When emotions improve reasoning: The possible roles of relevance and utility

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Abstract

New paradigms in the psychology of reasoning have included a consideration for general contextual factors that may impact on the reasoning process, including individuals’ goals and motivations. We suggest that emotions are one such important contextual factor that influences reasoning. The classic literature on thinking and reasoning has typically ignored the possible influence of emotion, except to consider it a source of disruption. We review findings from studies where participants were asked to reason about personally-relevant emotional experiences such as sexual abuse, war, and terrorist attacks. While some findings are consistent with the view that incidental emotions have a deleterious effect on reasoning, a number of findings also suggest a beneficial impact of emotion. For instance veterans reasoned more logically about combat-related syllogisms than structurally identical syllogisms with neutral contents; victims of sexual abuse reporting more negative emotions following the events also reasoned more logically on abuse-related contents, relative to neutral contents. This may be associated with integral emotions, when the affective reaction is relevant to the semantic contents reasoned about. We propose that the positive impact of integral emotions on reasoning can be explained by increased utility of problem content and increased utility of reasoning.
When emotions improve reasoning: The possible roles of relevance and utility

The psychology of reasoning, which examines the cognitive processes underlying rational thinking, has been the object of a major theoretical shift in recent years (Chater & Oaksford, 2001). While reasoning has traditionally been confined to the realm of logic (e.g., Braine et al., 1995), recent data suggest that reasoning should be modelled in a way that integrates a range of contextual factors in addition to, and sometimes rather than, logic (Evans, 2002). The present review focuses on the contribution to this debate of studies that have investigated the impact of emotion on reasoning. While there are only few such studies, we show that their results are compatible with ‘utility’ models that have placed people’s perception of content utility and their motivation at the centre of the reasoning process.

For a long time, reasoning was assessed as a function of logical deduction: people’s degree of rationality was defined as the extent to which they could resolve deductive reasoning problems where conclusions follow premises according to the rules classical of logic (e.g., Braine et al., 1995). According to traditional models, the normative standard for reasoning is drawn directly from mathematics. Thus, when a proposition “p” is assumed to be true, the probability that a proposition “q” is true is necessarily 100% given the logical relation that q validly follows from p. Any suggestion that q is not true does not follow the rules of logic and is not rational. Errors in logical deduction are explained by the fact that, due to insufficient cognitive capacity, incorrect rules are applied or intermediate steps are missed in the reasoning process (Johnson-Laird, Byrne, & Schaeken, 1992).

Within this framework, findings that negative emotional contents decrease logicality in deductive reasoning (Blanchette & Leese, 2011; Blanchette & Richards, 2004; Blanchette, 2006) come as no surprise. Specifically, a number of experimental studies have documented that reasoning about emotional contents and reasoning while in emotional states result in less normatively (or logically) correct reasoning. Some experiments have compared emotional and neutral reasoning using evaluative conditioning to manipulate the emotional value of the reasoning contents, other experiments have experimentally induced affective and neutral states. Both syllogistic and conditional reasoning have been shown to be negatively impacted by emotional contents. These findings can be explained in terms of reduced cognitive capacity, since emotion has been shown to have a negative impact on the availability of cognitive resources (e.g., Channon & Baker, 1994; Darke, 1988; Derakshan & Eysenck, 1998; Kensinger & Corkin, 2003), and anxious or stressful states can reduce the efficacy of cognitive functioning (e.g., Lieberman et al., 2005). This is consistent with the traditional model, accounting for departures from normative logic in human reasoning by limitations in available cognitive resources. Indeed there is evidence providing some
support for the view that at least negative emotional states affect reasoning through reducing available working memory resources (Oaksford, Morris, Grainger, & Williams, 1996).

More difficult to explain by traditional models, however, are recent findings showing that negative emotional contents can also improve reasoning performance (Blanchette & Campbell, 2012; Blanchette, Lindsay, & Davies, 2008; Blanchette, Richards, Melnyk, & Lavda, 2007; Johnson-Laird, Mancini & Gangemi, 2006). These findings were obtained when participants who experienced intense emotional events (i.e., sexual abuse, terrorism, or war) reasoned about emotional material semantically linked to their experiences. In the next section we present the theoretical rationale for these studies, centred on the issue of relevance, as well as the basic methodology and findings.

