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Review

Why stress and hunger both increase and decrease prosocial behaviour

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Abstract

Humans are regularly in suboptimal psychophysiological states like stressed or hungry. Previous research has made both claims that such impairments should decrease and that they should increase prosocial behaviour. We describe the overarching theoretical reasoning underlying these opposing predictions. Then we discuss empirical research on the two impairments most frequently studied, acute stress and acute hunger, and we find that neither alters prosocial behaviour clearly in one direction. We argue that this is because even under impairments, humans react flexibly to the incentive structure of the specific social situation they are in. Hence, either prosocial or egoistic tendencies get expressed, depending on which strategy can lead to fulfilment of the need the impairment triggered.

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Prosocial behaviour, Prosociality, Stress, Hunger, Impairment.

Introduction

Throughout history, humans faced challenging conditions such as danger or scarcity. As a result, individuals regularly were — and still are — in suboptimal states of psychophysiological functioning: under stress, in pain, sleep-deprived, and hungry. Such psychophysiological impairment states go along with a need for resources to either directly rectify the state or to more indirectly help coping with it (e.g. protection, time, sleep and food).

It has been a long-standing interest in science what implications such psychophysiological impairments have for individual-level functions like cognition. Only recently, research has expanded to how such impairments might also affect social functioning. Here, prosocial behaviour has been a focus, maybe because it is particularly relevant for an individual's resources: prosocial behaviour can be broadly defined as using own resources to the benefit of others [1,2]. At the same time, showing prosociality also serves the function of receiving resources, for example, via reciprocity mechanisms that enable long-term cooperation [3]. Hence, it is plausible that psychophysiological impairments that increase a need for resources should affect an individual's prosociality.

We will exemplarily discuss the two impairments that have found most attention in recent research in their effect on prosocial behaviour: acute stress and acute hunger.[1]

Psychophysiological impairments and prosocial behaviour: The theory

What effect should psychophysiological impairments like stress and hunger have on prosocial behaviour? We can follow two lines of reasoning that lead to contradicting predictions.

On the one hand, we can follow conservation of resources theory [4] which proposes that, when under threat, humans strive to protect their own resources and acquire new ones. Psychophysiological impairments are threats that reduce the resources people have freely available and/or increase their need to obtain resources to cope. Prosocial behaviour, however, means giving away resources. Hence, conservation of resources theory would predict reduced prosocial behaviour under psychophysiological impairments. This idea is also implicit in common lay conceptions, for example, in the belief that hunger turns people 'hangry', and hence, more selfish [5**].

On the other hand, work following costly signalling theory and biological markets in humans [6] has well established that prosocial behaviour is an effective means for (longer-term) resource-building by affiliating

[1] Here, we speak about everyday psychophysiological states as humans experience them in non-catastrophic, acute situations and as they are experimentally induced in research. These states are, hence, comparatively mild. In the following, we will simply refer to "stress" and "hunger" when we mean these acute states. About states like chronic stress or prolonged starvation we do not draw conclusions.

Table 1

Acute stress.

Definition

Acute stress is an adaptive reaction to perceived threat. It goes along with increased anxiety and tension, as well as with an activation of the hypothalamic-pituitary-adrenal (HPA) axis and the autonomic nervous system (ANS) and the resulting release of cortisol and noradrenaline.

Induction in the laboratory

The most common method used to induce stress in the laboratory to study social reactions is the Trier Social Stress Test (TSST [17]; for a review see [18]). In the TSST and related protocols, acute stress is evoked by participants performing cognitive tasks under social evaluative threat (e.g. a speech or mental arithmetic in front of an audience) and/or induction of slight pain (typically due to cold water exposure).

Measurement

The degree of acute stress is most commonly assessed via participants' self-reports of psychological stress and levels of cortisol, and more rarely, alpha-amylase (as a measure of noradrenaline levels) in saliva. Sometimes cardiovascular activity is measured in addition.

with a social group. Sacrificing own resources for others' benefit helps building a reputation as a desirable cooperation partner who grants benefits to allied others [7]. Such a positive reputation, in turn, increases the chances that others return the cooperative behaviour, including resource sharing (indirect reciprocity [3]). Following this line of reasoning, in face of psychophysiological impairments, the urge to affiliate with a social group should even increase, both because social belonging is a powerful resource in itself, but also because group membership provides access to further valuable resources like support [8]. Hence, this account would predict increased prosocial behaviour under psychophysiological impairments.

