highly relevant especially for predicting the *consequences* of revenge. McCullough et al. omitted this work – perhaps because of its misclassification as "catharsis" research. The findings are readily accommodated by Konečni's anger-aggression bidirectional-causation (AABC) model and can be usefully incorporated in an adaptationist view of revenge.

It is commendable that the authors of this excellent adaptationist account of an important aspect of human social interaction are concerned that "for some crucial questions about the revenge and forgiveness systems […] data are scant" (McCullough et al., target article, sect. 7, para. 2). However, this is not entirely accurate. The main objective of this commentary is to discuss some very relevant experimental work on revenge that has apparently escaped the attention of McCullough et al., in the hope that these neglected findings and the associated theoretical ideas can be usefully incorporated into their broad view.

Unlike the majority of findings cited by McCullough et al., the work in question is not from the domain of economic games, which is significant given the external-validity doubts that can be raised about games research with regard to the genuineness of participants' motivation and, especially, emotion. Instead, the data come from social-psychological behavioral experiments published in the1960s and 1970s (in top-tier journals), in which ecologically powerful procedures were used that the subsequent human-research regulations made difficult to implement. Furthermore, some of these experiments dealt with issues that may arise in long-term human dyadic relationships; such data may contribute to the authors' complex analysis of repeated "effective updating" (sect. 3.1.1, para. 2).

The key questions are these: What are the behavioral and emotional *consequences* of revenge? How might these outcomes influence both the avenger's (AV) and the initial offender's (IO) computations of the present and future costs and welfare tradeoff ratios (WTRs)?

Most of the data come from a three-stage research paradigm: (1) IO's offense against AV (such as insults); (2) AV's behavioral retaliation against IO (such as fictitious electric shocks); and (3) obtaining dependent measures of AV's arousal, anger, and *additional* behavioral aggression against IO. These experimental results are informative about the short- and longer-term, both internal (sympathetic arousal, rated anger) and external (additional aggressive behavior), consequences for AV (and for IO as the target of any additional aggression) of the retaliatory actions previously executed by AV against IO.

To summarize the data which have been obtained *as a function of revenge*:

1. A sharply *reduced* amount of *immediate* (*additional* – that is, post-revenge) *aggression by AV against IO* (and also against substitute or "scapegoat" targets) – not only in comparison with the behavior of would-be avengers who did not have a prior opportunity for retaliation (Doob & Wood 1972; Konečni & Doob 1972; Konečni & Ebbesen 1976), but also of those who were required to perform tasks (math problems) that minimized the likelihood of anger-producing rumination (Konečni 1975a). In fact, even observing the IO (allegedly) in pain (Bramel et al. 1968) or (allegedly) hurt by someone else (Doob & Wood 1972) decreased the amount of retaliatory aggression directed by the offended person at the culprit.

2. A significantly *decreased level of AV's physiological arousal* (that had been sharply raised by IO) compared to various control groups (Hokanson & Burgess 1962; Hokanson et al. 1963; Hokanson & Shetler 1961). Revenge decreases physiological arousal quickly. More generally, because aggressive responses apparently succeed in terminating noxious stimulation emanating from others more effectively than other responses, *ceteris paribus*, they acquire arousal-reducing properties (Konečni 1975a; Patterson & Cobb 1971).

3. Auxiliary findings that are theoretically congruent with those in point (2) have also been obtained: As a function of behavioral revenge against IO, avengers display a restored affinity for complex stimulation (Konečni et al. 1976) and a reduced level of alcohol consumption (Marlatt et al. 1975).

4. A significantly *lower level of AV's self-rated anger*, compared to participants without a retaliatory opportunity, but, importantly, *as high a level of AV's dislike for IO* as that observed in appropriate control participants (Konečni 1975a; Konečni & Doob 1972).