**Empirical Studies of Integral Emotion and Reasoning**

In one line of studies we have started investigating reasoning about personally experienced emotional events. The motivation for this line of studies was to explore whether the experimental findings evoked previously, showing deleterious effects of emotion on deductive reasoning, would extend to more intense levels of emotion. Experimental studies are essential because they allow the experimental control necessary to investigate the causal role of emotion. However, for obvious ethical reasons, it is impossible to experimentally induce high levels of emotion in the laboratory. This leaves open the question of whether the same effects would be observed when individuals reason about topics that generate more intense emotional reactions.

Blanchette and colleagues have conducted a number of studies comparing how groups of participants who have undergone a common and highly emotional (potentially traumatic) set of events reason about contents related to these events, other emotional topics, and neutral topics. They have examined reasoning in war veterans, victims of sexual abuse, and participants involved in terrorist attacks. In these cases, in addition to intensity, emotional topics that are reasoned about are also relevant. In the laboratory, experimental procedures typically induce incidental affective reactions, namely, emotional states that are unrelated to the semantic contents being reasoned about. Outside the laboratory, participants reasoning about emotional contents are experiencing affective states that are intrinsically linked to the contents being reasoned about. The effect of these “integral emotions” (Blanchette & Richards, 2010) had until recently not been examined. Thus by looking at how individuals reason about emotional contents outside the laboratory, we can examine more intense and more integral emotions.

Integral emotions are closely tied to the notion of relevance, which is important across a range of emotion theories. Appraisal theories of emotions, which propose that emotions result from an evaluation of the environmental situation and the individual’s
ability to cope with it, suggest that relevance is the first dimension along which situations are assessed (Mulligan & Scherer, 2012). If a situation is relevant to the person’s integrity, goals, core beliefs or identity, then it may evoke an emotion. Biological theories of emotion, including basic emotion theories, also grant relevance a central role. In biological theories relevance is assessed in terms of survival, but it is also thought to be a necessary condition to evoke an emotion (LeDoux, 2012; Panksepp, 1998). Thus, social and biological approaches to emotion both grant a central role to relevance in defining what constitutes an emotion.

The basic methodology used to investigate the impact of these relevant, integral emotions has thus been to examine reasoning in groups of participants who have undergone a common emotional event or sets of events. Blanchette and colleagues have constructed reasoning problems with neutral contents, generally emotional contents (usually negative) and emotional contents specifically related to the potential trauma. For instance, victims of sexual abuse were asked to reason about neutral contents (e.g. If a person has a driving license…), generally emotional contents (e.g. If a child has leukaemia…), and trauma-related contents (e.g. If a woman is raped…). In some studies they have focused on logicality as an outcome measure, in others they have measured the relative impact of heuristic and analytic processes.

**Logicality in Reasoning**

In one such study, Blanchette and Campbell (2012) examined the reasoning of 30 British veterans. They asked them to reason about categorical syllogisms that were neutral, generally emotional, or related to combat. Despite the fact that syllogisms were identical in structure, veterans provided more logically valid responses to combat-related contents (e.g. Some chemical weapons are used in wars. All things used in wars are dangerous. Some chemical weapons are dangerous) than to neutral contents (e.g. Some teas are natural substances. All natural substances are innocuous. Some teas are innocuous). Responses to the generally emotional syllogisms were in between and did not significantly differ from either combat or neutral syllogisms. This finding is at odds with previous findings of decreased performance with generally emotional content, compared to neutral content. It is possible however that emotional material used in this study may have been personally relevant (e.g. Some cancers are hereditary), especially to war veterans of a certain age. The more central finding however was that veterans reasoned more logically, not less, when reasoning about intense and personally relevant emotional combat-related contents. This finding is contrary to what is typically found in laboratory studies examining incidental emotions. Additional findings suggest that this result is not simply an artefact of familiarity or beliefs. The advantage in reasoning about combat-related contents was actually negatively linked with objective level of expertise, which was estimated using a standardised questionnaire where veterans report the nature
and duration of their combat-related experiences. There was also no difference in the believability of conclusions across content types, suggesting that belief bias did not account for the findings. Overall, this study provided evidence that emotion does not necessarily lead to impaired logicality.