Indeed, for the cases of stress and hunger either reasoning has been followed in earlier research, sometimes implicitly. For stress, on the one hand it had long been proposed that humans, similar to other animals, show a 'fight-or-flight' response to stress that makes them more hostile, and hence, less prosocial towards others [9]. On the other hand, it has been argued that people rather turn more prosocial under stress, as they aim to 'tend-and-befriend' to find affiliation and social support [10].[2] For hunger, aligned with research on self-regulation [11] it has been proposed that, in an adaptive response to body-energy resource depletion, humans attempt to keep and gain resources, and hence, reduce their prosocial behaviour [12]. However, from an anthropological perspective it has been emphasised that food sharing has been an intricate part of human societies since hunter-gatherer times and such prosociality even increases in times of (food) scarcity to maintain peaceful coexistence [13].

So, do humans behave less or more prosocial under psychophysiological impairments? Well, it is complicated, as our presentation of the state of empirical research on stress and hunger will show.

Psychophysiological impairments and prosocial behaviour: The data

Acute stress

The influence of acute stress (Table 1) on prosocial behaviour is a young and upcoming research area [cf. 14**]. We build our evaluation of the state of empirical research on studies that a) induce acute stress in adult participants in a controlled laboratory setting, b) report a physiological and/or psychological measure of stress, and c) measure prosocial behaviour.[3] We identified 19 studies that match these criteria (Table 2).

Of the 19 studies reviewed, when looking at the overall samples, seven studies [19–25] found decreased prosocial behaviour under stress, four [26–29] report increased prosociality (an effect also recently shown in children [30]), five [31-35*] describe mixed results depending on third moderating factors, and yet another three [36–38] found no behavioural differences between stress and control groups.

What to make of this? It seems there is the potential for both, decreased and increased prosociality as a response to stress. Which tendency gets the upper hand is likely to depend, we argue, on complex interactions between stress, attributes of the stress-exposed person, and crucially, the specific social situation.

Indeed, not all settings that enable acting more or less prosocial are equal. They vary, for instance, in who the recipient of prosociality is, how observable the behaviour is, or in how much cost or risk [39] is involved in being prosocial. Also when stressed, people know what they want in the sense that they are able to consistently express their preferences [40]. And we argue that they are still able to flexibly adapt to the incentive structure they are exposed to in a given situation and to prioritise their respective need fulfilment. For example, whether a stress-induced need to affiliate gets expressed or not should depend on whether in the respective situation there is the opportunity to 'tend-and-befriend' with

[2] Originally, "tend-and-befriend" behaviour has been suggested as a particularly female response to acute stress [10], while men were assumed to exhibit "fight or flight" behaviour. This suggestion has since been contested, and empirical evidence shows that while hormonal or endocrine differences that can correlate with sex might indeed influence people's behaviour under stress (see below), the original suggestion of a clear female vs. male distinction seems oversimplified.

[3] Throughout this article, we focus on behavioural measures of prosociality, that is on acts with actual consequences for the resources of the participants (rather than at self-reported behaviour intentions or prosociality-related concepts like empathy or morality). For overviews on behavioural measures of prosociality in experimental settings, see [15**, 16].

Table 2

Empirical studies on acute stress and prosocial behaviour.

