

Recalling emotional experiences affects performance on reasoning problems

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Abstract

We report effects of affective recollections on performance in two logically identical, content-rich reasoning problems. The between-groups manipulation entailed requesting a written autobiographical recollection of an event in which research volunteers had been cheated, had been the beneficiary of another's altruism, had been happy, or had been angry. The reasoning problems were two published variants of the Wason selection task: "cheater detection" and "altruist detection". Subjects who recalled having been cheated or angry performed significantly better on the cheater detection problem than those who recalled being happy or benefited, and those who recalled being benefited did significantly worse on the altruism detection problem than the other groups. We discuss the relevance of these results to the proposition that emotions are functional operating systems that facilitate situation-appropriate cognition.

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1. Introduction

If affective states are evolved components of the psyche, they have presumably been shaped by a history of natural selection to have adaptive functions. A common interpretation of the adaptive significance of moods and emotions is that they are "operating modes" in

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which certain kinds of behavior, and the detection and processing of certain kinds of information, are prioritized and facilitated (e.g., Buss, 2000; Cosmides & Tooby, 2000; Haselton & Buss, 2000; Nesse, 1990; Öhman & Mineka, 2001). Emotions are usually distinguished from moods by the duration of the feeling state and the contextual specificity in which they are manifested.

Research supporting the interpretation of feelings as facilitators of domain-specific information processing primarily concerns relatively “low level” perceptual and attentional processing of feared stimuli, such as snakes and spiders, which occur even when one is unaware of the nature of the stimuli because of a backward-masking procedure (e.g., Öhman & Mineka, 2003). However, emotionally laden experiences may affect “higher level” deductive reasoning and decision-making processes, too. Here, we report results of experimentally elicited written autobiographical recollections about being cheated or angry or benefited or happy, on performance in two logically identical, content-rich reasoning problems. We assume that the autobiographical task elicits the emotions experienced in the situation described in the recollection, albeit weakly, as well as activating some of the information-processing mechanisms associated with the recalled situation.

The reasoning task we used (Wason, 1966) has been at the center of debates about domain specificity and evolutionary adaptation in human reasoning. It entails informing subjects that four cards each contain one piece of information (which can be characterized as P or not-P) on one side, and another piece of information (Q or not-Q) on the other, and asking which of four cards with P, not-P, Q, and not-Q on their exposed faces must be turned over to test for falsifications of the proposition “if P, then Q.” The correct answer is cards P and not-Q. Imbuing logically equivalent versions of this problem with different content affects people’s ability to solve it. Cosmides (1989) demonstrated that a “cheater detection” framing, in which the task is to identify those who have taken benefits to which they are not entitled, facilitates performance, and argued that this is because cheater detection is a real-world problem that had significant fitness consequences in ancestral environments. Ensuing debate has focused on the specificity of this and other content effects (e.g., Cheng & Holyoak, 1989; Sperber, Cara, & Girotto, 1995), but there is no doubt that substantial content effects exist.

Victims of cheating are vulnerable to further exploitation unless they change their expectations and behavior (Axelrod, 1984; Fehr & Gächter, 2000). Thus, being cheated may facilitate vigilance for subsequent cheating, and we therefore predicted that recalling an episode in which one had been cheated would arouse a state facilitating solution of a cheater detection version of the Wason task. This is a risky prediction because such problems are already among the most readily solved (Cosmides, 1989; Cosmides & Tooby, 1992).

Anger is a response to victimization of oneself or others whom one values, which mobilizes attentional and information-processing resources and motivates actions to deter future victimization (e.g., Cohen, Nisbett, Bowdle, & Schwarz, 1996; Daly & Wilson, 1993; Damasio, 1994; Lerner, Goldberg, & Tetlock, 1998; Price, Cosmides, & Tooby, 2002). On the premise that anger is a central component of affective responses facilitating cheater detection, we hypothesized that merely recalling being angered might also facilitate performance, albeit perhaps less strongly than recalling being cheated, since the latter recollection entails priming content-congruent cues as well as recollections of being angry.

To test the specificity of the hypothesized effects, we also tested subjects on an additional Wason problem, and we asked other subjects to recall happier experiences. Brown and Moore (2000) reported that an “altruist detection” Wason problem is also easily solved, so we compared the effects of recalling being cheated or being angry versus being a beneficiary of altruism or being happy, on both cheater detection and altruist detection performance. If these manipulations facilitate problem solving because of general associative processes or the “congruency” of emotional “valences” (e.g., Forgas, 1995; Russell, 2003), one might expect symmetrical effects of the two framing manipulations on performance on their respective content-similar problems. However, this was not our prediction; we did not expect facilitation of altruism detection after content-relevant recollection, because it seems unlikely that being a beneficiary of altruism increases the utility of vigilance for subsequent altruism in the same way that being a victim of cheating increases the utility of vigilance for subsequent cheating.