Other findings from that study, however, are also consistent with the typical view of emotion as a cognitive strain. Blanchette & Campbell (2012) compared 16 veterans who suffered from Post-Traumatic Stress Disorder (PTSD) and 14 veterans who did not. Veterans suffering from PTSD were less likely to provide logically accurate responses across content types. This finding is in line with a relatively large literature suggesting that PTSD is associated with a number of cognitive deficits, including alterations in executive function and working memory (Buckley, Blanchard, & Neill, 2000). This would lead to an expectation that PTSD may negatively impact reasoning, and it is indeed what was found in the study on reasoning in veterans (Blanchette & Campbell, 2012). Importantly, despite the overall difference, both participants with and without PTSD showed increased logicality in reasoning about combat-related contents.

In subsequent studies, Blanchette and colleagues examined reasoning in women victim of sexual abuse compared to age-, gender-, and education-matched control groups. In a first study, they examined conditional reasoning (i.e. If p, then q) in a sample of 143 women including 72 reporting experiences of sexual abuse (Blanchette, Lindsay, & Davies, 2013). They used an inference verification task where participants had to indicate whether a number of valid and invalid inferences logically followed from the premises or not. Because participants in the victim group reported a very wide range of experiences, the researchers were particularly interested in examining the link between reasoning about contents related to sexual abuse and the emotional consequences of these experiences. They used a questionnaire termed the Impact of Event Scale (Brunet, St-Hilaire, Jehel, & King, 2003) that assesses the level of emotional distress related to the experiences reported. Scores on the IES were positively related to logicality in reasoning about sexual abuse contents after partialling out neutral reasoning responses. In other words, victims who reported more negative emotions (psychological distress) as a result of their experiences tended to be more accurate in reasoning about sexual abuse contents, compared to neutral contents.

In the same study, Blanchette and colleagues (2013) observed some differences between controls and victims of sexual abuse that were consistent with the literature on trauma-exposure, PTSD and cognitive function. On neutral problems, victims were less

Note that this measure is not related to PTSD symptoms, so it is not related to psychological distress. In other words, there does not seem to be a direct link between the “objective” level or intensity of experiences and psychological distress or emotional intensity.
likely than controls to provide normatively correct answers. The negative impact of trauma-exposure on neutral reasoning is consistent with the literature referred to previously, suggesting a link between trauma-exposure and deleterious effects on cognitive function. Of particular relevance are studies documenting a link between stressful life events and reduced working memory capacity (El-Hage, Gaillard, Isingrini, & Belzung, 2006; Klein & Boals, 2001; Stein, Kennedy, & Twamley, 2002).

In a different recent study we examined reasoning in victims of sexual abuse and controls using categorical syllogisms (Caparos & Blanchette, 2013). One of the reasons we conducted this second study was to further investigate generic reasoning abilities, using stimuli that are completely devoid of any semantic content. Thus, we included a category of abstract stimuli (e.g. All & are *, Some * are £. Therefore some £ are &). We also included syllogisms using the exact same structures with neutral, generally emotional, and neutral contents. In this study we compared 24 victims of sexual abuse to 36 control women who did not report such abuse. We used performance on the abstract problems as a measure of generic abstract reasoning ability. When controlling for generic reasoning, victims performed better than controls on the sexual abuse contents. Consistent with previous studies, there were differences between the groups in generic reasoning. Victims showed impaired performance relative to controls on all problem types except problems related to sexual abuse. The significantly decreased logicality in reasoning about abstract stimuli is consistent with the possibility of deficits in generic decontextualized abstract reasoning ability. This disadvantage was observed for semantically rich stimuli including neutral and generally emotional, contents, but not for abuse related contents.