Reference	Total sample analysed	Stress induction	Stress measure	Structure of prosociality measure	Overall effect of stress vs. control
Vinkers et al., 2013 [19]	N = 77 men	TSST	Self-reported stress; salivary cortisol and alpha-amylase	Dictator game	Decreased prosociality. Lower amount of money donated to Unicef in a one-shot charitable giving task when under stress. (Time-dependent results in an additional ultimatum game).
Sollberger et al., 2016 [20]	N = 79 men	TSST	Self-reported stress; salivary cortisol	Dictator game	Decreased prosociality. Lower amount of money donated in one-shot charitable giving to an environmental charity, but higher donation frequency when under stress (among those low in pro-environmental orientation).
von Dawans at al., 2018 [21]	N = 152 men	CPT; social evaluation	Self-reported stress; salivary cortisol	Dictator game; Trust games	Decreased prosociality. Less money transferred when playing a sharing game and trust games as investor and trustee with an interaction partner when under stress following either the CPT or social evaluation. (No effect of stress when CPT and social evaluation were combined).
FeldmanHall et al., 2015 [22]	N = 56 mixed-sex	CPT	Salivary cortisol and alpha-amylase	Trust game	Decreased prosociality. Less money transferred when playing a trust game as investor with a (simulated) interaction partner when under stress.
Potts et al., 2019 [23]	N = 96 mixed-sex	CPT, SECPT	Self-reported stress; salivary cortisol	Trust game	Decreased prosociality. Less money transferred when playing a trust game as investor with a (simulated) interaction partner when under stress induced by either the CPT or the SECPT.
Bendahan et al., 2017 [24]	N = 352 mixed-sex	TSST-G	Self-reported stress; salivary cortisol	Social risk game	Decreased prosociality. Less other-regarding behaviour in lottery decisions with consequences for self and an anonymous other when under stress.
Zhang et al., 2021 [25]	N = 80 women	MIST	Self-reported stress	Competition task	Decreased prosociality. More competition over money with a real interaction partner in a task where self-interest was opposed to other-interest under stress. (No effect in a cooperation task where interests were aligned).
Tomova et al., 2017 [26]	N = 66 men	MIST	Self-reported stress; salivary cortisol	Dictator game	Increased prosociality. Higher amount of money shared with an anonymous other participant under stress.
von Dawans et al., 2012 [27]	N = 67 men	TSST	Self-reported stress; salivary cortisol	Dictator game; Trust games	Increased prosociality. More money transferred when playing a sharing game and trust games as investor and trustee with an interaction partner when under stress.
von Dawans et al., 2019 [28]	N = 94 women	TSST-G	Self-reported stress; salivary cortisol	Dictator game; Trust games	Increased prosociality. More money transferred when playing a sharing game and a trust game as trustee with an interaction partner when under stress. No effect in a trust game in the investor role.

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Table 2 (*continued*)

Reference	Total sample analysed	Stress induction	Stress measure	Structure of prosociality measure	Overall effect of stress vs. control
Zhen et al., 2020 [29]	N = 64 mixed-sex	TSST	Self-reported stress; salivary cortisol	Allocation task	Increased prosociality. Higher amount of money shared with another alleged participant under stress, but only when this participant had received very little money in a dictator game by a third person before.
Nickels et al., 2017 [31]	N = 120 mixed-sex	TSST	Self-reported stress	Prisoner's dilemma; Ultimatum game	Moderator: sex. Increased prosociality under stress in women in the prisoner's dilemma, no effect in men. No significant effects in one-trial ultimatum games (proposer and responder).
Prasad et al., 2017 [32]	N = 39 mixed-sex	TSST	Salivary cortisol	Ultimatum game	Moderator: sex. Increased prosociality under stress in women who rejected less unfair offers as responders in a multi-trial ultimatum game. No significant effect for men.
Youssef et al., 2018 [33]	N = 118 mixed-sex	TSST	Salivary cortisol	Ultimatum game	Moderator: sex. Increased prosociality under stress in women, as they rejected less offers across fairness levels as responders in a multi-trial ultimatum game. No significant effect for men.
Margittai et al., 2015 [34]	N = 78 men	TSST	Self-reported stress; salivary cortisol	Dictator game	Moderator: social distance. Increased prosociality towards close others but not distant others under acute stress in a multi-trial dictator game.
Schweda et al., 2020 [35*]	N = 102 men	MAST	Self-reported stress; salivary cortisol and alpha-amylase	Dictator game	Moderator: social distance. Decreased prosociality towards distant others but not close others under stress in a multi-trial dictator game (when prosociality was measured in a take-frame).
Singer et al., 2021 [36]	N = 179 mixed-sex	TSST	Self-reported stress; salivary cortisol and alpha-amylase	Dictator game	No effect. No significant influence of stress on money donated in one-shot charitable giving for homeless people across two studies (N = 99 and N = 80).
Veszteg et al., 2021 [37*]	N = 187 mixed-sex	TSST-G	Self-reported stress; salivary cortisol	Dictator game; Prisoner's dilemma	No effect. No significant influence of stress on money transferred in a one-shot dictator game and a version of the prisoner's dilemma with an anonymous other participant.
Schweda et al., 2019 [38]	N = 202 mixed-sex	TSST-G	Self-reported stress; salivary cortisol and alpha-amylase	Intergroup prisoner's dilemma	No effect. No direct effect of the stress manipulation on money contributed to ingroup- or outgroup-members (based on political preferences).