There may be individual differences in vigilance for failures of reciprocity. Murstein, Cerreto, and MacDonald (1977) proposed that “individuals can be placed on a continuum according to the degree to which they believe equity of exchange should characterize their relationships,” and Sprecher (1992) further subdivided “exchange orientation” into concern about being “underbenefited,” which means being exploited or cheated, and concern about being “overbenefited,” which is presumably aversive because of anxiety about indebtedness. We included Sprecher’s (1992) scales to assess whether these putative personality dimensions would account for any of the variance in cheater or altruist detection performance.

2. Methods

2.1. Subjects

Participants were 122 McMaster University students (68 women, 54 men; average age 19.9 ± 2.7 years S.D.), who volunteered as partial fulfillment of an introductory psychology course requirement.

2.2. Recollection task manipulation

All participants were asked to recall an event in their lives and write about it on a blank page that was provided. Alternative instructions about this task constituted the independent variable. Participants in the cheated condition ($n = 45$) were asked to write anonymously about a situation in which “someone cheated or swindled you”; those in the angry condition ($n = 33$) about “some event that made you particularly angry”; those in the benefited condition ($n = 21$) about an occasion “when you were the recipient of some altruistic act, that is, when someone did something for your benefit but not their own”; and those in the happy condition ($n = 23$) about “some event that made you particularly happy.” Everyone was instructed to “try to recall how you felt at the time and to relive the moment as vividly as possible.”

At the end of the session, they were asked to indicate on the back of the research package whether this autobiographical recall task successfully evoked the feelings they described. For

those who indicated yes, their anonymous stories were subsequently read by a set of 7 independent judges (3 men and 4 women) who also were undergraduate psychology students at McMaster University. These judges rated each story, using Likert scales, with respect to each of 11 emotional states. A score of 1 indicated that the story did not convey the specified emotion very well and zero not at all, whereas a score of 5 indicated that the story conveyed the specified emotion very effectively. The judges were “blind” to the hypotheses, the experimental condition, and the sex of the author.

2.3. Wason selection problems

After being allowed 10 min to complete the recollection task, subjects solved two Wason problems, presented in random order: a cheater detection problem from [Cosmides \(1989\)](#), and an altruist detection problem from [Brown and Moore \(2000\)](#). People have been found to perform much better on both of these problems than on abstract Wason tasks.

In the cheater detection problem, subjects read a paragraph about a fictitious culture in which eating “cassava root,” a purported aphrodisiac, is a privilege restricted to married men whose status is revealed by facial tattoos. “If a man eats cassava root (P), he must have a tattoo on his face (Q).” Subjects were told that each card represents one man, and “Your task as a member of this society is to determine who is breaking the law.” The task was to indicate which of four cards—eating cassava root (P), eating molo nuts (not-P), tattooed (Q), and not tattooed (not-Q)—must be turned over to catch potential lawbreakers. On one side of the card is information about what the man is eating, and on the other side whether he has a tattoo. The correct answer is to check men who are eating cassava root (P) for the requisite tattoo, and men who are not tattooed (not-Q) to see whether they are eating the banned food; molo nut eaters and tattooed men cannot be violating the law and therefore need not be checked.

In the altruist detection problem, the story involves selecting a trustworthy baby-sitter to care for your infant upon returning to work from maternity leave, on the basis of information about their work as volunteers. The “if P, then Q” proposition is “if they volunteer, then they seek credit,” and the task is to locate someone who volunteered (P), but did not seek credit (not-Q), on the premise that someone who volunteers without seeking credit is genuinely concerned about the welfare of others and is thus a superior candidate. One side of each card tells whether a candidate has done volunteer work (P) or not (not-P) and the other side whether they had sought credit (Q) or not (not-Q). The “falsifying” combination P and not-Q is the genuine altruist, and hence the preferred baby-sitter.

2.4. Exchange orientation scales

[Sprecher’s \(1992\)](#) underbenefiting exchange orientation (UEO) and overbenefiting exchange orientation (OEO) scales each consist of 18 Likert-scale items (1 = *sounds not at all like me* to 7 = *sounds very much like me*), with pairs of items within each scale having similar content domains. We divided these pairs to create a 9-item pretest version and a 9-item posttest version of each scale, then mixed up the UEO and OEO items to create two 18-item

scales. Subjects completed the 18-item pretest scale before the autobiographical task divided them into experimental groups, and the posttest scale after.