Together the results of these three studies provide evidence consistent with a dual impact of highly emotional events on reasoning. Part of our results are consistent with the neuropsychological literature on trauma, PTSD, and stress, showing deleterious effects of emotion on cognitive resources and higher level cognitive function, particularly on neutral or abstract stimuli. The findings of impairments in victims compared to controls are not necessarily illustrative of purely long term stable impacts but may instead illustrate an effect of incidental emotion akin to what has been observed in previous experimental studies of emotion and reasoning. Reading the trauma-related materials may induce negative emotions in victims (and veterans groups), more than in control groups. These emotional reactions are incidental, when it comes to reasoning about neutral stimuli (presented in a random order, before or after). Thus, the decreased performance on neutral contents by victims could result from the incidental negative emotions evoked by the other materials presented in the study. Altogether the findings of impairments as a result of emotion or trauma are consistent with classic models of reasoning that could account for increased errors on reasoning task as a function of
limitations in processing capacity. However, the second set of results, more counterintuitive, suggests improved reasoning about trauma-related emotional content.

We argue that the beneficial effect of trauma exposure on reasoning about semantically related contents may be a function of relevance. While most previous experimental studies have indexed the effect of incidental emotions, we suggest that the studies presented here index the effect of integral emotional reactions on reasoning. When victims of sexual abuse are reasoning about abuse-related contents, or when veterans are reasoning about combat-related materials, their emotional reactions are caused by the content of what they are reasoning about (in light of their personal experiences) and thus affect and semantics are intrinsically linked. The emotional reaction meets the basic function proposed by emotion theories, which is to indicate relevance, signalling that they are reasoning about something that is likely to have an impact on their own well-being. This, we suggest, is the important feature that is modulating the impact of emotion on reasoning, producing effects that are opposite from those observed in experimental studies of incidental emotions.

**Heuristic vs. Analytic processing**

The studies presented in the previous section focused on examining logicality as the outcome measure to try to delineate the possible effect of emotion on reasoning. We started with logicality because this is arguably the one aspect on which emotion should not have an impact. The logical validity of arguments is determined by their structure, excluding the possibility that emotion should have an impact on their validity. If emotion has an impact even on dimensions of reasoning on which it should not, then this might be true a fortiori for other aspects of reasoning, where semantics, goals, and beliefs might play a role.

New paradigms in the psychology of reasoning have moved away from using logicality as a dependent measure towards using various outcome measures that may correspond more closely to the way reasoning is used in everyday situations. One such important dimension is the relative impact of beliefs on reasoning. Blanchette and colleagues have investigated the impact of emotions on the balance between heuristic (belief-based) and analytic (logical validity) processes (Blanchette, Richards, Melnyk, & Lavda, 2007), using the belief bias paradigm. In one study, they tested participants who were more or less closely affected by a highly emotional, potentially shocking event: the London terrorist attacks of 2005. They tested 73 participants shortly after the attacks, comparing 28 participants who were in London at the time of the events (and very close to where one of the coordinated attacks took place), 29 participants who were in Manchester UK, and 16 participants who were in Canada. The researchers presented categorical syllogisms with three different types of contents: neutral, generally
emotional, and related to terrorism. Problem conclusions were logically valid or not, believable or not. Common sense would suggest that participants who are more emotional would be influenced by beliefs, stereotypes (e.g. All Muslims are terrorists…) to a greater extent than participants who were less emotionally affected. Actually, results from this study showed the opposite. In the first week following the events, participants in London UK did report higher levels of emotions than participants in Canada. However, they were less influenced by the believability of conclusions than participants in Canada, specifically for contents related to terrorism. This was not the case for other content types, suggesting an effect specific to personally relevant emotional contents. Thus, participants in London were better able to rely on logic and inhibit the influence of stereotypes related to terrorism than participants who were not as closely involved in the events. Of course the differences observed between Canadians and Londoners could result from cultural idiosyncrasies. However results from participants tested in Manchester, UK, argue against this possibility. When tested shortly after the attacks, Mancunians reported similar levels of emotion as Londoners and showed the same reduced effect of stereotypes on terrorism-related problems. When tested six months later, Mancunians reported reduced emotional reactions while Londoners reported no decrease of emotions related to the attacks. Simultaneously, Londoners still showed the same reduced heuristic processing of terrorism-related contents, while Mancunians reasoned, six months later, like Canadians. This shows an interesting association between reported levels of emotion and increased analytic and decreased heuristic processing, for emotion-relevant contents, and suggests that the effects are probably at least not entirely due to cultural differences.