The entire observed pattern of findings, (1) to (4), can be accommodated by Konečni's (1975a; 1984) anger-aggression bidirectional-causation model (AABC). The model also predicts, because of the data in the above-mentioned points (2) and (4), that the *future* execution of aggressive acts by AV against IO would be more likely in long-term dyads (and occur sooner in the offense-revenge sequence): The original angry, righteous avenger may become an anger-free ("cold-blooded") bully who strikes with little or no provocation. Such pre-emption complicates the computation of long-term WTRs beyond what McCullough et al. have proposed for revenge, possibly with large errors along the long road of adjustment or even a complete breakdown of the relationship (often with dire consequences). *Retaliatory pre-emption* – an unprovoked attack camouflaged as retaliation for an (imaginary) offense – is also relevant for the computation of "indirect [third-party] deterrence" (sect. 3.1.2).

Another important fact – predicted by the AABC model – that should influence the computations by both AV and IO is that the *amount* of revenge is strongly affected by the random arousal-related circumstances in which the initial offense occurs. Specifically, the amount of revenge has been observed in experiments to increase as a function of additional (*unrelated*) stressors that are present concurrently with, or immediately following the initial offense. When AVs do strenuous physical exercise (Zillmann et al. 1972) or listen to loud and complex tones (Konečni 1975b), their retaliation against IOs is more severe than that performed by controls. Therefore, from both AV's and IO's computational perspective, the context of the initial offense is important – as is the perceived intentionality of both the offending and vengeful actions.

The research described above has been largely ignored – for various (bad) reasons. It was pigeonholed as "catharsis" and falsely related to the outmoded "hydraulic" model of Freud and Lorenz, or to Aristotle's "pity and terror" – but, significantly, not to Plato's correct judgment of the benefits of revenge. There was the dubious idea that watching boxing films, fantasy aggression, or children attacking inanimate targets (none of these genuine *vengeful* activities) should reduce aggression – yet the opposite, and correct, result is predicted by the AABC model. A slew of inadequate experimental procedures has been used to disprove straw "catharsis" hypotheses and reach the socio-politically desirable conclusion that "aggression breeds aggression" (something easily achieved, according to AABC). Fortunately, sound evolutionary thinking (in the target article) has finally imposed a reality check on wishful thinking.

## The fuzzy reality of perceived harms

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**Abstract:** We review two subjective (mis)perceptions that influence revenge and forgiveness systems. Individual differences predict more (e.g., narcissism) or less (e.g., empathy) revenge, with the opposite pattern for forgiveness. Moreover, differences in victim versus perpetrator perceptions can influence revenge and forgiveness systems, perpetuating never-ending cycles of revenge. These two examples point to the need for

theories of revenge and forgiveness to address the role of cognitive and motivational biases in the functionality of such behavioral responses.

When it comes to revenge and forgiveness, there is no black and white world where harms are objective. Perceptions matter, whether the misperceptions of individuals who overestimate or underestimate their deservingness of benefits, or misperceptions that stem from the fuzzy nature of "who started it." Such misperceptions can exaggerate harm, and ultimately lead to miscalibrated revenge responses relative to initiating circumstances. Theories of revenge and forgiveness must account for cognitive and motivational processes that serve to inflate or reduce perceptions of harm.

First, what happens when individuals consistently miscalibrate their estimations of others' welfare tradeoff ratios (WTRs) toward the self? Although McCullough et al. touch on the role of individual differences, they mainly focus on ones related to physical strength (e.g., sex), which directly maps onto one's ability to enact revenge. However, individual differences in the propensity toward revenge and forgiveness cannot all be explained this way.

For example, it is likely that people scoring high on the personality trait narcissism overestimate others' WTRs toward themselves, and if so, they would perceive continual violations of these expected WTRs. This would lead to over-active revenge systems to try to increase others' regard for their welfare. Practically, this would manifest itself as increased sensitivity to others' harms to the self, over-reactive anger responses, and a lower likelihood of forgiveness, each of which are correlates of narcissism (Exline et al. 2004; McCullough et al. 2003; Rhodewalt & Morf 1998). Although in past research males often scored higher than females in narcissism, such sex differences are small and are becoming smaller over time (Twenge et al. 2008). And most research on narcissistic anger and aggression finds that these effects occur independently of sex (Twenge & Campbell 2003). Thus, narcissists should be likely to see themselves as deserving of unquestioning respect, and to (mis)perceive violations of their expected WTRs, regardless of sex. This rules out the possibility that such individual differences are only explained by the power to successfully enact revenge.