2.5. Procedure

Subjects worked through the tasks in groups of 10 to 25 persons, well-spaced in a 64-seat classroom, with the exception of two groups ($n_s=6$ and 10), who were run in a 14-seat seminar room. Each participant received a booklet containing all the measurement instruments, including the blank page on which to write the autobiographical recollection, and was unaware that there were experimental groups with different instructions for this task.

Subjects worked privately and quietly, but were collectively instructed aloud when to proceed to the next task. They had 10 min to complete the autobiographical recall task, and 2.5 min for each of the two Wason tasks. At the end of the session, they were asked to indicate whether the recollection task had successfully evoked the feelings they described.

3. Results

3.1. Effect of experimental condition on the Wason problem performance

Fig. 1 portrays the percentages of subjects in each experimental condition who correctly solved each of the two Wason problems.

Overall, 56.6% of the 122 subjects correctly solved the cheater detection problem, with a significant effect of condition [$\chi^2(3)=9.7, p=.02$]. As predicted, those who were instructed to recall being cheated did best, and those in the angry condition did next best. There was no

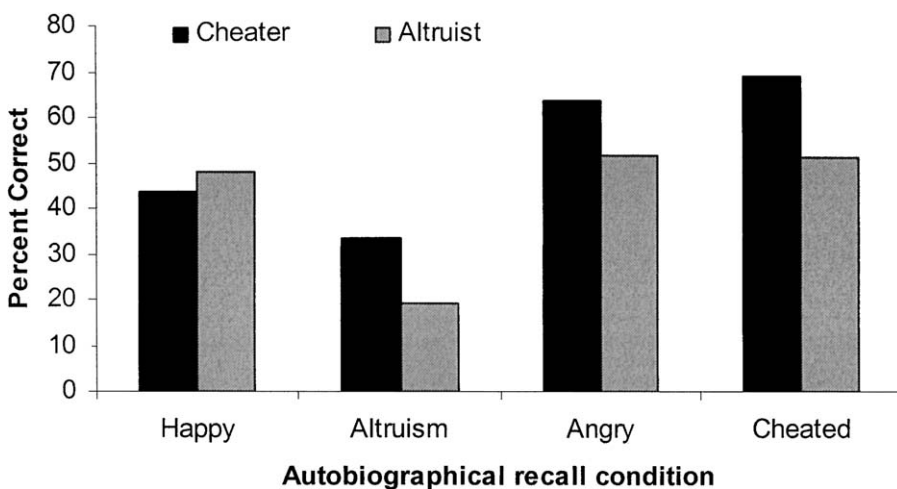


Fig. 1. Percent correctly solving the cheater detection (black bars) and altruist detection (hatched bars) social reasoning problems in four experimental groups who had recalled different sorts of emotional experiences.

significant difference between the cheated and angry conditions (68.9% and 63.6%, respectively), nor between the benefited and happy conditions (33.3% and 43.5%). However, there was a significant difference [$\chi^2(1)=9.0$, $p=.003$] when the benefited and happy conditions were combined (38.6% correct) and contrasted with the combined cheated and angry conditions (66.7% correct).

Overall, 45% correctly solved the altruism detection task, with a condition effect that was not quite significant [$\chi^2(3)=7.03$, $p=.07$]. Surprisingly, the only apparent group difference lay in the fact that subjects in the benefited condition, who had been specifically instructed to recall being the beneficiaries of “altruism,” performed worst. There was no significant difference between the cheated and angry conditions (51.1% and 51.5%, respectively), but there was a statistically significant difference [$\chi^2(1)=4.05$, $p=.04$] between the benefited (18.2%) and the happy (48.0%) conditions. Comparison between the combined cheated and angry conditions (51.3% correct) and the combined benefited and Happy conditions (34.1%) was still not quite significant [$\chi^2(1)=7.0$, $p=.07$].

Both problems were solved correctly by 32.8% of subjects. In the combined cheated plus angry conditions, 41.5% got both correct, compared to just 18.2% of those in the combined benefited plus happy conditions [$\chi^2(1)=6.65$, $p=.01$].

There were no effects of the order in which the two Wason problems were presented.