Here again we suggest that relevance may be key in interpreting these findings. In this study on the London terrorist attacks (Blanchette et al., 2007), when participants in London and Manchester are reasoning about terrorism shortly after the attacks, their emotional reactions to the stimuli are indicative of the fact that they are reasoning about a very consequential topic. It may be that cognitive resources are mobilized to a greater extent, heuristic processes inhibited, as participants feel they are in a context where reasoning about these problems has important consequences, for example in terms of the relations between groups in the community. Thus, the emotional consequences are proportional to the significance or relevance of the topic, for individuals living in the affected society. Relying on quick, automatic, and stereotypic thinking in those cases may be willfully avoided, and this may result in increased analytic processing and reduced belief-bias in syllogistic reasoning.

**Reasoning, Emotion, Relevance, and Utility**

The dual impact of emotion on reasoning cannot be entirely explained by traditional models of reasoning. While the deleterious effects of incidental emotions and
trauma on logical or abstract reasoning can be explained in terms of cognitive resources, the beneficial impact of trauma on logicality cannot. Instead, it might be possible to explain this beneficial impact in terms of recently proposed utility theories. These theories suggest that contextual factors which increase utility of problem content and of problem solving can result in facilitated deductive abilities. Utility is understood here to predict goal achievement such that any event or action which allows an agent to reach his/her goal has a higher utility (Bonnefon, 2009). We suggest that utility, in its different forms, is intrinsically linked to relevance, which is a defining feature of reasoning about integral emotions. There is a notion that positive emotions signal progress towards a goal, while negative emotions generally signal goal achievement is hindered (Ellsworth & Scherer, 2003). Globally, emotions can be thought to signal relevance in terms of the person’s progress towards goals, and in this sense, emotions are linked to utility.

Content Utility

Content utility in a reasoning problem refers to the desirability for an action to be performed given the situation described in the problem. Studies have shown that irrelevant contextual information can affect content utility (Bonnefon, 2009). Higher content utility results in a stronger belief in the logical connection between the propositions of the problem and, following from this, in better logical deduction for some inferences (Oaksford & Chater, 2009). For instance, the support for a Modus Tollens conditional inference (i.e., “if p, then q; q is not true; therefore p is not true”), which is generally not very high, can increase if ‘real world’ contextual elements enhance a listener’s belief in the high utility of problem content (Bonnefon, 2012). Thus, adding the contextual qualifier “Thomas is very hungry” to the inference “if the seller comes nearby, Thomas will buy some food; Thomas did not buy food” considerably increases the likelihood to reach the logical conclusion that “the seller did not come nearby”.

Content utility affects reasoning by influencing people’s assessment of the probability that problem content is true (Oaksford & Chater, 2009). Probability here does not refer to objective facts but rather to a person’s degree of belief in the possibility that events can happen. This probabilistic view of reasoning takes into consideration the fact that the world is highly unpredictable and consequences of actions are never completely certain (Oaksford & Chater, 2009). According to this idea, “if p, then q” holds a probability of being true that is equivalent to the conditional probability of q given p. In this model, the estimation of the probability of q – given p – is proposed to be positively correlated to the utility of “if p, then q”. Consistent with this suggestion, in the ‘seller’ example used above, the contextual qualifier (“being very hungry”) considerably increased the desirability to perform the action (“buying food”) if an opportunity allowed it (“a seller passing nearby”). This increased people’s belief in the high probability that, if the action was not performed, it can only mean that there was no opportunity for it (¬p
given – q). The effect of utility is observed on conditional syllogisms of the type “if p, then q” but also on categorical syllogisms of the type “some As are Bs; no Bs are Cs; therefore some As are not Cs”. The conclusion of such syllogisms will be more strongly endorsed if people attach a high utility to the premises “some As are Bs” and “no Bs are Cs” (Oaksford & Chater, 2001).

The principal factor that determines utility of problem content is prior knowledge about the world (e.g., about preferences of the agents involved in the reasoning problem; Bonnefon, 2012). Other factors, notably emotionality, can also play a role (Perham & Oaksford, 2005). In reasoning problems, negative emotional contents can have lower utility since the state of the world they evoke is not desirable; Perham and Oaksford (2005) have thus suggested that a ‘regret factor’ accounting for this negative effect should be taken into account when estimating content utility. This might account for some findings of reduced logicality about negative emotional content (Blanchette, 2006; Blanchette & Leese, 2011; Blanchette & Richards, 2004).