Note. TSST = Trier Social Stress Test, TSST-G = Trier Social Stress Test for Groups, MIST = Montreal Stress Imaging Task, CPT = Cold Pressor Test, SECPT = Socially Evaluated Cold Pressor Test, MAST = Maastricht Acute Stress Test.

others that are beneficial affiliating with. We have some empirical indications that the experimental manipulation of acute stress [34, 35*] or at least increase in cortisol [38] is associated with more prosocial behaviour towards others who are close/members of the in-group, but not distant/out-group others ([41] did not find this effect but used hypothetical scenarios). Further illustrating such strategic need-fulfilment, in a situation that allowed both deciding whether to give to charity and how much, participants under stress more frequently chose to donate while the amounts they donated were smaller [20]. It seems stressed participants managed the balancing act between keeping resources for themselves and investing resources to affiliate with others by signalling generosity while actually giving away less. Hence, to understand what

Table 3

Acute hunger.

Definition
Acute hunger is caused by deprivation of sufficient food for a relevant period. It goes along with craving for food and feeling hungry and decreased levels of blood glucose.

Induction in the laboratory
Acute hunger is induced most commonly by letting all participants fast for a period of several hours (up to overnight). The control condition participants then receive a meal or glucose-drink prior to testing.

Measurement
The amount of acute hunger is ideally assessed by measuring both self-reported hunger and blood glucose levels.

effect stress will have in social situations (and whether it should be strong enough to deviate from a control condition), we need to consider the resources-related incentive structure a situation creates. That means we need to understand whether the situation entails social opportunities or demands (e.g. affiliation with others, norm-following, longer-term reputation building) and how those relate to the resource-needs the impairment evoked. Empirical research only now starts to systematically investigate such situational aspects.

Person-attributes are likely to complicate this. Different person-attributes that can influence stress reactivity have been discussed, for example, personality traits and — most prominently — sex differences [31,33]. Research so far has not isolated any person-attribute that unambiguously makes people more or less likely to show prosocial behaviour when under stress. Yet, it is reasonable to assume that a person's hormonal and endocrine make-up (that e.g. correlates with sex) influences how this person reacts to a particular social situation under stress.

Table 4

Empirical studies on acute hunger and prosocial behaviour.

Reference	Total sample analysed	Hunger induction	Hunger measure	Structure of prosociality measure	Overall effect of hunger vs. control
van Dillen et al., 2021 [42*]	N = 245 mixed-sex	Fasting (vs. no fasting)	Self-reported hunger	Dictator game	Decreased prosociality. Lower amount of biscuits shared with an anonymous other participant when hungry across two studies (N = 45 and N = 220).
Xu et al., 2014 [43]	N = 94 mixed-sex	No-glucose drink (vs. glucose drink)	None	Dictator game	Decreased prosociality. Lower amount of lottery tickets shared with an anonymous other participant after no-glucose drink.
Briers et al., 2006 [44]	N = 85 women	Food cues (vs. no food cues)	None	Dictator game	Decreased prosociality. Lower amount of money transferred to an anonymous other participant in a version of the dictator game when exposed to olfactory food cues.
Rantapuska et al., 2017 [45]	N = 101 mixed-sex	Fasting (vs. fasting + meal)	Self-reported hunger; blood glucose	Dictator game; public goods game; trust game; prisoner's dilemma	Mixed effects. No effect in one-shot charitable giving nor a public goods game. More money transferred when playing trust games as investor and trustee and a prisoner's dilemma with an interaction partner when hungry.
Fraser & Nettle, 2020 [46]	N = 370 mixed-sex	Fasting (vs. no fasting)	Self-reported hunger	Ultimatum game; public goods game	Mixed effects. No significant effects in one-trial ultimatum games (proposer and responder; N = 106).Complex pattern in multi-round public goods game (N = 264) that cannot be classified as more or less prosocial. (Hungry participants were more influenced by others' behaviour and less likely to use punishment options).

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Table 4 (*continued*)

Reference	Total sample analysed	Hunger induction	Hunger measure	Structure of prosociality measure	Overall effect of hunger vs. control
Häusser et al., 2019 [5**]	N = 795 mixed-sex	Fasting (vs. fasting + meal); natural hunger	Self-reported hunger; blood glucose	Dictator games; ultimatum game; public goods game; stag hunt game; social mindfulness	No effect/moderator. No significant influence of hunger on money or food transferred in a series of studies. Small effect of hunger reducing prosociality in non-interdependent (vs. interdependent) tasks in meta-analysis across studies.
Aarøe & Petersen., 2013 [12]	N = 104 mixed-sex	Fasting (vs. fasting + glucose drink)	Blood glucose	Dictator game	No effect. No direct influence of blood glucose level on money transferred in a one-shot dictator game to an anonymous other participant.
Harel & Kogut, 2015 [47]	N = 196 mixed-sex	Fasting (vs. fasting + meal/no fasting)	Self-reported hunger	Dictator game	No effect. No significant influence of hunger on money donated in one-shot charitable giving for people in need.
Gidlöf et al., 2021 [48]	N = 60	None	Self-reported hunger	Purchasing decision	No effect. Subjective (non-manipulated) hunger in supermarket customers did not correlate with more prosocial (sustainable) food purchases.

