



Time-dependent changes in altruistic punishment following stress

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Summary Decisions are rarely made in social isolation. One phenomenon often observed in social interactions is altruistic punishment, i.e. the punishment of unfair behavior by others at a personal cost. The tendency for altruistic punishment is altered by affective states including those induced by stress exposure. Stress is thought to exert bi-directional effects on behavior: immediately after stress, reflex-like and habitual behavior is promoted while later on more far-sighted, flexible and goal-directed behavior is enhanced. We hypothesized that such time-dependent effects of stress would also be present in the context of altruistic punishment behavior. Healthy male participants ($N = 80$) were exposed to either a grouped stress test or a control condition. Participants were tested in prosocial decision making tasks either directly after stress or 75 min later. Altruistic punishment was assessed using the Ultimatum Game. General altruism was assessed with a one-shot version of the Dictator Game in which an anonymous donation could be offered to a charitable organization. We found that stress caused a bi-directional effect on altruistic punishment, with decreased rejection rates in the late aftermath of stress in response to ambiguous 30% offers. In the Dictator Game, stressed participants were less generous than controls, but no time-dependent effect was observed, indicating that the general reward sensitivity remained unchanged at various time-points after stress. Overall, during the late aftermath after acute stress exposure (i.e. 75 min later), participants acted more consistent with their own material self-interest, and had a lower propensity for altruistic

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punishment, possibly through upregulation of cognitive self-control mechanisms. Thus, our findings underscore the importance of time as a factor in simple, real-life economic decisions in a stressful social context.

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1. Introduction

Human decisions are often made in the context of social interactions (Fehr and Fischbacher, 2003). Balancing self-interest and altruistic preferences, people sometimes voluntarily decide to forego monetary benefits in order to punish violations of social norms (altruistic punishment) (Fowler, 2005). This enforcement of social norms by punishing non-reciprocity may even occur at a personal cost and generally does not yield any obvious material benefits. One approach to examine such responses to fairness is the Ultimatum Game (UG) (Güth et al., 1982). In the UG, two players must divide a sum of money, with one subject proposing the specific division. The other subject then decides to accept or reject this offer. If the offer is accepted, the sum is split as proposed. If it is rejected, neither player receives anything. The UG thus measures strategic social decisions about resource allocation and can be used to assess altruistic punishment behavior by determining how rejection rates depend on the absolute offered amount or on the offered percentage of the stake.

Several studies have suggested that altruistic punishment strategies and social decision making induce an emotional response. Thus, unfair offers in the UG elicited higher emotional arousal as measured by skin conductance responses (van't Wout et al., 2006), and also elicited activity in the anterior insula (Sanfey et al., 2003), a brain area involved in negative emotions (Phillips et al., 1997). Also, rejection of unfair offers in the UG was accompanied with an increase in alpha-amylase (Takagishi et al., 2009). Conversely, stress and emotion are known to alter altruistic punishment strategies and social decision making (Takahashi, 2005). For instance, sadness induced by a movie clip resulted in increased rejection rates of unfair (but not fair) offers in the UG (Harle and Sanfey, 2007), a finding that was later replicated and accompanied by increased activation of the anterior insula (Harle et al., 2012). Also, cortisol levels in response to stress were found to correlate positively with egoistic decision-making in emotional moral dilemmas (Starcke et al., 2011).

Studies have already shown that stress affects various cognitive domains including memory, attention, decision making, and social reward systems (Henckens et al., 2009; van den Bos et al., 2009; Wolf, 2009; Merz et al., 2010; Starcke and Brand, 2012) including social approach behavior (von Dawans et al., 2012). It has increasingly become evident that stress-induced changes in behavior may follow a distinct temporal pattern (de Kloet et al., 2005). Thus, immediately after stress, individuals rapidly adjust behavior to promote instrumental and habitual short-term behavior (Schwabe et al., 2010). This process most likely involves catecholamines and the fast (non-genomic) effects of corticosteroids (Joels and Baram, 2009). In contrast, later on – in the late aftermath of stress – behavior is assumed to aim at restoring higher cortical functions, with more flexible behavior to meet long-term goals (Diamond et al., 2007; Williams and Gordon, 2007). Using hydrocortisone administration, these

late restorative effects of stress have been ascribed to genomic corticosteroid actions (Henckens et al., 2010). We hypothesized that changes in altruistic punishment strategies under stressful conditions may also follow a time dependent course. Specifically, we expect that acute stress may result in more habitual and less goal-directed behavior, which could be expressed as stronger emotional reactions to unfairness and consequently higher impulsive rejection rates in the UG. By contrast, later on, an increase in deliberative and goal-directed behavior is expected to lead to enhanced cognitive control and therefore reduced rejection rates of perceived unfair offers. Alternatively, altruistic punishment could be considered as an act of self-control rather than an impulsive response to unfair treatment (Nowak et al., 2000; Knoch et al., 2006, 2008). According to this idea, a responder may reject unfair offers in the UG to prevent a reputation of being easily exploitable and to enforce social norm compliance at the cost of failing to maximize economic self-interest. Thus, rejecting unfair offers would require an inhibition of the impulse to maximize economic interests (Knoch et al., 2006; Yamagishi et al., 2009).

To our knowledge, no published studies have directly investigated the time-dependent effects of acute social stress on altruistic punishment. Therefore, eighty healthy male participants were exposed to either a grouped stress test (Grouped Trier Social Stress Test, TSST-G) or a control condition (von Dawans et al., 2011). Social decision making was assessed either directly after stress (incompatible with genomic actions of corticosteroids) or 75 min later (sufficiently long to allow the development of gene-mediated events) using a 2 (stress/control) × 2 (early/late) between-subjects design. It is possible that stress-induced changes in altruistic motivations may result in a non-specific inclination to reward others (von Dawans et al., 2012), and social evaluation has been found to increase money allocation (Takagishi et al., 2009). Such altruistic rewarding (as opposed to altruistic punishment) could confound the interpretation of the UG results. As a control test, we therefore measured the altruistic inclination using a one-shot version of the Dictator Game (DG). In this simplified version of the DG, a second party is the passive recipient of the proposer's offer and therefore cannot reject it. The magnitude of allocated amount in the DG is considered a proportional measure of altruism because there is no direct personal gain for the proposer (Kahneman et al., 1986; Rilling and Sanfey, 2011). To measure altruism beyond the interpersonal and economic domain, we chose a variant of the DG in which an anonymous donation could be offered to a charitable organization (Moll et al., 2006).

2. Methods

2.1. Participants

Male adult healthy participants were recruited ($N = 80$, Table 1). The study was approved by the Utrecht Medical Center

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