Negative emotional content, however, might also have higher utility if it provides information about how to avoid negative outcomes and how to increase well-being and safety (e.g., If this baby puts his fingers into the power socket, he will get electrocuted). In addition, when negative emotional content is reminiscent of past experiences and matches subjective experience, utility and probability of accepting the truthfulness of the statement should be high. Thus, compared to non-victims, victims of sexual abuse should strongly endorse experience-related inferences, such as “If a woman is sexually abused, then she feels unsafe”; they should perform better on logical deductions related to such statements.

Another theoretical model has proposed that the relevance of the contents has a central impact on reasoning. Evans’ heuristic-analytic theory (2006) suggests that in the first step in reasoning, heuristic processes generate one hypothetical possibility (epistemic mental model) based on the information presented as well as prior knowledge. Crucially, according to Evans’ theory, the relevance principle states that this hypothetical possibility will be the most relevant in the context. This will often be the most probable or most believable possibility. If the context is more broadly defined, this means emotion can orient the construction of this initial mental model. The relevance principle would suggest that emotional possibilities are more likely to be included in this initial model, given that emotion signals relevance.

Utility of problem content is not the only factor that might account for the positive effect of integral emotional content on reasoning performance. In the following section, we address the contribution or problem-solving utility.

**Problem Utility**
While reasoning is often understood just as a tool necessary to improve knowledge and make better decisions, Mercier and Sperber (2011) have proposed that reasoning serves a more specific purpose, namely, supporting argumentative communication. According to this model, the function of reasoning is (1) to improve the quality of logical arguments in order to convince others and (2) to evaluate the quality of others’ arguments in order to decide whether conclusions are supported or not. An important implication of this model is that reasoning performance should be sensitive to the situation in which reasoning takes place, in particular if the situation promotes argumentation. Argumentation may be more broadly related to the importance or consequentiality of reasoning in different circumstances. We suggest that certain situations lead individuals to devote more cognitive resources to the reasoning task, maybe when topics are particularly self-relevant.

The argumentation hypothesis of Mercier and Sperber (2011) suggests that several steps are involved in deductive reasoning. First, previously held beliefs are activated and compared to the information presented in the logical problem in order to interpret the problem. When incoherences exist between old and newly communicated information, participants try to find counterarguments. If they cannot find counterarguments they agree with the conclusion of the problem. Critically, the process of finding counterarguments has a high cognitive cost and its efficiency is function of participants’ motivation (Mercier & Sperber, 2011).

Contextual factors that increase motivation are key to predict participants’ performance at abstract reasoning tasks. For instance, when put in an argumentative setting (such as a group debate), people become more motivated to prove a conclusion wrong; the time they spend finding counterarguments increases and their logical performance improves (Mercier & Sperber, 2011). We suggest that emotional relevance is another critical motivational factor to consider. Emotional situations are pertinent to individuals’ goals. For instance, personal experiences of sexual abuse evoke strong emotions because they pose a threat to psychological integrity and severely disrupt basic beliefs about security and sense of worth. Motivation for reasoning about relevant emotional content should thus be considerably enhanced. There is some evidence consistent with this idea in the social psychology work on persuasion. For example Petty and Cacioppo (1979) examined participant’s ability to generate counterarguments in the context of an explicit persuasion attempt. Participants for whom the topic was more personally relevant (e.g., proposed changes in regulation affected them personally) generated more counterarguments than participants for whom the topic was less personally relevant (e.g., the same proposed changes affected another school). Thus, self-relevance may increase the amount of cognitive effort allocated to the reasoning task, and this may affect the outcome.
According to the argumentation hypothesis, the boost in motivation promoted by emotional content should be especially strong when reasoning about inferences inconsistent with prior emotional experience. Indeed, beliefs that result from intense emotional experiences are likely to be very resilient and difficult to challenge. Information inconsistent with those beliefs might be perceived as provocative and result in strong motivation to generate counterarguments (Mercier & Sperber, 2011).