3.2. *Deductive reasoning errors in the cheater detection task*

If subjects were indeed trying to falsify “if P, then Q,” they should have focused on men eating cassava root (P) and those without tattoos (not-Q). Oaksford et al. (1996) computed a “falsification index” reflecting to what extent subjects comply with this normative approach: The index is defined as the sum of correct P and not-Q choices minus the sum of not-P and Q choices. The average falsification indices for the four conditions were not significantly different [$F(3,118)=2.24$, $p=.088$], although the cheated condition had the highest value (1.44 ± 1.0) and the angry condition (1.27 ± 1.2) second highest, as predicted, and both were higher than the happy condition (1.00 ± 1.1) and the benefited condition (0.76 ± 1.2). This falsification index was significantly different [$F(1,120)=5.74$, $p=.018$] when the conditions were collapsed with a mean of 1.37 ± 1.05 for the combined cheated and angry conditions and 0.89 ± 1.13 for the combined benefited and happy conditions.

One sort of reasoning error is to seek confirmatory (P plus Q) cases, rather than falsifications. An index of such a confirmatory tendency is the sum of P and Q minus the sum of not-P and not-Q. The average values of this index were not significantly different among conditions [$F(3,118)=1.5$, $p=.22$; cheated: 0.16 ± 0.8 ; angry: -0.06 ± 0.8 ; happy: 0.13 ± 1.1 ; benefited: 0.48 ± 1.0]; neither was there a significant difference when the conditions were collapsed into two sets of combined conditions [$F(1,120)=1.81$, $p=.181$].

3.3. *Emotional evocation of the autobiographies*

Upon completion of the protocol, 62.3% of the participants indicated that the recollection task was effective in reminding them of how they had felt, but a logistic regression indicated that

responses to this question were unrelated to Wason task performance. Those in the combined cheater and angry conditions who agreed that their recollection evoked the feelings reminiscent of the event ($n=42$) solved the cheater detection problem correctly in 62% of the cases, while those who said no ($n=36$) solved it correctly in 72% of the cases; 35% of those in the combined happy and benefited conditions who agreed ($n=34$) that the recollection was effective solved the cheater detection problem correctly, as did 50% of those who said no ($n=10$).

The altruism detection problem was also solved about equally well by those who did and did not agree that the recollection task was effective, for both the combined happy and benefited conditions [agreed: 35%, $n=37$, and disagreed: 30%, $n=10$; $\chi^2(1)=0.76$, $p=.38$] and for the combined cheated and angry conditions [agreed: 48%, $n=42$, and disagreed: 54%, $n=37$; $\chi^2(1)=0.57$, $p=.45$].

For the stories rated by the independent judges, the average ratings for the 11 emotional states (Table 1) were logically consistent with the autobiographical task, even though the judges were blind to the experimental condition. A multivariate analysis with Tukey's HSD post hoc comparisons indicated that all ratings for 11 emotion adjectives except proud ($p=.06$) were significantly ($ps<.05$) different for the angry and cheated conditions versus the happy and benefited conditions. Within these latter positively valenced conditions happy, grateful, and proud were significantly different for the happy and benefited conditions. Within the negatively valenced conditions, angry and disappointed were significantly different for the angry and cheated conditions; otherwise, they were rated similarly.

3.4. Exchange orientation scores

Subjects' initial scores on the overbenefiting (OEO1) and underbenefiting (UEO1) exchange orientation scales were not statistically significant predictors of solving the cheater detection problem, but the autobiographical framing condition was (logistic

Table 1
Average judges' ratings (\pm S.D.) of emotions conveyed in the autobiographical portrayals, according to the experimental condition happy, benefited, angry, and cheated

Emotion adjective	Happy ($n=18$)	Benefited ($n=16$)	Angry ($n=18$)	Cheated ($n=24$)
Happy	4.8\pm0.3	3.9\pm1.1	0.7 \pm .02	0.8 \pm 0.3
Grateful	2.2\pm1.4	4.7\pm0.3	0.3 \pm 0.7	0.2 \pm 0.3
Proud	2.3\pm1.7	0.9 \pm 0.7	0.1 \pm 0.2	0.1 \pm 0.2
Angry	0.3 \pm 0.2	0.3 \pm 0.2	4.5\pm0.4	3.9\pm0.9
Annoyed	0.2 \pm 0.3	0.4 \pm 0.6	3.5\pm1.2	3.5\pm1.0
Resentful	0.05 \pm 0.07	0.1 \pm 0.1	2.7\pm1.0	2.8\pm1.1
Betrayed	0.001 \pm 0.03	0.1 \pm 0.1	2.8\pm1.8	2.9\pm1.3
Hurt	0.2 \pm 0.4	0.2 \pm 0.5	3.0\pm1.7	2.7\pm1.4
Disappointed	0.2 \pm 0.1	0.4 \pm 0.7	2.2\pm1.2	3.1\pm0.8
Deceived	0.01 \pm 0.03	0.1 \pm 0.1	1.9\pm1.5	2.4\pm1.4
Frustrated	0.1 \pm 0.2	0.5 \pm 1.0	3.2\pm0.7	2.8\pm0.8