Acute hunger

Research on acute hunger (Table 3) and prosocial behaviour is even younger. Analogous to stress, we aimed for articles that a) use an experimental manipulation of subjective hunger and/or blood glucose levels in adult participants, b) measure subjective hunger and/or blood glucose, and c) assess prosocial behaviour.[3] Because so few studies have been published to date, we also included work that did not fully meet criteria a) or b), but were strict on c). We found nine relevant articles (Table 4).

Does hunger decrease prosocial behaviour, as conservation of resources theory and research on self-regulation would predict? Or does sharing persist or even increase under this impairment? The answer could be clearest when looking at sharing tasks with a dictator game-structure, as such tasks are included in eight of the nine articles reviewed. In these dictator game tasks, however, three articles report decreased prosociality when hungry [42*-44], while five found no effect that went beyond trends or intentions [5**,12,45–47].

It seems that also in the case of hunger, the incentive structure of the specific social situation is crucial. We think that people are able to suppress egoistic tendencies hunger might cause when they deem acting prosocially more beneficial in the respective social situation. In a small meta-analysis across our own studies [5**], we found that hunger reduces prosocial behaviour — but only to a very small degree — in non-interdependent settings, that is in 'stripped down' social situations where there is no future interaction to be expected (e.g. dictator games). In interdependent settings, that is more rich social situations that allow for reputation building (e.g. public goods games), hungry people did not behave less prosocial. This strategic aspect fits an influential study in which participants with lower blood glucose levels signalled more support for social welfare, but did not turn more prosocial in actual behaviour [12]. Relatedly, a study on consumer attitudes found higher self-reported hunger to go along with increased abstract interest in environmentally friendly food, but no translation into actual sustainable buying behaviour (- an effect the authors replicated with a hunger manipulation and hypothetical buying decisions) [48].

Further supporting the idea that the social situation is crucial, two developmental studies found that 4–9 year old children shared less in an anonymous one-shot dictator game when they were hungry [49*], while infants also when they were hungry shared their food in a situation where they were directly observing a person in 'food need' [50]. This fits a recent study in adults [42*] where knowledge about the other person being also hungry increased sharing in food-deprived participants. Indeed, people can overcome their hunger when the social situation requires them to, and do so already from childhood.

Conclusion: Flexible adaption to the specific social situation

Neither stress nor hunger alters prosocial behaviour clearly in one direction. We argue that this is because even under psychophysiological impairments, humans react flexibly to the *resource-related incentive structure* of the specific *social situation* they are in. So, when faced with increased need for resources under a psychophysiological impairment, either striving for social resources (like affiliating or building reputation) or striving for individual resources (like keeping money or food) can get the upper hand. It depends on the specific need the impairment creates (like protection by others or food) and what need fulfilment opportunities the situation entails.

Crucially, we think that this reasoning is not limited to stress and hunger: we have described before [51**] that people flexibly adapt to social incentives despite their psychophysiological impairments, including for example also sleep deprivation [52]. In that sense, the social situation, particularly when it allows obtaining social resources, can trump egoistic motivations arising from increased need for resources due to psychophysiological impairments. In such situations, we might not see a behavioural difference between impaired and non-impaired people.

The state of empirical research for stress and hunger being non-conclusive is not surprising for such young research fields. There are considerable differences between study designs (e.g. the situations allowing for prosocial behaviour), and researchers have barely even started to systematically translate those into potential moderators that can be empirically tested (which will require larger sample sizes than those currently used). We are glad to see relatively many null findings being published in this field — it will be of great help in identifying moderators. And amongst such moderators, we regard the incentive structure of the social situation to be absolutely core.

More generally, the emerging research on the effects of psychophysiological states on prosocial behaviour also enables a fresh perspective on the old debate whether humans are good or bad in their 'true nature'. When would we expect to see such 'true, natural behaviour'? When individuals are safe, calm, and saturated or when they are in a state of need and emergency? This unclarity illustrates the value of identifying specific predictors of prosociality — including psychophysiological states and social incentive structures — rather than trying to arrive at a definitive conclusion on whether prosocial or egoistic behaviour is the true expression of human nature.

Conflict of interest statement

Nothing declared.

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