved) emotional capacities and the situation, then we might try to change the environment in such a way that avoids continuous mismatches. For instance, it might be that our emotional make-up is neither suited to large urban environments nor to world wide virtual environments with large amounts of information and an enormous number of interactions. If empirical research were to confirm such an hypothesis, we may want to use this information to re-design alternative environments (to the extent that this is possible). However, even if we chose this course, we would want to take into account other concerns, values, and principles that guide our search for better ways of life. Moreover, we will also have to argue why *other* tools to deal with these new environments are not doing their job: there are ways of coping that did not evolve during millions of years but that are the result of much shorter processes in cultural history, upbringing, and education. And if we reject some elements of our tradition and upbringing, most likely because some forms of social engineering result in mismatches between our learned behavioral patterns and the environment (a kind of mismatch different from the mismatch between trait-as-adaptation and environment meant by evolutionary psychology), we have to argue why there are no alternative social-cultural means of adapting to environments or why they cannot be developed.

Finally, I should mention another possibility that emerges on the horizon of scientific and technological change: next to using social-cultural means to adapt to the environment or next to changing the environment, we can now change ourselves. Here I do not mean changing ourselves by education or training. I also do not refer to psychotherapy. These methods of change rank among the tools we already have and use to adapt to the environment. What I have in mind is the possibility to change the genetic make-up of our species, to change human nature, to 'take evolution into our own hands'. One motivation for so-called 'human enhancement' may be to avoid mismatches in the following way: imagine that we adapt emotions and other mind-body traits *immediately* to contemporary situations and environments rather than wait for us (the human species) to evolve. On such a view, adaptation is not something one observes (evolutionary psychology) but a moral imperative: *thou shalt adapt*. Apart from other ethical considerations that can cast doubt on the acceptability and desirability of such a project, someone arguing for what we may call 'adaptionist human enhancement' would have to show that this measure does a better job than evolution. As I said before, evolution takes a long time and the EEA is a statistical composite. This means that it promotes adaptations to situations and features of the environment that are long-lasting and stable. One problem with adaptionist human enhancement – at least if it changes traits in a way that renders them inheritable (if it changes the human genome) – is that we would need to be able to identify a set of recurrent, stable situations and environmental features which we then use as reference points to modify our mind-body

make-up (for instance, our emotions). In other words, we would need to be able to predict the (very) long-term future. If this would prove too difficult and setting aside other ethical objections for the sake of argument, only non-inheritable enhancement would be acceptable. However, I will not further discuss this issue here.

CONCLUSION

In this paper, I have explored the implications of mismatch theory for understanding and evaluating emotional responses to technological risk. I have argued that we face two tasks with regard to technological risk: (1) adapting to socio-technological environments and (2) evaluating and changing these environments. Evolutionary psychology in general, and mismatch theory of emotions in particular, can assist both tasks by (1) contributing to a better understanding of our current adaptation problems (it can show the inadequacy of some of the emotional tools we use to respond to some situations in some environments) and by (2) informing normative reflection on how we want to change our environment and ourselves based on that understanding. However, it remains up to us how we take our evolutionary past into account into our designs of future environments: although possibilities for change are not unlimited, we and the environments we shape and re-shape are always different from those of the past. Of course, that past is fundamental to our self-understanding as a species. Narratives of evolution are one of the stories we have at our disposal to help us to understand ourselves. But our relation to these stories need not be marked by passivity. Part of what we do as human beings is that we continuously re-construct and re-imagine our evolutionary, historical, and personal past. A better self-understanding is one of the benefits evolutionary psychology has to offer. However, what this better understanding implies for ethics of technological risk must necessarily and fortunately remain controversial given the freedom we have as beings who have the capacity to actively perceive, co-shape, evaluate, and respond to technological risk.

REFERENCES

- Cosmides, L. & Tooby, J. (2000). Evolutionary Psychology and the Emotions. In M. Lewis & J.M. Haviland-Jones (Eds.), *Handbook of Emotions*, (2nd edition, 91-115). New York: Guilford.
- Damasio, A. R. (1994). *Descartes' Error: Emotion, Reason, and the Human Brain*. New York: Avon.
- de Sousa, R. (1987). *The Rationality of Emotion*. Cambridge, MA/London: MIT Press
- Epstein, S. (1994). Integration of the cognitive and the psychodynamic unconscious. *American Psychologist*, 49, 709-724.
- Fischhoff, B. (1995). Risk Perception and Communication Unplugged. *Risk Analysis*, 15(2), 137-145.
- Haselton, M. G. & Ketelaar, T. (2006). Irrational emotions or emotional wisdom? The evolutionary psychology of emotions and behavior. In J. P. Forgas, (Ed.), *Hearts and*

- minds: Affective influences on social cognition and behavior*, (21-40). New York: Psychology Press.
- James, W. (1884). 'What is an Emotion?' *Mind*, 9, 188-205.
- James, W. (1890). *The Principles of Psychology Vol. II*. Cambridge, MA/London: Harvard University Press, 1981.
- Nesse, R. M. (1990). Evolutionary explanations of emotions. *Human Nature*, 1(3), 261-289.
- Nesse, R. M. (1998). Emotional disorders in evolutionary perspective. *British Journal of Medical Psychology*, 71, 397-415.
- Prinz, J. (2004). *Gut Reactions: A Perceptual Theory of Emotion*. New York: Oxford University Press.
- Roeser, S. (2006). The Role of Emotions in Judging the Moral Acceptability of Risks. *Safety Science*, 44(8), October, 2006, 689-700.
- 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(2), 311-322.
- Slovic, P. & Peters L. (2006). Risk Perception and Affect. *Current Directions in Psychological Science*, 15(6), 322-325.
- Solomon, R. C. (2003). *Not Passion's Slave: Emotions and Choice* Oxford: Oxford University Press.
- Tooby, J. & Cosmides, L. (1990). The past explains the present. Emotional adaptations and the structure of ancestral environments. *Ethology and Sociobiology*, 11, 375-424.