Information consistent with beliefs resulting from prior emotional experience might be less strongly challenged, resulting in less motivation to generate counterarguments. Alternatively, if belief-consistent information leads to a bias into searching validating arguments (rather than counterexamples; see the selective processing model of belief bias; Evans, Handley, & Harper, 2001), information consistent with prior emotional experience may boost motivation to find validating examples for believable conclusions. This suggests that differential effects may be observed for emotional problems with valid and invalid conclusions.

New analyses on those of our data where believability was manipulated revealed some patterns consistent with these suggestions. In participants close to the London terrorist attacks (Blanchette et al., 2007) and in victims of sexual abuse (Caparos & Blanchette, 2013), the advantage observed with emotionally relevant material appeared to be present mostly in the non-believable valid condition. This could indicate that participants made more efforts to find counterarguments and realised that they could not find any, and thus ended up correctly endorsing the apparently invalid conclusions as being indeed valid. In addition, in one study of sexual abuse, the believable invalid condition appeared to be the only condition in which logical performance was worse in victims than in controls. This could indicate that, when the argument was believable, victims made fewer efforts to find counterarguments, or more efforts to find validating arguments (Evans et al., 2001), and thus have been less able to detect invalidity. Note that the trends observed in the abuse study did not reach significance, possibly due to the small number of participants. We are currently collecting more data to confirm these initial findings.

In sum, both problem-solving utility (motivation) and content utility might improve logical deduction with problems involving integral emotional content. The effect of problem-solving utility might be especially strong when reasoning about problems involving emotional material that is inconsistent with prior emotional experience.

Unresolved Issues and Future Work

We have presented empirical data that are consistent with the hypothesis that integral emotions have a positive impact on reasoning and we suggest that this may be
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linked to utility. There are, however, some inconsistencies across studies in the precise form taken by this positive impact.

First, whereas veterans reasoned more logically about combat-related contents in absolute terms (i.e., performance was better for combat-related than for neutral content), sexual-abuse victims reasoned more logically about abuse-related contents only in relative terms (i.e., while performance was worse for abuse-related than for neutral content, this difference was smaller for victims than for controls). It is possible that the ‘regret factor’ proposed by Perham and Oaksford (2005), namely, the general decrease in utility associated with negative contents, was greater for abuse-related than for combat-related content, making the base-level utility lower for the former than for the latter.

A second limitation concerns the terrorist attack study where there was a positive impact of integral emotion only for problems where logic and belief conflicted but not overall. This finding might be predicted if the positive effect of emotions in the terrorist-attack study operated through problem rather than content utility, since positive effects of problem utility might be greatest for non-believable valid material, where participants make more efforts to find counterarguments and realise that they cannot find any (see above). In any case, future work will be necessary to examine more directly the contribution of utility in its different forms to the effect of emotions on reasoning. Studies could include actual measures of utility for problem content, for instance by using subjective ratings of problem material. Problem-solving utility may also be examined, for instance by measuring the time spent processing the information before providing a response. Work is also needed to understand other dimensions of emotional processes that moderate the effects. One important dimension may be the difference between more short term emotional episodes, such as reactions to the terrorist attacks, and more long term consequences of events. It will be important to take a closer look at the distinction between more or less successful adaptations following the potentially traumatic events. Specifically, we are trying to disentangle the relative effect of “normal” negative emotional reactions and less adaptive reactions, such as those characterizing PTSD. The former may be positively related to trauma-related reasoning while the latter might not.

Finally, we also need to examine more closely the components in cognitive processes that are mediating the effect of emotion on reasoning. As mentioned previously, the generation of counterexamples has been proposed as a key step in the reasoning process, and one that may be importantly modulated by problem utility. It is also the case that emotional information inherently attracts attention and may be more readily retrieved from memory which would increase the likelihood that it influences this first stage in the argumentation process.
Conclusion

In conclusion, emotions do not just exert disruption on the reasoning process. When the affective reaction is relevant to the semantic contents reasoned about, emotions may have a positive impact on reasoning and this effect may be mediated by utility, where both utility of problem content and utility of reasoning are increased. Emotions are an essential factor to consider in new paradigms in the psychology of reasoning.
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