Similarly, people high in dispositional empathy may chronically miscalibrate their WTRs in the opposite direction, and have under-active revenge systems and over-active forgiveness systems (Macaskill et al. 2002; Stuckless & Goranson 1992). This could make these individuals ripe for potential exploitation, leaving open questions about the evolution of such individual differences. Again, although there are sex differences in self-reported empathy, these differences disappear in physiological measures (Eisenberg & Lennon 1983; Lennon & Eisenberg 1989). Thus, it is unlikely that empathy is associated with less revenge and more forgiveness because empathic individuals are less able to successfully enact revenge. A number of other personality variables are also consistently associated with more or less revenge and forgiveness (Mullet et al. 2005).

One way to explain such individual differences in revenge and forgiveness may be to consider the role of interdependence (see sect. 4.2, para. 2). For example, those scoring high in narcissism see themselves as less interconnected and interdependent with others (Konrath et al. 2009), and do not place a high value on relationships (Foster et al. 2006). Thus, they may not be concerned about the relational costs of enacting revenge for even minor perceived transgressions. Because they are always on the lookout for new and better relationship partners (Campbell & Foster 2002; Campbell et al. 2002), the potential to lose current partners might not bother them too much. However, even if this were the case, it would only explain their *individual* motivations for being overly vengeful, and not the *evolutionary* function – unless this type of behavior offered them some sort of survival or reproductive advantage.

Other misperceptions are also important to consider. For example, how do differences in victim versus perpetrator perceptions influence revenge and forgiveness systems? Victims and perpetrators do not always see eye-to-eye on the impact of harms, such that victims perceive harms as having continuing implications for their relationships, whereas perpetrators perceive harms as being isolated incidents without long-lasting implications for their relationships (Baumeister et al. 1990; Zechmeister & Romero 2002). Given such discrepancies in perceptions of harms, victims may retaliate against perpetrators to deter future harms, but these actions may in turn be seen as overreactions or unjust by initial perpetrators, which can ironically lead to feelings of victimization in them. Thus, the roles of the victim and perpetrator can easily reverse and perpetuate cycles of revenge (Schumann & Ross 2010; Stillwell et al. 2008). In other words, when both parties' perceptions of the harms are not calibrated, revenge cycles may be initiated.

McCullough et al. touch on counter-revenge as a cost to revenge and the "echo effect," but more elaboration is needed. When victims and perpetrators are in revenge cycles, how do these cycles end if their actions are driven by (mis)perceptions? What triggers forgiveness in these cycles? Or, at what point do relationships simply dissolve? Also, what is the evolutionary function of revenge cycles?

Victims may seek revenge to change perpetrators' WTRs toward them. However, because perpetrators may also see themselves as victims, they may also try to increase avengers' WTRs toward them. Thus, both victim and perpetrators may feel compelled to increase their retaliation level in order to change WTRs, which can cause irreparable damages to relationships and make it surprising that forgiveness ever occurs at all. Perhaps one function of revenge cycles is to give individuals an opportunity to assess the value of their relationships, so that they can withdraw from potentially unproductive ones (Kearns & Fincham 2005). That being said, it is also possible that revenge cycles may be more likely to occur *after* individuals have already decided to dissolve a relationship. In other words, such misperceptions might be more common in the presence of unproductive relationships, and may serve as a catalyst toward dissolution.

We have reviewed two subjective (mis)perceptions that may influence revenge and forgiveness systems, pointing to the need for theories of revenge and forgiveness to address the role of cognitive and motivational biases in the functionality of such behavioral responses.

## On the differential mediating role of emotions in revenge and reconciliation

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**Abstract:** McCullough et al. suggest that revenge and forgiveness rest upon risk computation. Risk computation is implemented by emotions that evolved for additional functions, giving rise to phenomena such as betrayal aversion and taboo-tradeoffs, and specific patterns of forgiveness we have documented. A complete account of revenge and reconciliation should incorporate broader constructs from social psychology, including emotions and values hierarchies.

McCullough et al. analyze revenge and reconciliation in terms of computation of risk and the welfare tradeoff ratio (WTR). Their functional analysis does not clarify how these mechanisms are implemented, but suggests that the same computational psychological mechanisms are always involved. This leaves out a significant component of a complete account.