Values in a bold font were significantly different from those in regular font, and the italicized bold font indicates a significant difference from the nonitalicized bold.

regression: UEO1 $p = .23$; OEO1 $p = .11$, experimental condition $p = .016$). However, OEO1 predicted whether the altruism problem was solved correctly, whereas UEO1 score and experimental condition did not (logistic regression: UEO1 $p = .40$; OEO1 $p = .04$; experimental condition $p = .07$). Those who solved the altruist detection problem correctly had higher OEO1 scores (mean 5.3 ± 0.60) than those who did not (5.1 ± 0.67); a high OEO score may be interpreted as reflecting concern that one not be indebted to others.

4. Discussion

As predicted, subjects who recalled being cheated did better on a cheater detection reasoning task than those who recalled happier experiences. This result might be attributed to general “cueing” or “priming” effects of content similarity, but (again as predicted) there was no such positive effect of recalling being a beneficiary of altruism on altruist detection. Indeed, subjects in the benefited group actually did worse than others, a result that we did not predict and for which we have no ready explanation, but which certainly speaks against a domain-general facilitatory effect of content similarity. In the absence of any framing or priming manipulation, [Brown and Moore \(2000\)](#) found that 50% of undergraduate subjects at another Canadian university solved this altruism detection problem correctly, a value close to that obtained in three of our four groups; this suggests that our “benefited” manipulation actually impaired performance, rather than that the other conditions facilitated it.

We had an independent set of three male and four female undergraduates read a subset of the anonymous stories. They identified the relationship of the protagonists to the author, and the content and circumstance of the events, and they rated each story on a 5-point Likert scale according to relevant bipolar emotions while blind to the author’s sex and experimental condition. These judgments confirmed that subjects complied with the request to describe a personal recollection about being cheated or angry or benefited or happy. Subjects in the angry group did not write stories about being victimized by cheaters, but they did well on the cheater detection problem, supporting the possibility of a facilitatory role of anger on information processing in this social domain. We did not have an adequate sample size to evaluate the effects of the various contexts and parties portrayed in the anger stories on the two reasoning problems they were asked to address. The judges rated the autobiographical stories in the anger condition as portraying significantly more anger than in the cheated condition, and this difference likely reflects differences in the feelings of the people when they wrote about their recollections.

In normal circumstances, anger presumably influences the thought processes of others, as well as those of the angry individual. Displays of anger are attention getting (e.g., [Öhman, Lundqvist, & Esteves, 2001](#)) and memorable (e.g., [Gilboa-Schechtman, Erhard-Weiss, & Jeczemien, 2002](#)), suggesting that the targets of anger make considerable cognitive investments in detecting and processing its cues, as they should do if angry people might inflict high costs. As for the angry party, anger is a high-risk emotion in that it motivates one to engage in punitive responses that could entail costs to self. We would therefore expect that in most circumstances angry people, rather than being in a “blind rage,” are sophisticated

processors of information indicative of the dangers or potential costs inherent in social situations. Being cheated and angry are probably associated with good reasons for enhanced social vigilance, while being benefited or happy are not.

Our results indicate that oppositely valenced emotional episodes are not equally effective in facilitating solution of these social reasoning problems, but further research is required to determine how content specific the emotional modulation of inferential processing may be. The emotion manipulation produced similar effects on both reasoning problems with the negative emotion groups performing best and those who recalled being the beneficiaries of altruism performing worst (Fig. 1), so although the effects were emotional state specific, they were not demonstrably reasoning problem content specific. On the other hand, even greater specificity might also be anticipated; for example, fear should facilitate the detection of threats but not necessarily the detection of free-riding cheaters who are not themselves fear inducing. Fear might also facilitate performance on the altruist detection problem used here because failures of detection supposedly placed one's child in jeopardy, but we might not expect fear to facilitate performance on just any altruist detection problem.

In addition to content effects, the probability of solving Wason problems can be affected by familiarity, context, perspective, and the personal palatability of the conditional proposition (e.g., Dawson, Gilovich, & Regan, 2002; Johnson-Laird & Byrne, 2002; Sperber & Girotto, 2002), and to this list, we have now added a framing task of recalling an emotional episode. Our results do not address questions about logical reasoning in general, but they do suggest that recalling emotionally laden events can affect the recruitment of mental operations relevant for reasoning about potentially costly situations. We encourage researchers to take an adaptationist perspective on the emotional modulation of information processing. Such an approach would be consistent with recent critiques (e.g., Cosmides & Tooby, 2000) of the view that emotions and cognitions are functionally separable mental processes.

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